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FINAL REPORT

AGRICULTURE RECONSTRUCTION AND DEVELOPMENT PROGRAM FOR IRAQ

ARDI

December 2006

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AGRICULTURE RECONSTRUCTION AND DEVELOPMENT PROGRAM FOR IRAQ

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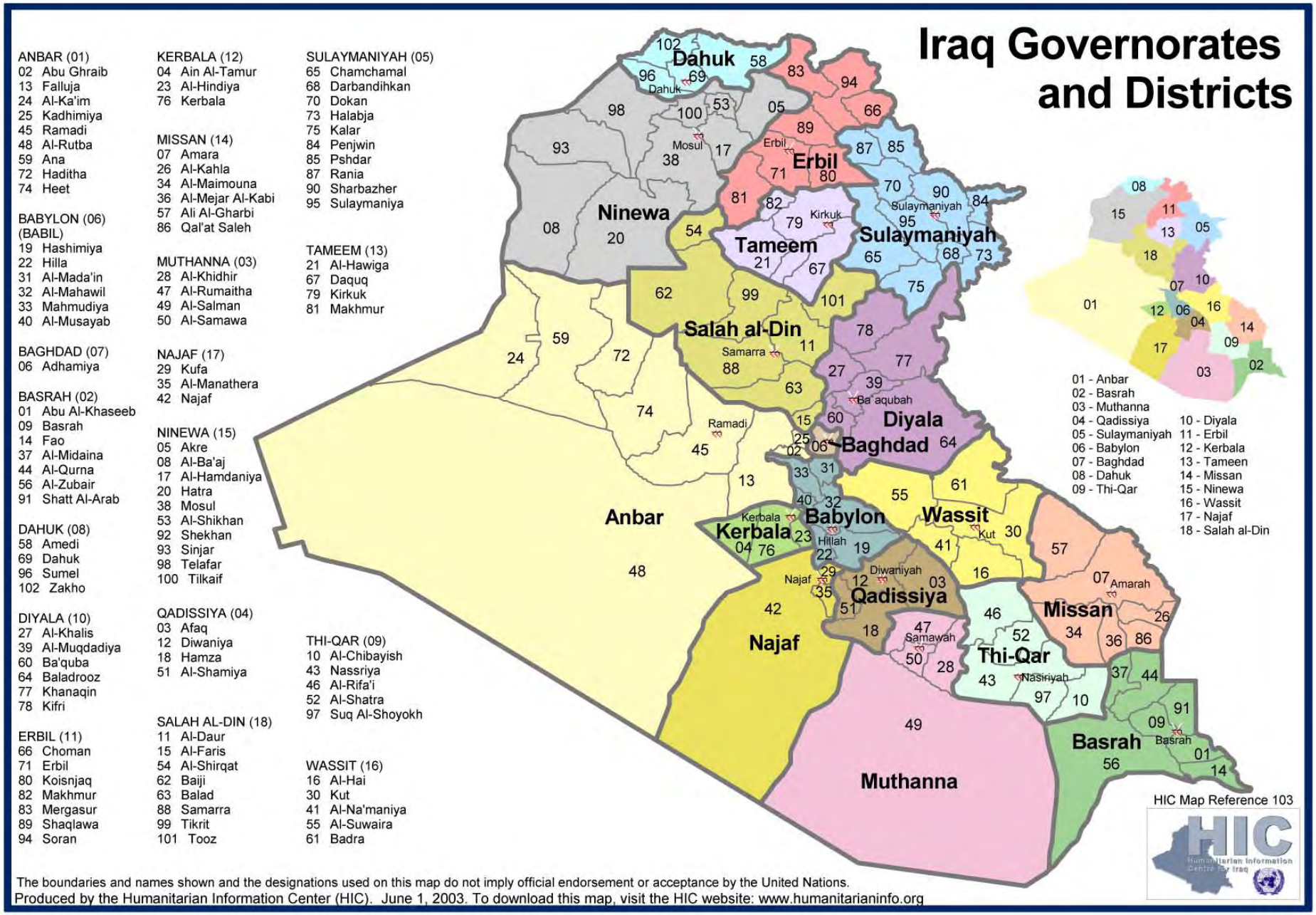
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THE FACES OF ARDI

The many Iraqis who were part of ARDI deserve personal recognition and congratulations for their contributions. Due to security concerns, they remain faceless and nameless in this report to preserve their privacy and protect their identity. This ignominy in no way denigrates or diminishes their dignity or humanity but preserves a certain anonymity to allow them to continue as ordinary citizens in this strife-torn country. They were part of the development process in an extraordinary period in the history of Iraq.

Although ARDI collected specific governorate, district, and village names with GPS coordinates for our activities, these details have been generalized in this report to protect the communities we served.

Throughout this report, we use maps like the above to indicate the governorates where the referenced activities occurred.

Farmer in Basrah.

PROGRAM AREAS IN THIS REPORT

ARDI implemented 367 discrete activities (not including individual training events). All were designed to restore and revitalize the agricultural sector, and create new employment and income opportunities for rural residents and businesses. Below is a summary of ARDI project activities by component. Chapter 1 is an Introduction and Summary of the project. More detailed descriptions of activities and results are found in Chapters 2 and 3.

Chapter 4 briefly describes the ARDI's work in Iraq's marshlands. These activities did not form a separate program component, but have been grouped together in this report for clarity. The discussion brings together the results of several activities in the areas of crop demonstrations, fisheries stocking, date palm nurseries, orchard restoration, veterinary clinics, drop irrigation, and canal cleaning into one location.

Chapter 5 presents an evaluation of ARDI's programs against contractually mandated C5 results.

Appendix A list ARDI's 367 program activities, which are organized according to the discussions in Chapters 2 and 3. Appendix B full preliminary report for the *Strategy for Water and Land Resources in Iraq* (SWLRI). Appendix C is the full version of the Marshlands Monitoring Activities report.

CHAPTER 2

PHYSICAL AND TECHNOLOGICAL IMPROVEMENTS

Agronomic Crop Production: The lack of certified seed, modern farm machinery, pest control methods, soil analysis capabilities, and affordable credit, coupled with unpredictable rainfall and security concerns, have worked to limit the productivity of Iraq's cereal crops.

Improved and cleaned seed leads to increased yields and larger harvests, producing more income for farmers. Improved seed also reduces Iraq's dependence on imported grain, saving the country millions of dollars each year in foreign exchange. ARDI provided technology, inputs, services, demonstrations of improved cultivation methods, and training in all 18 governorates to help Iraq significantly increase the yields of its cereal crops.

Mechanization: One of the major obstacles to developing a modern agricultural system in Iraq is the shortage of properly functioning agricultural machinery. More than 80% of the country's tractor stock is over 16 years old and operating at less than design capacity, which contributes to reduced yields and production.

The use of tractors increases land usage and provides for larger harvests, which results in increased income for farmers and tractor owners, who often rent their tractors during harvest season. ARDI invested in basic repairs to make the tractor fleet operable and trained mechanics to provide these services in the future. This assistance gives both farmers and agribusinesses incentives to invest private equity in a countrywide infrastructure for agricultural machinery.

High-Value Agriculture: The lack of high-quality and affordable planting stock, the reduced capacity of extension services, and farmers' reliance on traditional cultivation methods have hampered fruit and honey production in Iraq. Once orchards and apiaries begin producing, they can help increase farmer incomes, raise revenues for private agribusinesses, meet local demand, replace costly imports, and aid in soil erosion and watershed management efforts.

The program worked with the MOA and farmers to revitalize Iraq's fruit and beekeeping subsectors, which provide livelihood for hundreds of thousands of small farmers. The program established orchards and nurseries, provided seeds and seedlings, and held demonstrations to help farmers, MOA staff, and NGOs learn about improved technologies and horticultural methods.

Water Use Efficiency: The deteriorated water conditions in central and southern Iraq have damaged one of the country's most valuable resources and hurt both farmers and marsh dwellers in the region. Properly functioning irrigation and drainage systems increase land usage, provide for larger harvests, and conserve soil and water, all of which result in increased incomes for farmer.

ARDI worked with the Ministries of Agriculture and Water Resources and farmers to improve water management on agricultural lands. Activities included building the capacity of government staff to plan for the water sector and training farmers to install and operate irrigation systems. The program also directly assisted farmers by rehabilitating thousands of hectares of the country's irrigation infrastructure and increasing access to irrigation systems.

Animal Health and Livestock Production: The lack of previous extension services and breeders' reluctance to give up traditional breeding methods severely limited the productivity of this subsector, which includes thousands of Iraq's poorest farmers.

ARDI focused on working with the MOA and individual livestock breeders to increase production by introducing better breeding methods and training tens of thousands of animal breeders on improved animal care. It also rehabilitated MOA veterinary clinics, established private sector veterinary services, improved sheep dipping tanks, and implemented a large-scale Brucellosis vaccination campaign.

CHAPTER 3

INSTITUTIONAL AND ORGANIZATIONAL IMPROVEMENTS

Capacity Development: Good decisions by the public sector and a proper regulatory framework will form the basis for a sound, market-driven agricultural economy in Iraq, but these decisions must be based on good information and careful analyses.

ARDI trained public officials in such areas as statistical surveys and use of modern tools, and mentored them in advanced mapping and other technologies. Its work on extension and integrated pest management helped both the private and public sectors to move toward national programs in these areas. ARDI's work with the private sector supported the development of

NGOs, cooperatives, and private sector associations to improve the quality of agricultural products and services, while raising local incomes

The remainder of this report presents more comprehensive discussions of ARDI's activities and results. They comport with USAID's Strategic Objectives for the program:

Expanding Private Sector Economic Opportunities: physical and technological improvements: seed production, mechanization, high-value agriculture, water use efficiency, and animal health and livestock production (Chapter 2).

Improve the Capacity of National Government: agricultural information, digitized cadastral system, national extension program, integrated pest management, and water strategy (Chapter 3). This chapter also addresses capacity building activities for the country's non-government organizations, cooperatives, private professional organizations, and other private sector entities.

CHAPTER 4

Restoring the Marshlands: This Chapter discusses the major findings of the monitoring team and the activities undertaken in the marshlands to improve the lives of farmers and other marsh dwellers. Fish restocking, restoration and date palm plantation and crop demonstratiions are some of the topics in this chapter.

CHAPTER 5

C5 Results: The results to be achieved by ARDI are listed in Section C5 of the contract. This section identified a series of objectives that will be measured as results of the ARDI program in Iraq. These are discussed in the various chapters in this report. This section and the M&E section discuss these achievements in greater detail.

APPENDIX A - ARDI GRANTS AND ACTIVITIES

APPENDIX B - STRATEGY FOR WATER AND LAND RESOURCES IN IRAQ (SWLRI) *

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* Bound separately

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Volume 4	Annex 1*	*Technical Report 02*: Development of the Tigris-Euphrates Water Management System Model
Volume 4	Annex 18	*Technical Report 03*: Pilot Trial of ResPRM on Diyala Basin

These technical reports and guidance notes prepared during Phase 1 are accompanied by a number of associated models and analytical tools. Both the documents and the models are held together on a Claromentis system.

* This report and the final versions of the computer models will be submitted separately.

APPENDIX C - MARSHLANDS MONITORING ACTIVITIES

1.0 INTRODUCTION AND SUMMARY

IRAQ'S AGRICULTURAL SECTOR

Agriculture and agribusiness support nearly 7.5 million people (27% of the population) in Iraq, and these sectors' contribution to national income is second only to that of the oil industry. Iraq has the natural and human resources, management capacity, and opportunities to develop a modern and competitive agriculture sector that can satisfy much of its food needs, and export high-value products to the Middle East and beyond.

In recent decades, a combination of wars, poor government policies, and economic sanctions brought the sector to the brink of collapse. Iraq's agricultural sector, once export-oriented and able to satisfy a large portion of the country's food needs, declined precipitously. By the early part of this decade, Iraq's agricultural sector was largely decapitalized and demonetized. There was so little money in the economy that demand for goods plummeted and even maintenance of capital goods was impossible. Iraq sank into a low level economic quagmire; it had been a middle income country, but the confluence of these disastrous events brought cruel impoverishment to its population.

Conditions for the sector became especially bad during the sanctions period that followed the 1991 Gulf War, a period which reduced Iraq's gross domestic product by nearly 80%. The decline in agricultural production was particularly sharp during this period because Iraq was not permitted to purchase agricultural inputs and spare parts on world markets. At the same time, as noted above, Iraqis' purchasing power dropped dramatically, resulting in low effective demand for all products, including food crops.

By 1995, economic hardship was so severe that a humanitarian crisis was declared, resulting in the Oil for Food Program (OFF) established by UN Security Council Resolution 986. OFF had two components relevant to the agricultural sector: 1) it permitted the Iraqi Government to purchase badly needed agricultural inputs such as fertilizer, seeds, tractors, and feed grains with the objective of raising production levels to help ameliorate the humanitarian crisis; and 2) it replaced the partial food supplementation system that the regime instituted in the early 1990s with the Public Distribution System (PDS). PDS was a universal program to distribute free imported food in quantities sufficient to avert malnutrition. Every citizen of Iraq, regardless of income, received rations of food to provide approximately 2,400 calories daily. PDS eliminated the risk of mass hunger and reduced malnutrition and disease.[1] Yet the universal

[1] It is important to acknowledge that PDS, for all of its faults, saved many lives in Iraq. The economy had declined to the point where middle class professionals, who in the past had monthly salaries in the hundreds or even thousands of dollars, received monthly compensation of less than $10. Many rural residents, some estimate between 60 to 80 percent in the south, depended on PDS for all food requirements. Even worse, the economy was demonetized to the extent that PDS was for many the only form of income.

distribution of free and imported food created market distortions that essentially undercut the ability of the agricultural sector to redevelop, in spite of the resumption of imports of agricultural inputs.

USAID's Agricultural Reconstruction and Development Program for Iraq thus faced a dire agricultural situation in 2003. The challenges that ARDI and its partners in the new Iraqi Government and the private sector faced are broadly outlined below.

Iraqi farmer prepares his land for planting.

Demonetization The embargo resulted in artificially low prices of most goods and services. In 2003, agriculture in Iraq continued to suffer from market distortions caused by continuing PDS, though the consequences had lightened somewhat. Farmers had little buying power to purchase inputs needed for efficient production, and the new government could not continue the practice of subsidizing up to 80 percent of agricultural inputs. This was due to lack of funds, and because the Coalition Provisional Authority (CPA), which controlled procurements refused to permit the importation of inputs. It did not deem agricultural supplies to be a high priority. Further, CPA was reluctant to permit the Iraqi Government to subsidize inputs, even though most farmers, especially small scale farmers, had yet to recover from the sanctions period. With little cash and no access to finance, few were capable of purchasing inputs needed for good production. Consumer spending in the cities recovered more quickly than rural spending, but still unemployment contributed to low purchasing power. Iraq needed an injection of cash at all points of the economy to restart its engine of growth.

Decapitalization The former regime invested little in agriculture infrastructure and the embargo exacerbated this problem. Irrigation and drainage systems had not been maintained over the years, rendering water control and distribution difficult. Iraq's irrigated areas have declined by 30% since the 1970s, principally due to neglected or broken infrastructure. The FAO and World Bank (2003) estimated that at least 500 irrigation and drainage pumps were in critical condition in 2003 and the canal network had been substantially damaged by lack of repair and maintenance. Apart from infrastructure, other forms of capital had declined. The seed supply deteriorated, the national herd declined in quantity and quality, and orchards were neglected and not maintained. Agricultural machinery was in a sorry state, and spare parts were scarce. Soils in the south central and south became highly saline, and in some areas of Mesopotamia salinity eliminated agricultural production altogether. Human capital also suffered. For twenty years, Iraqi professionals, many of whom were highly educated, had little contact with international organizations, and few after the mid-1980s had the opportunity to study abroad. Finally, as if the debacle of the previous twenty years were not bad enough, the looting in April and May of 2003 destroyed government buildings and facilities, making the rebuilding program that much more expensive.

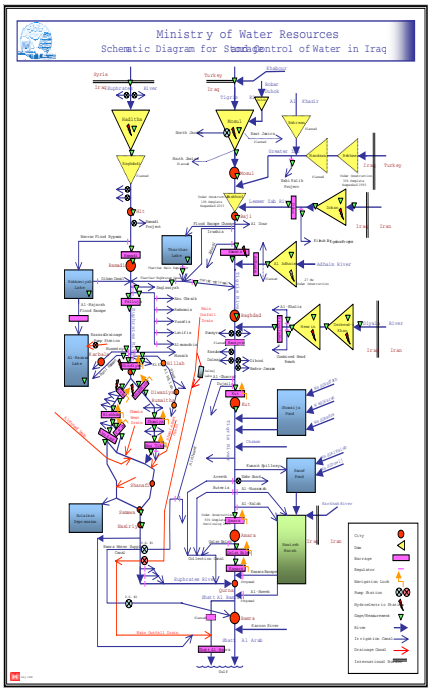
In addition to the broad problems of decapitalization and demonetization, the agricultural sector suffered from weak government services. Massive budget cuts brought about a serious decline in research, extension, animal health, production support, plant protection, and other services. At the same time, funding shortages and political animosities forced the departure of many skilled and experienced personnel.

Neglected and weed infected crops in saline soil.

Finally, the agriculture sector's most vital resource – water – slowly dwindled away. Overirrigation and other poor water management practices led to waterlogging and salinity in central and southern Iraq. An estimated 50% of the country's irrigated land – which accounts for 70% of its cultivated land and an even higher percentage of its total agricultural production – is now either saline or waterlogged. Ironically, the government systematically drained 15,000 square kilometers of the country's unique marsh habitat in the mid-1990s, destroying the livelihood of up to 100,000 farmers and fishermen who lived there.

All of this led to a general decline in productivity unprecedented in economic history. The combined forces of war, sanctions, poor government policies, and ad hoc planning reduced the productivity of all of the country's cereal and high-value crops to but a fraction of what it had been. For example, in 2003, Iraq produced only about 600 kg of wheat per hectare, while the production of neighboring countries was two to three times that amount. Such high-value crops as dates also suffered; productivity dropped from 32 kg/tree to about 10 kg/tree between 1970 and 2000 (FAO, 2003). Sanctions curtailed the export of dates, such that by 2003, Iraqi farmers and exporters sold only small amounts of date syrup and industrial products abroad.

Yet, despite the challenges and difficulties, there was and is good reason for hope. At one time, Iraq's agriculture was so productive that exports were common; in the 1970s Iraq even exported wheat. There is no reason to assume that the country cannot be transformed again into an agricultural powerhouse. There is near universal agreement that, with favorable policies and operating environments, and with sufficient and well-targeted investments, a restored and revitalized agriculture sector can help bring prosperity to millions of farmers and contribute in large measure to national recovery efforts.



Schematic of Iraq's irrigation water system.

PROGRAM OVERVIEW

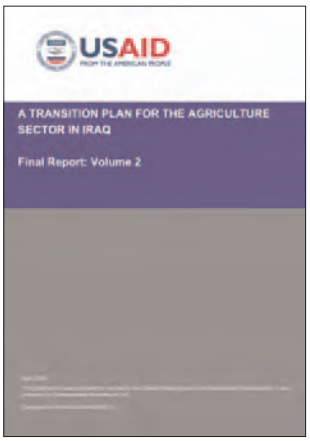
USAID's Agricultural Reconstruction and Development Program for Iraq (ARDI) began on October 15, 2003. This three-year program provided its contractors the flexibility to tackle the myriad problems noted above. Rather than focus on large-scale reconstruction activities, USAID correctly sought through ARDI to touch the lives of millions of average Iraqis throughout the country. The focus of the program was on employment generation, improvements in production and marketing to increase income, and improvement of the policy and regulatory framework to allow the sector to redevelop and recover.

Specifically, USAID sought to correct many of the Iraqi agriculture sector's ills by expanding agriculture productivity and restoring the capacity of rural agro-enterprises to produce, process, and market agricultural goods and services, as well as to improve soils and water management.

Thus, the ARDI team arrived to Baghdad with an ambitious work program. Unfortunately, ARDI's first year of funding was delayed, which forced a team restructuring and drastic alteration in the work plan. The new work plan focused on small-scale activities and key studies intended to equip the ARDI team with knowledge and on-the-ground understanding of conditions so that, once fully funded, it would be well-prepared to implement quickly a much larger set of activities, and to make targeted and strategic investments. During the first year, the ARDI team also strove to gain the confidence of both government and private sector officials. Effective implementation of a large reconstruction and development program was contingent on these important Iraqi partnerships.

One of the main products of ARDI's initial period was *A Transition Plan for the Agriculture Sector in Iraq (Volume I and II)*. Ambassador Bremer, who in February 2004 came to understand the importance of agriculture to the prosperity and security of Iraq, requested that ARDI and the MOA work together to develop a set of recommendations and guiding principles to inform those working in the agricultural sector of specific development and reconstruction needs. For more than two months, a large ARDI team worked with MOA staff, CPA officials, and private sector business people to produce the three-year plan. It became a document which provided overall strategy for ARDI interventions during the balance of the project's three years. It was also used extensively by other donor agencies and the military to focus investments in agriculture.

The *Transition Plan for the Agriculture Sector in Iraq* had two major goals. The first was to move responsibility for the sector from the Coalition Provisional Authority to the Ministry of Agriculture by 2004. When the CPA was dissolved in June 2004, attention turned to the second goal: to begin moving the sector

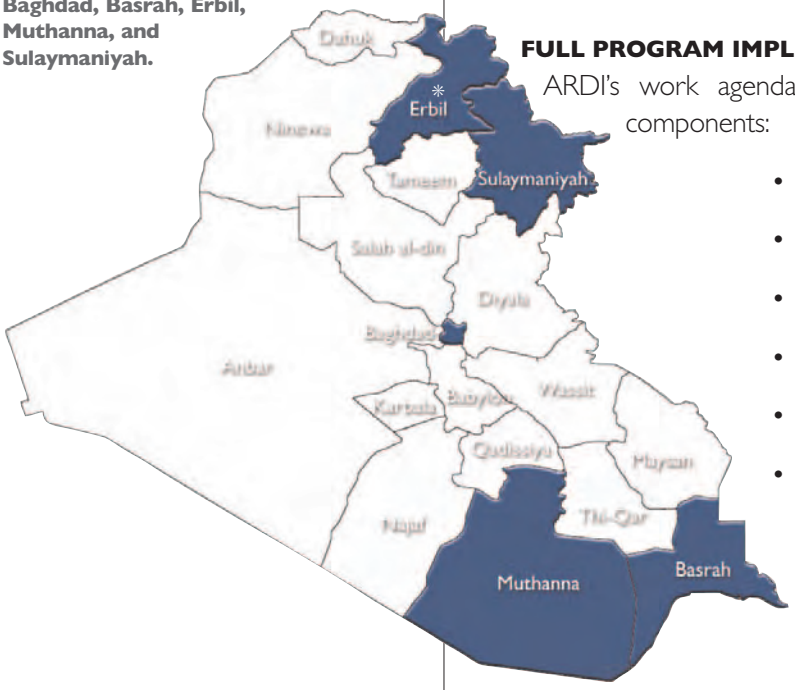


A copy of the Transition Plan for the Agriculture Sector in Iraq may be downloaded at: http://usaid.gov/iraq

from a command-and-control production and marketing system to a market-driven system within the next three to five years. Specific recommendations from the *Transition Plan for the Agriculture Sector in Iraq* are given below.

The *Transition Plan for the Agriculture Sector in Iraq* brought necessary attention to the importance of the agricultural sector to Iraq's overall economic recovery, and focused on what was specifically needed for the sector to prosper. Little by little, USAID and the CPA, followed by the US Embassy, increased the funds obligated to the ARDI contract. By mid-2004, the new Minister of Agriculture in the Interim Iraqi Government, and her staff, worked with ARDI team members to develop a coherent and timely work agenda. She presented this agenda to the US Ambassador and ARDI subsequently received full funding. For the next two years ARDI, the MOA, and other stakeholders in agriculture worked together on the strategic plan set forth in the summer of 2004.

ARDI Office Locations: Baghdad, Basrah, Erbil, Muthanna, and Sulaymaniyah.



FULL PROGRAM IMPLEMENTATION BEGINS

ARDI's work agenda, developed jointly with the MOA, had six components:

- Agronomic Crop Production
- High-Value Agriculture
- Animal Production and Health
- Crop, Soils and Water
- Government to Market Transition
- Private Sector Development

Each of these components had a manager and team charged with developing and implementing discrete projects and activities, all of which were designed to contribute to overall results as outlined in the contract. ARDI implemented three types of interventions:

1) activities implemented directly by the Technical Assistance Team usually with local partners in government, the private sector, communities, or the NGO community. An example of this type of intervention is ARDI's activity to multiply wheat seed in cooperation with the MOA;

2) grants to local groups. An example of this is a grant to a local NGO to hire hundreds of young men and women in southern Iraq to clean irrigation canals; and

3) training. ARDI trained thousands of Iraqis through field days, seminars, workshops, and formal classroom training. ARDI's Iraqi partners also took part in selected conferences and training abroad.

ARDI set up five offices around the country: Baghdad, Erbil, Samawa, Basrah, and Sulaymaniyah. Project management was centralized, first in Baghdad and subsequently, due to serious and growing security concerns, in Erbil. Activities proposed by branch office staff were vetted by component managers and their

Transition Plan Recommendations	
Short-Term Stabilization Plan 2004-2005	**Medium-Term Transition Plan 3 to 5 years, beginning in 2004**
Provide agricultural input supplies. To get the sector moving immediately, procure fertilizer, good-quality seeds, proper pesticides, and other inputs (e.g., electricity and diesel for machinery) and provide them to farmers.	***Create the appropriate policy environment.*** The government must cede control of production decisions and focus on regulation, supervision, and certification of private sector activities. Some import subsidies must be phased out, while natural resources are protected (through, for example, government provision of animal vaccines). Export restrictions on major crops and animals must also be resolved. Reform the public distribution system (PDS) for food by eliminating the market disincentives associated with the current limited and price-controlled domestic purchases and by gradually reducing the scope of the PDS plan to make it needs-based.
Reestablish the domestic market for wheat. The Ministry of Trade and the private sector should begin an orderly transition to a wheat market characterized largely by market-based private sector participation, which will lead to farmers receiving international prices for wheat.	***Enable public sector capacity to support a market-based agricultural economy.*** The rules of engagement between the private and public sectors should be reconstructed to ensure that production, marketing, and processing are safe for humans and the environment, and that farmers' rights are protected. This includes developing and implementing regulations, training government officials, and developing their capacity in policy and economic analysis.
Reclaim the natural resource base. To halt natural resource degradation, drainage systems should be rehabilitated immediately and short-term improvements made to on-farm irrigation. The MOA should focus on rehabilitating on-farm canals and strengthening extension services.	***Programs for the development of the sector.*** 1) The MOA should establish the capability to coordinate donor activities so donors work and contribute to a common agenda, 2) Inject working capital to jumpstart the agricultural economy, 3) Test programs in wheat and sheep production and date palm restoration in two governorates and expand the successful ones nationally, 4) Develop pilot projects for the reclamation of saline soils and water resources to direct efforts to tertiary and on-farm irrigation improvements within improved land systems, 5) Work to understand how to initiate necessary changes in the land tenure system, and 6) Protect vulnerable groups (displaced families, the very poor, subsistence farmers) by reaching down into rural communities to provide needed assistance.
Rehabilitate and reequip MOA facilities. Priority should be given to reconstructing veterinary clinics in the 15 southern governorates and repairing and reequipping research and extension facilities.	***Continue the rehabilitation program.*** All facilities need to be equipped and staff trained.
Establish floor prices for maize and cotton. To avoid sharp declines in the production of these two strategic crops, the government should establish floor prices that are below international prices but high enough to give farmers an incentive to produce.	***Establish declining value floor price*** while the market recovers.

AGRICULTURE RECONSTRUCTION AND DEVELOPMENT PROGRAM FOR IRAQ

DAILY REPORT
AUGUST 24, 2006

CROPS-SOIL-WATER RELATIONSHIPS

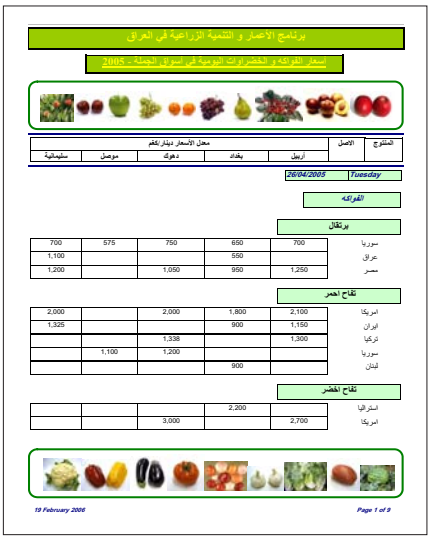
Laser Leveling System Improves Production on Fields That Use Gravity Surface Irrigation Method:

Over 90% of irrigation in Iraq uses the gravity surface method, which involves creating earth channels for water conveyance and water applications by furrows or in basins. It is estimated that over 60% of water is wasted in using this method. This considerable water loss is due in part to uneven fields, which results in uneven water distribution. Areas of high elevation do not receive sufficient water while areas of low elevation become waterlogged and prone to the buildup of salts. Crop uniformity and reduction of seeds, which are essential to high crop yields, require that soil moisture content is relatively constant throughout a field. Therefore, the fields of Iraqi farmers who use gravity surface irrigation must be as level as possible. As traditional methods of leveling a field are inaccurate, time-consuming, inconvenient and costly, ARDI is introducing farmers to a laser leveling strategy in order to help them create even fields and ultimately optimize water-use efficiency for improved cultivation.

Laser leveling requires a tractor and laser technology to shift soil from the high points of a field to the low points. The system consists of a laser transmitter placed in the field, and a laser receiver, electrical control computer and hydraulic control valve connected to a four-wheel drive tractor. The tractor is driven in a circular motion from the high areas to the low areas. The transmitter in the field emits a beam, which is intercepted by the receiver mounted on the drag moving soil across the field. This signal then goes to the control computer on the tractor, which interprets the signal and either opens or closes the hydraulic control valve in order to raise or lower the bucket. Once the tractor has covered every part of the field, it should do a final leveling, and the field should be surveyed to make sure it has been sufficiently leveled.

ARDI recently completed a three week training course to teach this process to operators of NGOs. The course began with instruction on tractor maintenance and how to assemble, operate and maintain the parts of the laser system. Participants were taught principles, methods, advantages and problems associated with laser leveling. During the

ARDI Daily Report carried a topical item of interest each day.



برنامج الإصلاح و التنمية الزراعية في العراق

سعر الفواكه والخضروات الأولية في الأسواق المحلية 2005

المنتوج	الاصل	معدل الأسعار دينار/كغم				
		أربيل	بغداد	دهوك	موصل	سليمانية
26/04/2005	Tuesday					
الفواكه						
برتقال						
سوريا		700	650	750	575	700
عراق			550			1,100
مصر		1,250	950	1,050		1,200
تفاح أحمر						
امريكا		2,100	1,800	2,000		2,000
ايران		1,150	900			1,325
تركيا		1,300		1,338		
سوريا				1,200	1,100	
لبنان			900			
تفاح اخضر						
استراليا			2,200			
امريكا		2,700		3,000		

19 February 2006 Page 1 of 9

Wholesale Market Price Reports were available via web, email, and SMS to a mobile phone.

teams and senior management, to ensure that activities or grants in each of the regional offices contributed to the overall success of the project. Regional offices had the advantages of finding and mentoring local partners, tailoring specific activities and grants to local conditions, and providing more direct monitoring and evaluation of project activities. At the same time, they were guided by the same overall work agenda and they stayed focused on the national results that ARDI aimed to achieve. Later in the implementation of the project, ARDI added a liaison office in the International Zone to facilitate contacts with USG and military colleagues.

ARDI interventions, including directly implemented activities, grants, and training, were geared towards the following five categories of achievement. These categories were consistent with specific contract results, they crosscut the component areas listed above, and they fit with the everchanging security and political conditions which ARDI faced.

- Recapitalizing the agricultural sector, with construction and equipment support to MOA offices; extension centers; rural veterinary clinics; computer, communications, and training facilities; and agro-meteorological field stations.
- Employing tens of thousands of Iraqis to reestablish agricultural capacity, create reforestation projects, and rehabilitate the irrigation infrastructure.
- Reestablishing major production programs in 1) wheat, through farmer-saved seed treatment and cleaning, procurement of certified seeds, a disease/pest elimination campaign, and tractor repairs; 2) procurement and distribution of high-yield hybrid maize varieties; 3) honey production to provide equipment and training to hundreds of beekeepers; 4) fruit production with new orchards and vineyards, and rehabilitation of existing plantations; 5) irrigation services improvement; and 6) animal health, through the rehabilitation and resupply of veterinary clinics and hospitals, and the vaccination of sheep.
- Introducing new technology through trials and demonstrations for maize, rice, salt-tolerant wheat and rain-fed wheat, orchard fruits and vineyards, and Sunn pest control; experiments on drainage and salinity control; laser land leveling; drip irrigation; buffalo and sheep reproduction; and interplanted fodder crops.
- Creating institutional development and capacity building through programs conducted with government agencies on agro-ecological zone information collection and analysis, a water resources management strategy, agricultural land ownership cadastral digitization and registration support, the collection of survey data by MOA statistical units, the collection and dissemination of wholesale market prices, integrated pest management and extension capacity, and extensive training programs. ARDI also directed considerable time and resources toward the organization and capacity building of civil society organizations, including NGOs, PVOs, and cooperatives, and helped to create the National Association of Agricultural NGOs.

FACTORS INFLUENCING ARDI'S PROJECT IMPLEMENTATION

Many of the circumstances under which ARDI operated influenced its direction, activities, and implementing partners, as well as the practices of its staff. Chief among these was the country's uncertain political and security situation. These circumstances compelled project management to remain flexible and attuned to rapidly changing conditions. ARDI management had daily briefs with security providers and political contacts to assess the feasibility and desirability of implementing certain activities in any given areas. The main factors influencing project implementation are summarized below.

- **Discontinuity in the government** The installation of the CPA-appointed governing council and the three elections held while ARDI was operating led to a series of inconsistent public policies for the agriculture sector. Between October 2003 and April 2006, the leadership of the MOA changed four times. Each of the four ministers had different visions for the sector, and views toward USAID assistance. The MOA during the Iraqi Interim Government was an excellent partner to ARDI, and most of the joint MOA-ARDI activities conducted throughout the life of the project were developed during the Interim Government period. The MOA during the Transitional Government and the current MOA are controlled by political parties and militias. While ARDI was able to continue to cooperate with Directors General on established programs, access to the Minister and deputies was difficult and dangerous. It was during the tenure of the last two ministers that ARDI with the concurrence of USAID made a deliberate decision to focus more project resources on the private sector and the nascent NGO community.

- **De-Ba'athification of the government** Much of the talent in the MOA and other ministries was dismissed under the de-Ba'athification program first promulgated by the CPA. While many officials who had been members of the Ba'ath party were initially able to remain as consultants with the MOA, subsequent purges, especially during the current government, meant that much of the institutional memory and experience base of the MOA was no longer accessible to play a role in the redevelopment and reconstruction of the sector. Most of those purged from the MOA were party members through necessity, and had no hand in the atrocities of Saddam's regime. It removed experienced and well trained talent at a time when Iraq needed it most.

- **Sectoral control** Most of the activities for all sectors in Iraq are still centrally planned, but the responsibility for the oversight of a given sector does not always lie with its ministry. The MOA is no exception. For

example, the Ministry of Trade still controls all agricultural imports and exports, with MOA concurrence, while the Ministry of Planning was responsible for agricultural statistics when ARDI began.

- **US military influence** In addition to providing the MOA with much-needed equipment and supplies, US military civil affairs advisors tried to implement development projects directly with local populations. While these were honorable interventions, and had the counterinsurgency objective of "winning the hearts and minds" of the local population, there was no overriding strategy for individual civil affairs units around the country to follow. The challenge that faced ARDI and the MOA was to provide focus so that military interventions complemented the efforts of USAID and the Iraqi Government.
- **Border issues** When ARDI began working, Iraq had no real border security, making it difficult to develop and enforce policies on quarantines, the importation of seeds, and the export of controlled items.

SECURITY: A DEFINING FACTOR

Security: A daily concern.

An explosion near a field where staff were working at a demonstration plot of salt tolerant wheat.

Early in the program, ARDI staff were able to travel widely. Staff members made low-profile trips by car to Kut, Najaf, Kerbala, Kirkuk, Tikrit, Mosul, Basrah and other major cities in the country. ARDI's security, based on information and stealth first and brute force only as a last option, relied on local information from around the country to provide detailed analyses of current security conditions. ARDI management's decision principle regarding security was that if the use of force was at all likely in order to travel or conduct a certain activity, the plan for implementation would be altered so that violence would be avoided.

By late 2004, living and working in the Red Zone of Baghdad became too dangerous. Several high-profile kidnappings of foreigners occurred close to the ARDI compound in Mansour, and ARDI's intelligence network warned of possible kidnapping attempts. ARDI Iraqi staff were also at grave risk. In addition to threats against ARDI team members local and foreign, the deteriorating

Live munition in a test field in central Iraq.

ARDI Security presence at all field activities.

security situation at that time also made it difficult for ARDI team members to meet with local partners. Local government and private sector officials had been warned not to work with Americans. ARDI management, as a result, chose to relocate to Erbil, where security was easier to maintain, and Iraqi officials could meet with ARDI staff without undue fear.

At first this move was considered temporary. But as time passed, security only continued on a downward trend, and ARDI managers moved the headquarters permanently to Erbil. While being away from the center is usually not optimal, the move to Erbil provided unexpected benefits. It gave the expatriate staff an opportunity to work closely with local stakeholders, especially in such areas as seed cleaning training and high-value agriculture crops. In addition, it provided for freer interaction with Ministry of Agriculture staff, who traveled to Erbil and stayed at program houses to work on surveys, mapping and other activities. The Minister of Agriculture, who was publicly anti-American, turned a "blind eye" to his staff traveling to program meetings and training, as well as the assistance USAID provided to the MOA. The training, conferences, and meetings held in Erbil also afforded an opportunity to individuals from government, NGOs, and the private sector, most from southern or central Iraq, to interact and collaborate in an environment that was free from the stress and danger of Baghdad. ARDI managers, often criticized for being headquartered in Erbil, noted repeatedly that ARDI was able to function as a national project precisely because it was located in Erbil and not in Baghdad. In Baghdad, ARDI managers were able to meet USAID and the embassy only. In Erbil, they were able to meet the full range of stakeholders in the agricultural sector.

The security situation led to innovative solutions for implementing activities. ARDI adopted a layered approach to delivering technical assistance, always keeping a local organization between USAID/program staff and farmers, private companies, NGOs, and such government employees as extension agents. The next section discusses this activity more fully. Implementing projects through local companies and NGOs protected both program staff and beneficiaries, while also creating income and employment opportunities for local enterprises. While many beneficiaries may have been aware that USAID was providing the funding for their activities, they chose not to acknowledge this publicly, which allowed them to continue receiving assistance safely. [2]

Nonetheless, security continued to be an overriding issue throughout the program, and such concerns will continue to dominate USAID projects in Iraq for the foreseeable future. For this reason as well, ARDI received a waiver from USAID's branding procedures (such as placing stickers on equipment), and even the faces of beneficiaries in this report have been intentionally blurred for their future protection.

[2] There were also project staff who were not cognizant that they were hired by an American organization. For example, the livestock development team had a staff of 25 animal scientists and support staff to implement a series of projects in south central and southern Iraq. Only four of this team knew that their salaries were paid by an American company on contract with USAID. This protected those staff members, and it protected the managers

LOCAL IMPLEMENTATION; NATIONAL RESULTS

DEVELOPING CAPACITY AND ENSURING THE BEST RESULTS

To the greatest extent possible, ARDI drew on local resources to implement its activities. The main exception made was on projects that required a high degree of technical sophistication.

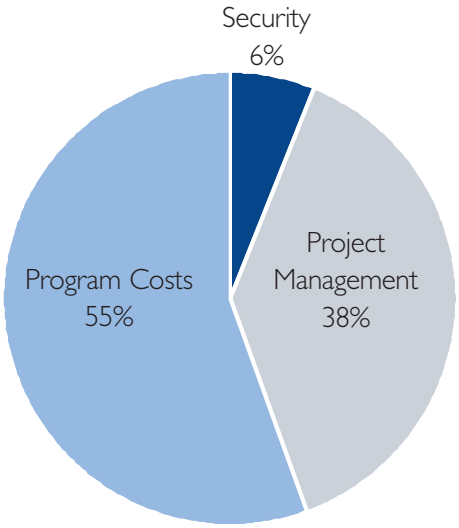
Grants to NGOs, cooperatives, and nonprofit organizations comprised 12% of the program, while the services of local companies for contracting, monitoring, procurement, construction management, tractor repair, and other activities were procured from local Iraq firms. ARDI fully implemented the USG's "Buy Iraqi" policy in the procurement of goods and services, including the provision of most training within Iraq instead of utilizing facilities in neighboring countries. The choice of local partners, whether the contracting vehicle was a grant or a Letter of Agreement (LOA) with the MOA, carried advantages to both the program and those implementing it:

- ARDI put an estimated $80,000,000 back into the local economy through contracts for equipment, construction, and other services.
- The program's activities generated jobs for 34,000 people in a given week.
- ARDI built the skills of 19 NGOs active in agriculture development; 293 agricultural cooperative members through 15 newly formed cooperative associations; 4,300 beekeepers and honey producers establishing new associations and restarting others; 233 independent pesticide dealers into a national association; and provided 526 extension specialists with participatory service delivery training.
- Ministry of Agriculture staff were also prime beneficiaries from assistance provided through the project. For example, ARDI trained MOA extension agents through a "learn by doing" methodology in the field. This enhanced the capacity of the government, improved their relations with clients, and brought new production techniques to thousands of farmers. A few days before ARDI ended, the director general of the State Board for Extension approved the participatory extension methodology that ARDI introduced.

The contributions of local program staff proved to be an invaluable addition to the program; their technical skills, language abilities, and cultural knowledge allowed them to work with a degree of autonomy, mobility, and responsibility that would not have been possible for the program's expatriate staff. The day-to-day management of all programs in the 15 governorates south of the Kurdish

Indigenous carpenters are trained to make beehives locally.

ARDI EXPENDITURES BY TYPE 2003 - 2006

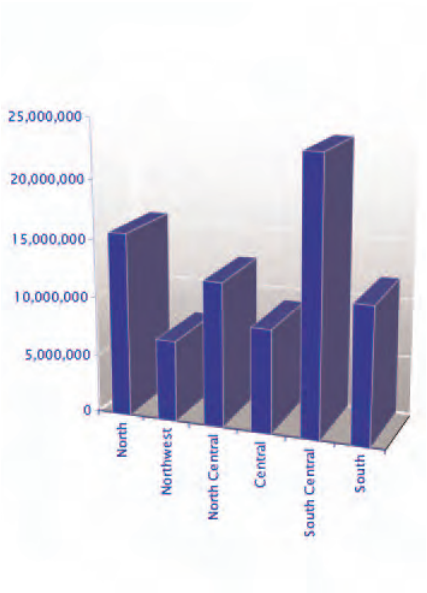


Regional Government was the direct responsibility of these staff, and most of ARDI's success in central and southern Iraq can be attributed to them.

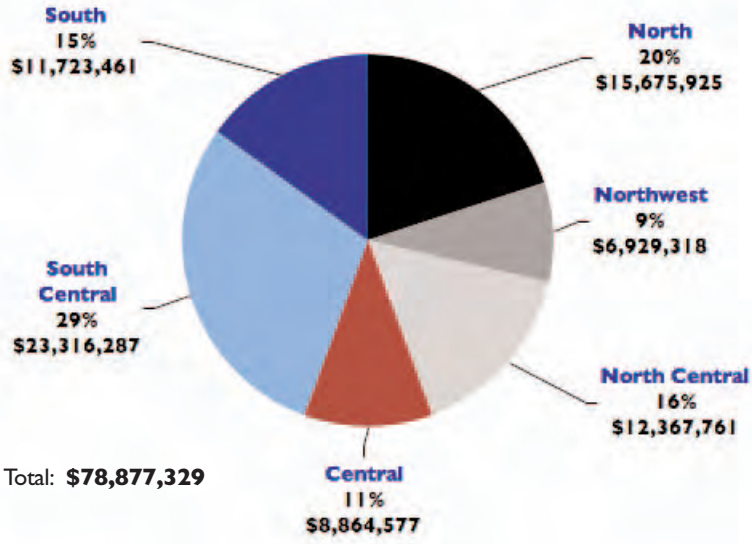
Working from regional offices, ARDI maintained the flavor and agility of a local project, but its goals and strategic focus remained national in scope. Although certain agricultural activities predominate in different geographic regions of Iraq (e.g., date palms and irrigation in the south, wheat and barley in the north), ARDI was careful to distribute its assistance as evenly as possible. The south-central region of Iraq was the largest beneficiary of program assistance.

This distribution of project activities ensured that many of the agriculture sector's most pressing problems were addressed, and also made a contribution toward ensuring the future well-being of all Iraqis.

ARDI EXPENDITURES BY REGION ($) 2003 - 2006



ARDI EXPENDITURES BY REGION (%) 2003 - 2006



Total: **$78,877,329**

IT INFORMATION TECHNOLOGIES

The introduction of information technology through internet centers enabled agricultural researchers to gain unfettered access to the world's information storehouses for the first time in years.

When ARDI set up operations in the Fall of 2003, senior staff made repeated visits to the various branches and departments of the Ministry of Agriculture, as well as institutions dedicated to agricultural development in the country, such as university schools of agriculture and veterinary services. These visits were part of the initial needs assessment surveys that would help to guide ARDI in investing in projects with the greatest impact, in terms of delivery of services for increased agricultural productivity and profitability.

It was apparent from the beginning of the project that there was a woeful deficit in the area of modern information technologies (IT) to support agricultural development. Iraq started out at a serious disadvantage for two reasons. First, years of economic sanctions made it extremely difficult for the government to purchase imported items that were deemed "non-essential" under the terms of the trade embargo. Second, the authoritarian government exercised great control

IT @ ARDI

Information technology was also a key tool for the managers of ARDI. The nationwide scope of ARDI, with five offices throughout the country, with three hundred plus staff, three ministries of agriculture and numerous other GOI institutions and subcontractors, required a significant communications infrastructure. A robust IT infrastructure was designed to link it all together electronically. Daily video conferences with the project offices allowed managers and staff to quickly share information and identify issues requiring attention. These video casts were in real time and simultaneous.

Communications was significantly enhanced with IT: almost all staff had access to computers and were trained in the use of e-mail, word processing and analysis. Web sites, file transfer platforms and relational databases were also incorporated into the IT plans.

These electronic systems also required the design, implementation and maintenance of reliable sources of power. Through the use of innovative power technologies we were able to keep the power sources running, even through the most difficult times without power from the grid.

DAI has developed a Lotus Notes based project management system (TAMIS). Not only does it provide email services it served as a database of project activity information. The staff used it for email and collaborative work. This system contains a rich data bank of detailed information on project implementation, execution and results which could be shared immediately among the staff and managers.

(and censorship) over information technologies in general, and internet operations in particular. Apart from these initial disadvantages, however, the looting that occurred soon after the military action in early 2003 was especially destructive to facilities that worked with computer technologies. Looters and thieves immediately targeted the high-value and highly portable computers and peripheral equipment without realizing that much of the goods would be essentially antiquated and useless in a more modern IT environment. During the first visits made by ARDI, even the deans of graduate schools and the Directors General of Ministry of Agriculture departments did not have computers in their offices.

ARDI contributed to the development of IT capability in a number of ways. First, ARDI made direct grants to institutions to establish basic IT support systems, such as centralized computer facilities and internet services. These support systems usually included a number of computers with printers and peripherals to support a functioning facility, furniture and other necessary items to equip a working environment, and a six-month initial subscription to an internet service provider. ARDI also provided for installation, and training for personnel who would use the facility. In rare cases, additional work was required, such as repairs to the facility (especially electrical works). A basic IT grant package included the following:

- IT Equipment, as needed: computers, printers, server, photocopier, camera equipment and appropriate software.
- Furniture/Fixtures/Equipment: computer tables, chairs and air conditioning.
- Civil and engineering works: rarely required.
- Initial installation and training to facility staff.
- Cost to Project: maximum $100,000.
- Sustainability considerations: Beneficiary to hire and train personnel to operate and maintain new IT facilities.

A second way that ARDI contributed to the dissemination of new information technologies was by ensuring that essential IT support was included in grants and assistance packages when that support would contribute significantly to the successful outcome of the overall project. This support was offered for two principal reasons:

1) to contribute to institutional development, such as expanding capacity of agriculture-oriented NGOs and other organizations; and
2) to assure the success of discreet project activities, such as provision of Geographical Information Systems (GIS) handsets and training to map essential information gathered through farm surveys or community-level education and extension activities.

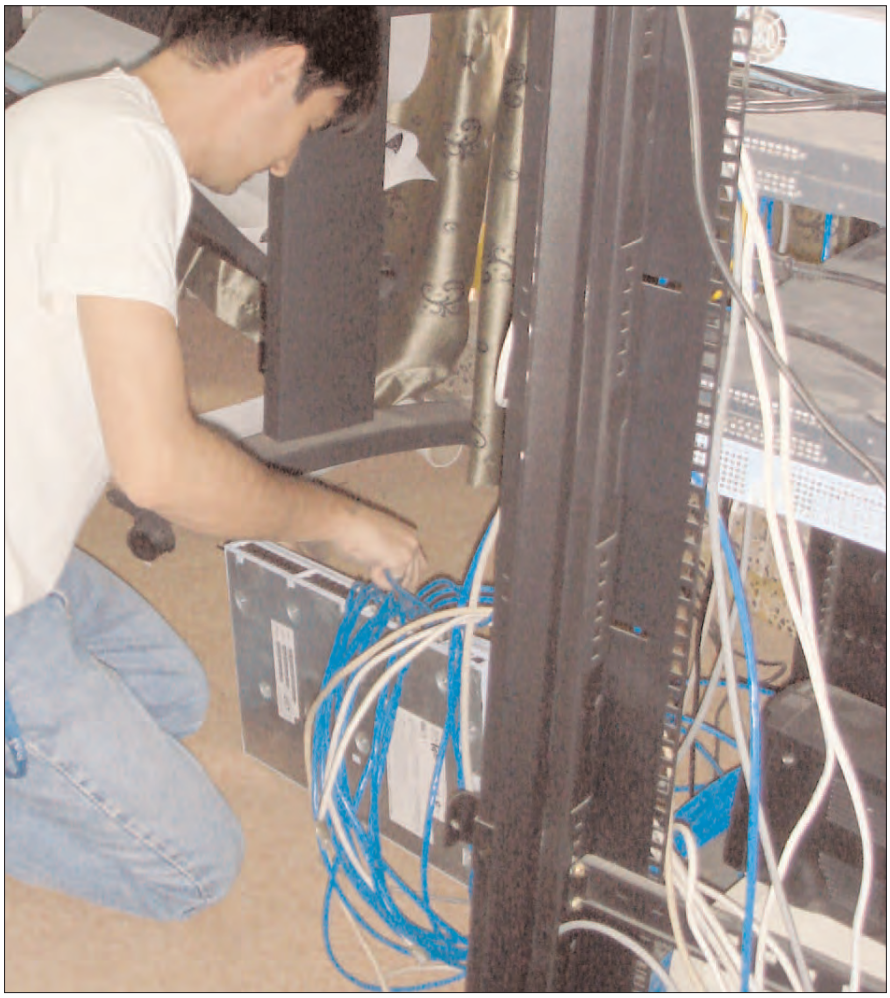
Technological support in the form of computer and internet capability was built into grants to renovate 4 agricultural extension centers in the northern part of the country, and equip the National Beekeeping Library and Extension Center of the Ministry of Agriculture in Baghdad. In these cases, the inclusion of IT support greatly enhanced the ability of the institutions to perform effectively. There were also a number of projects, supported through grants, subcontracts, or letters of

DIRECT GRANTS IN SUPPORT OF IT PROJECTS

Name	Location	Governorate	Cost	Permanent Employees
State Board for Lands Internet Center	Baghdad	Baghdad	$62,000	90
Equipping Media Center at the GD Research & Extension in Erbil	Erbil	Erbil	$30,000	10
Equipping Media Center at The General Directorate of Agriculture Research and Extension in Sulaymaniyah	Sulaymaniyah	Sulaymaniyah	$35,000	10
Equipping the Computer Training Hall at the General Directorate of Agriculture Research and Extension in Erbil	Erbil	Erbil	$30,000	100
Agriculture Training and Development Center, Mosul Agriculture Chamber.	Mosul	Ninewa	25,000	11
University of Baghdad, College of Veterinary Medicine, Internet Center	Abu Ghraib	Baghdad	$62,000	5
State Board of Agricultural Research, Internet Support	Abu Ghraib	Baghdad	$62,000	5
State Board of Agricultural Extension, Internet Center	Abu Ghraib	Baghdad	$55,000	72
U of Baghdad, College of Veterinary Medicine - Media Center	Abu Ghraib	Baghdad	$5,000	20
Land Registration System for the State Board for Agricultural Lands - Phase I	Baghdad	Baghdad	$79,200	8
Land Registration System for the State Board for Agricultural Lands - Phase II	Baghdad	Baghdad	$95,200	--
National Program for the Preparation of Agro-ecological Zone (AEZ) Maps - Phase I	Baghdad	Baghdad	$71,000	8
National Program for the Preparation of Agro-ecological Zone (AEZ) Maps - Phase II	Baghdad	Baghdad	$98,900	--
Total : 13 Grants; 10 projects			**$710,300**	**339**

agreement, which required specialized IT support to assure the success of the project. These included a number of agricultural production surveys (see Section 3.1) and community education projects in zoonotic diseases. These projects required training in the use of GIS tools to map the extent of project coverage,

(below left) Maintenance of the IT infrastructure (below) Marine power systems were adapted for stability of the electrical system.



(top) control panel to monitor system, (middle) three stage fuel filter for generator, (bottom) Reliable power is one of the key elements in maintaining sensitive IT and communications equipment.

and specialized computer programs for data treatment. ARDI furnished GIS handsets either through purchase or loan for government agencies and participating NGOs, and provided training in the use of the tools and the statistical programs necessary for returning data in its most useful form.

Finally, ARDI supported several national level projects which were contingent upon newly introduced information technologies for their successful completion. That is, the goal of the projects was not to introduce new technologies, but the new technologies were necessary to achieve the goals. In those cases, ARDI put considerable resources into the acquisition of equipment and in training of personnel to utilize the equipment and assure project sustainability into the foreseeable future. Training was a key component of these projects, and ARDI was able to either bring expert trainers into the country from other parts of the world, or provide assistance so that Iraqis could attend specialized training institutions in other countries.

These projects tended to be large-scale and have broad impact, in the sense that the benefits of the projects would assist the national-level institutions in strategic and long-range planning activities, and would therefore extend to virtually all agricultural producers in the country. These projects have been discussed in detail elsewhere in this report, so the list of projects below includes the appropriate reference for further information:

- Agro-ecological Zoning and Mapping System – Section 3.1
- Cadastral Mapping and Lands Administration Project – Section 3.2
- Agro-Meteorological Network – Section 3.1
- Monitoring Wholesale Market Prices – Section 3.1
- Establishing Ministry of Agriculture Statistical Unit – Section 3.1
- Survey for Water and Land Resources in Iraq – Section 3.7
- Marshlands Monitoring Program – Section 4.1
- Avian Influenza Working Group – Section 2.5

2.0 PHYSICAL AND TECHNOLOGICAL IMPROVEMENTS

2.1 IMPROVING AGRONOMIC CROP PRODUCTION

ARDI implemented 24 projects to improve Iraq's infrastructure for crop production in 2003 - 2006:

WHEAT AND BARLEY

2 projects to demonstrate improved wheat and barley production technology

3 projects to multiply certified wheat seed

2 projects to encourage expanded wheat production

2 projects to implement wide-scale wheat seed cleaning

3 projects to reduce damage from Sunn pest

RICE

2 projects to demonstrate improved rice production technology

SORGHUM

1 project to test performance of hybrid sorghum

1 project to demonstration sorghum production in the Marshlands

MAIZE

3 projects to establish inbred maize lines in Iraq

3 projects to demonstrate hybrid maize production technology

1 project to demonstrate maize production in the Marshlands

POTATO

1project to demonstrate improved potato production technology

Training for seed cleaning operations.

Seed cleaners have been distributed and technicians have received specialized training in operations and maintenance.

WHEAT AND BARLEY PRODUCTION

Wheat farmer in Dahuk.

Wheat grains were domesticated in the Fertile Crescent 10,000 years ago, with yields estimated to have been one metric ton per hectare (mt/ha)[1]. Today, wheat production is a significant economic activity in Iraq; wheat grows well in the higher rainfall areas of northern Iraq, and is also grown in other areas under irrigated conditions. The development of salt tolerant varieties makes wheat production possible, even on the saline soils of central and southern Iraq.

Despite favorable conditions for wheat production in Iraq, domestic production does not meet current food needs. Much of Iraq's population is sustained by bread wheat imports that enter the Public Distribution System (food ration) as milled flour, effectively reducing private sector returns to agriculture. While the command economy under the previous regime directed farmers to plant bread

[1] Jared Diamond, in Collapse, and Guns, Germs and Steel, relates the story of the domestication of wheat in the Fertile Crescent approximately 8,500 BC.

wheat, starting in 2003 Iraq's farmers could elect to plant bread wheat, or durum wheat (for pasta and poultry feed), or barley (for livestock feed) based upon their calculation of expected return from the crop.

However, wheat yields in Iraq are low compared to neighbors with similar growing environments. Yields are constrained by a number of factors, the most significant of which are lack of financial incentive (low procurement price) and lack of farm-family cash or credit to purchase higher-yielding inputs. Wheat is often grown as a subsistence crop—with barley substituting for wheat in drier regions. A listing of the agronomic requirements for higher yields of both wheat and barley includes:

- Certified new high-yielding wheat seed introduced to a farm every 4-5 years;
- Seed cleaners and treatment for farmer-saved seed;
- Disease and pest control;
- Mechanized farm equipment (tractors, seed drills, combines);
- Availability of fertilizer, particularly DAP, and other agricultural chemicals; and
- Knowledge of how best to manage moisture retention in rainfed production through no-tillage conservation agriculture.

ARDI has provided significant assistance to wheat and barley producers in Iraq through the introduction of improved technologies to increase yield. Winter Crop Technology Demonstrations in the 2003 – 2004 and 2004 – 2005 winter cropping season demonstrated the importance of using improved certified seeds and other improved cultivation practices to increase yields. ARDI has also worked to improve the availability of high quality wheat seed through procurement and multiplication of certified seed, and through a widespread seed cleaning program. In addition, ARDI has provided assistance to address the problem of pest control, in order to reduce the effect of Sunn pest, which is significant for wheat and barley in Iraq's northern region.

Seed multiplication was implemented with local farmers to increase the amount of "Certified" or "Certified +1" available for planting.

WINTER CROP TECHNOLOGY DEMONSTRATIONS FOR WHEAT AND BARLEY

Farmer field day.

Very shortly after arriving in Iraq in October 2003, ARDI coordinated with the MOA/Baghdad to implement Winter Crop Technology Demonstrations for the 2003 – 2004 winter wheat and barley planting season. The demonstrations were intended to introduce improved technologies and practices to Iraqi cereal crop producers to increase yields of wheat and barley, in order to increase domestic production of these crops and to farmers' income. ARDI and the MOA designed the demonstrations based on the following premises:

- A large problem faced by small-scale farmers in Iraq is low farm productivity, which leads to low income and standards of living;
- Increased crop productivity will help to raise the standard of living of the farmers and their families and enhance national development;
- Adaptive crop research will yield improved technology, appropriate to

NOTE ON CONDUCTING DEMONSTRATION PROGRAMS IN FARMERS FIELDS:

A farm is a production unit with the primary objective of increasing productivity, profit and the well-being of the farm household. Consequently, researchers who experiment in farmers' fields must recognize and cope with the characteristics of an experimental area where production, not research, is the top priority.

Some of the distinctive features of the farmer's field as a test site, relative to research station, are:

- Lack of experimental facilities such as good water control, pest control, and equipment for such operations as land preparation and processing of harvest;
- Large variation between farms and even between fields in a farm;
- Poor accessibility, which creates problems of supervision by researchers;
- Lack of data describing the soil and climate of the experimental field;
- Availability of the farmer and his practices for use in experimentation.

the local conditions, situations, and needs of the farmers;

- The improved technology exhibited and tested in demonstration programs can be effectively delivered to the farmers by an extension system;
- The farmers will accept and adopt the improved technology after the utility and profitability of the technology has been effectively demonstrated; and
- The project can be maintained and institutionalized by the Ministry of Agriculture through an effective extension service.

Crop technology demonstrations are a key element of the overall "extension" or "technology transfer" process that usually begins in laboratories, progresses to field experiments, then to applied research, and finally to recommendations, demonstrations, and production campaigns. In 2003-2004, agriculture in Iraq was ripe for innovation, and new technologies indeed found their way from scientists to farmers' fields. The MOA/ARDI Winter Crop Demonstration 2003 – 2004 project was successful in introducing improved technologies for wheat and barley to Iraqi farmers; most remarkable was the breakthrough in salt tolerant wheat varieties. MOA/ARDI demonstrations showed skeptical farmers that wheat can indeed grow on saline soils. Farmers also observed improved cropping techniques, and saw that often less irrigation can be as good as maintaining high levels of moisture in their fields. Finally, farmers saw for the first time cereal crop yields topping four tons per hectare on their fields, using improved varieties and practices.

In 2004 – 2005, ARDI and the MOA expanded the Winter Crop Demonstration project to include sites in six additional governorates and to introduce new cropping techniques for potatoes, rice – wheat relay cropping, and barley and vetch for livestock forage. Perhaps the most important lesson learned in 2003 – 2004 was the remarkable response by Iraqi agriculture administrative and scientific leadership. Iraqi staff of the Ministry of Agriculture and associated universities commanded and executed agricultural extension in both the 2003 – 2004 and the 2004 – 2005 programs with excellence, determination, and confidence.

PROJECT DESIGN FOR WINTER CROP TECHNOLOGY DEMONSTRATIONS

The improved technology for crop production introduced in the Winter Crop Technology Demonstration projects was based on research by the State Board of Agricultural Research (MOA), the College of Agriculture at the University of Baghdad, and the Ministry of Science and Technology (MOST). The technology represents the most suitable combinations of practices for small-scale farmers in Iraq in the different agro-ecological zones (high rainfall, moderate rainfall, low rainfall, and irrigated conditions).

The MOA selected farmers and sites on which to establish demonstration plots according to the following criteria:

- The demonstration site was representative of most of the fields in the region;

Demonstration sites were marked with signs for Improved Practices and Technologies (left) and Traditional Practices (right)

- Location of the site was within the crops' agro-ecological zone (i.e. suitability);
- The site was easily accessible to both farmers and team members.

In this report, the "demonstration plot" refers to the area in which improved practices were implemented. Most of the demonstration plots for the Winter Crop Technology Demonstrations for wheat and barley were one hectare in area, except for irrigated plots which were two hectares in area. In most cases, a "local check" plot planted with traditional farmer cultivation practices was established adjacent or near to the demonstration plot, for purposes of comparison. In most cases, production data were collected from both the demonstration plot and the local check, and where available these figures are included in this report.

In all of the MOA/ARDI winter crop technology demonstrations, field days were an extremely important element. They were generally held, when possible, during the growing season and/or at harvest, at the demonstration sites. Area farmers were invited to attend these field days, which were led by technical staff from the Ministry of Agriculture, the College of Agriculture, and ARDI staff, who discussed with farmers the new technology used in the demonstration and answered questions about crop production. The local check plots enabled the farmers to observe firsthand the differences between using the new technology and the traditional practices, further encouraging them to adopt new technology on their own fields to increase yields and income. The field days enhanced the extension aspect of the demonstration program and fulfilled the objective of the crop technology demonstrations to introduce new crop technology to as many farmers as possible. In 2004 – 2005, 460 farmers attended field days for wheat production, In 2005 – 2006, 2,640 farmers attended field days for wheat production, and 100 farmers attended field days for barley production.

The results of the 2003 – 2004 and 2004 – 2005 Winter Crop Technology Demonstrations are discussed below (wheat, barley, and rice-wheat relay cropping). Results for the barley/vetch demonstration are discussed in 2.5: Improving Forage Crop Production and Rangelands.

Field days at trial plots were used to expose larger groups of farmers to the new technologies demonstrated during the trials. For many farmers it was the first on the ground intervention by an extension activity in their village in many years.

WHEAT CROP TECHNOLOGY DEMONSTRATIONS

A farmer crushes wheat in his palm to release the grain during a 2004 Winter Crop Demonstration field day.

As part of both the 2003 – 2004 and the 2004 – 2005 Winter Crop Technology demonstration projects, ARDI and the MOA implemented wheat demonstration plots to exhibit an improved package of technologies to increase yields over those from the farmers' traditional practices. The demonstrations were implemented in low rainfall areas, moderate rainfall areas, and high rainfall areas, as well as under supplemental irrigation and full irrigation conditions. MOA/ARDI also conducted demonstrations to introduce improved salt tolerant varieties of wheat during both the 2003 – 2004 and the 2004 – 2005 programs.

ACTIVITIES

The demonstration plots were planted according to the improved technical package with assistance and supervision of MOA Baghdad, MOAI/Sulaymaniyah, MOAI/Erbil, the College of Agriculture at the University of Baghdad, and MOST. The improved practices and technologies included:

Students from the College of Agriculture attend a field day to learn about wheat cropping technology

- Minimum tillage if possible of fallow land for weed control, two times;
- Chisel plowing for seed bed preparation or disking if needed in heavy clay soils;
- A harrow and/or drag used following the plowing to break up clods and flatten the seed bed;
- Modern drill use to place the seed at the correct depth in the soil, with a band of fertilizer laid in simultaneously underneath the seed;
- Use of improved varieties of certified seed treated with fungicide;
- A side dress of urea at tillering stage; and
- Herbicide application when necessary.

Production (yield) data were recorded from both the production plots and, when available, a local check plot planted with farmers' traditional practices for the purpose of comparison. Farmers attended field days to observe the improved yields and higher production from the fields planted with the improved technology package, and to learn more about this package so as to implement the practices in their own fields to improve their production. In the 2003 – 2004 demonstration project, a total of 460 farmers attended field days. The 2004 – 2005 project dramatically increased this number to 2,640 farmers who attended to learn about improved wheat cultivation practices.

Wheat demonstration sites 2003-2004.

HIGH RAINFALL AREAS

MOA/ARDI implemented technology demonstrations of bread and durum wheat during both the 2003 – 2004 cropping season and the 2004 – 2005 cropping season (see Tables 1 and 2).

TABLE 1 WHEAT DEMONSTRATION SITES 2003-2004

Governorate	Type of Wheat	Number of Sites
High Rainfall Areas		
Ninewa	Bread	4
	Durum	10
Moderate Rainfall Areas		
Ninewa	Bread	4
	Durum	12
Irrigated Fields		
Baghdad	Bread	3
Wassit	Bread	3
Qadissiya	Bread	2
Salt Tolerant demos		
Baghdad	Salt Tolerant	6
Qadissiya	Salt Tolerant	2
Wassit	Salt Tolerant	4
Total Sites		**38**

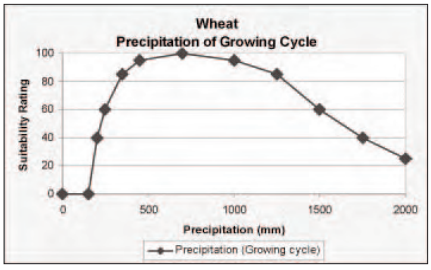
TABLE 2 WHEAT DEMONSTRATION SITES 2004-2005

High Rainfall Areas		
Governorate	**Type of Wheat**	**Number of Sites**
Ninewa	Bread	13
	Durum	14
Sulaymaniyah	Bread	2
	Durum	8
Dahuk	Durum	1
Erbil	Bread	4
	Durum	6
Moderate Rainfall Areas		
Ninewa	Bread	4
	Durum	5
Tameem	Bread	5
Sulaymaniya	Bread	4
	Durum	5
Erbil	Bread	9
	Durum	3
Dahuk	Bread	3
	Durum	9
Low Rainfall Areas		
Erbil	Bread	2
	Durum	6
Supplemental Irrigation		
Tameem	Bread	3
	Durum	2
Sulaymaniya	Bread	8
Dahuk	Durum	2
Irrigated Fields		
Qadissiya	Bread	7
	Durum	6
Salt Tolerant		
Baghdad	Salt Tolerant	2
Babylon	Salt Tolerant	2
Wassit	Salt Tolerant	4
Qadissiya	Salt Tolerant	2
Total Sites		**141**

In 2003 – 2004 the demonstrations were implemented in Ninewa governorate, which is the largest wheat growing area in Iraq and has some of the best conditions for wheat production. A total of four sites were planted for bread wheat and ten for durum wheat.

In the high rainfall areas, the demonstrations of bread wheat (Cham-4 cultivar) did not show improvements over farmers' varieties and practices; the average yield for the demonstration plots was 1.3 mt/ha, while the farmers practices yielded 2.1 mt/ha (see Table 3). It must be noted that the demonstration plots were planted late in the season due to late delivery of the seed, and thus received less rainfall. Bread wheat requires a lot of water relative to other wheat varieties for good production, and so the lack of rainfall on the demonstration plots had a significant impact on yield.

Wheat demonstration sites 2004-2005.



Climatic requirements for wheat with respect to precipitation for the entire growing season.

Cleaned and treated wheat seed stored in warehouse for planting in next season.

The improved durum wheat cultivars (Cham-1 and Cham-3) cultivated with improved techniques did perform better than those planted according to farmer practices; these cultivars were less affected by late planting and lack of rain. On average, the demonstration plots yielded 1.3 mt/ha, while the plots planted with farmer practices yielded 1.0 mt/ha.

TABLE 3 WHEAT YIELDS IN HIGH RAINFALL AREAS 2003-2004

Location	Type of Wheat	Number of Sites	Average Yields (mt/ha)		% Improvement
			Demo Plot	Local Check	
Ninewa	Bread	4	1.3	2.1	-40%
	Durum	10	1.3	1	34%

A farmer in Dahuk examines extension materials distributed by the MOAI Erbil as part of the Wheat Crop Technology Demonstration project.

2004 - 2005

The demonstrations for durum and bread wheat in high rainfall areas were expanded as part of the 2004 – 2005 Winter Crop Technology Demonstration project. Additional demonstration plots were established in Ninewa, as well as in Sulaymaniyah, Dahuk and Erbil (see Table 4).

It must be noted again that the demonstration plots in Ninewa were planted late in the 2004 – 2005 season, and the crop therefore missed essential early rains, resulting in low yields. In addition, deteriorating security concerns in Ninewa during the 2004 -2005 season prevented ARDI or MOA staff from reaching the local check plots planted with farmer practices, and therefore no data were collected from these plots.

In Sulaymaniyah, Dahuk and Erbil, both bread and durum wheat cultivars planted with improved technology produced higher yields than the local check plots. The highest yield improvements were seen in Sulaymaniyah governorate, where the improved cultivar IPA-99 showed a 192% improvement over the local check

High rainfed wheat demonstration sites 2004 - 2005.

TABLE 4 WHEAT YIELDS IN HIGH RAINFALL AREAS 2004-2005

Location	Type of Wheat	Number of Sites	Average Yields (mt/ha)		% Improvement
			Demo Plot	Local Check	
Ninewa	Bread	13	0.86	n/a	n/a
	Durum	14	0.97	n/a	n/a
Sulaymaniyah	Bread	2	2.6	0.9	192%
	Durum	8	2.5	1.7	51%
Dahuk	Durum	1	1.1	n/a	n/a
Erbil	Bread	4	1	n/a	n/a
	Durum	6	2	1.8	11%

(based on one local check plot). The durum wheat demonstration plots planted with the improved cultivar Acsad-65 showed an improvement of 51% over the local check plots.

MODERATE RAINFALL AREAS

2003 – 2005

In 2003 – 2004, demonstrations for bread and durum wheat were planted in Ninewa governorate; four sites were planted with improved Cham-6 bread wheat, and 12 were planted with improved Cham-1, Cham-3 and Cham-5 durum wheat cultivars. A number of local check plots were planted using farmer practices. The improved technology package planted with improved bread wheat cultivars resulted in an average yield of 1.6 mt/ha, representing an increase in yield of over 22% as compared to the local check (see Table 5). The improved technology package planted with durum wheat did not show an increase over the local check plot planted with farmer practices; both yielded 1.9 mt/ha.

In 2004 – 2005, the demonstrations for bread and durum wheat in moderate rainfall areas were expanded to include sites in Sulaymaniyah, Dahuk, and Erbil. Demonstrations were planted in Ninewa again, but as noted above the crop was planted late and missed essential early rains and therefore produced low yields. Also, the deteriorating security situation prevented ARDI or MOA staff from reaching the local check plots, and no data were collected from these plots.

Moderate rainfed wheat demonstration sites 2004 - 2005.

TABLE 5 WHEAT YIELDS IN MODERATE RAINFALL AREAS 2003-2004

Location	Type of Wheat	Number of Sites	Average Yields (mt/ha)		% Improvement
			Demo Plot	Local Check	
Ninewa	Bread	4	1.6	1.3	22%
	Durum	12	1.9	1.9	0%

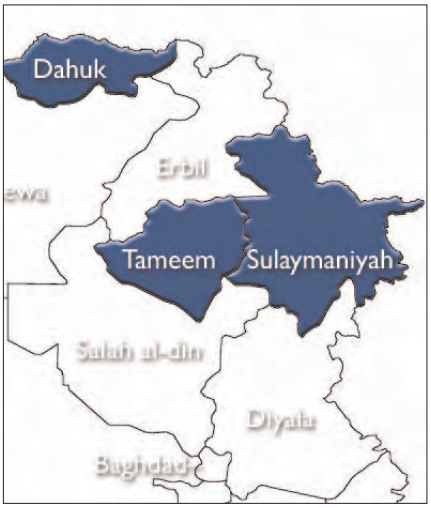
TABLE 6 WHEAT YIELDS IN MODERATE RAINFALL AREAS 2004-2005

Location	Type of Wheat	Number of Sites	Average Yields (mt/ha)		% Improvement
			Demo Plot	Local Check	
Ninewa	Bread	4	0.39	0.7	-44%
Tameem	Bread	5	1.9	2.3	-19%
Sulaymaniyah	Bread	4	2.17	0.96	126%
	Durum	5	2	0.78	151%
Dahuk	Bread	3	1.3	n/a	n/a
	Durum	9	1.2	0.9	35%
Erbil	Bread	9	1.4	1.1	30%
	Durum	3	2	1.4	37%

TABLE 7 WHEAT YIELDS, LOW RAINFALL AREAS 2004-2005

Location	Type of Wheat	Number of Sites	Average Yields (mt/ha)		% Improvement
			Demo Plot	Local Check	
Erbil	Bread	2	1.7	n/a	n/a
	Durum	6	1.9	1.7	10%

The best results from these demonstrations came from Sulaymaniyah, were the demonstration plots planted with the improved technology package achieved yields of 2.6 mt/ha for bread wheat and 2.5 mt/ha of durum wheat.



Low rainfed wheat demonstration sites 2004 - 2005.

LOW RAINFALL AREA

2004 – 2005

Demonstration plots were planted in 2004 – 2005 in low rainfall areas of Erbil, to demonstrate use of improved varieties and technologies to increase production in areas where wheat does not normally grow well due to lack of rain. The improved durum wheat cultivars (Acsad-65 and Cham-3) planted with improved practices yielded an average of 1.9 mt/ha, slightly better than the bread wheat cultivars planted with improved practices (1.7 mt/ha). The durum wheat planted with improved practices yielded an average of 10% higher than the local check plots planted with farmer practices (see Table 7). There were no local check plots planted for bread wheat.

SUPPLEMENTAL IRRIGATION

In northern Iraq, wheat production can benefit from supplemental irrigation. Demonstrations of supplemental irrigation for bread and durum wheat were held as part of the 2004 – 2005 Winter Crop Technology Demonstrations, on sites in Tameem, Dahuk and Sulaymaniyah governorate. In Tameem, plots were planted and irrigated at 50% moisture and at 100% moisture (see Table 8). The use of irrigation at 100% moisture produced higher yields than using irrigation at 50% moisture; for bread wheat, the improvement was 21%, and for durum wheat the improvement was 22%.

Supplemental pivot irrigation system in low rainfed area.

In Sulaymaniyah and Dahuk, the demonstration of irrigated wheat production consisted of plots planted with improved varieties and improved practices, including proper irrigation. Local check sites planted with farmer practices were planted in adjacent or nearby plots for comparison purposes. In Sulaymaniyah, the improved bread wheat cultivar (IPA-99) planted with improved practices including supplemental irrigation outperformed the local check in terms of yield by 148%. In Dahuk, the improved durum wheat cultivars (Acsad-65 and Cham-3) planted with improved practices including supplemental irrigation outperformed the local check by 13%.

TABLE 8 WHEAT YIELDS, SUPPLEMENTAL IRRIGATION (50% AND 100% MOISTURE) 2004-2005

Location	Type of Wheat	Number of Sites	Yield mt/ha	
			50% Moisture	100% Moisture
Tameem	Bread	3	3.3	4
	Durum	2	3.4	4.2

TABLE 9 WHEAT YIELDS, SUPPLEMENTAL IRRIGATION 2004-2005

Location	Type of Wheat	Number of Sites	Average Yields (mt/ha)		% Improvement
			Demo Plot	Local Check	
Sulaymaniyah	Bread	8	2.7	1.1	148%
Dahuk	Durum	2	3.3	2.9	13%

FULL IRRIGATION

Wheat can grow well in the central region of Iraq under irrigated conditions. In 2003 -2004, ARDI and the MOA implemented demonstrations at nine sites in Baghdad, Qadissiya, and Wassit to exhibit an improved technological package that featured the use of the improved Iraqi-developed IPA-99 cultivar, as well as proper irrigation practices in terms of timing and quantity of water used. The plots planted with improved practices showed an increase of 60% over plots planted with farmer practices (see Table 10).

In 2004 – 2005, the demonstrations were expanded to 13 sites, seven in Qadissiya and six in Baghdad.

The average yield of all sites using improved practices increased from the 2003 – 2004 demonstration results (3.2 mt/ha) to 4.2 mt/ha. The yields obtained using farmer practices also improved, from 2.0 mt/ha to 3.0 mt/ha.

Full irrigation wheat demonstration sites 2004 - 2005.

TABLE 10 WHEAT YIELDS, FULL IRRIGATION 2003-2004

Governorate	Type of Wheat	Number of Sites	Average Yields (mt/ha)		% Improvement
			Demo Plot	Local Check	
Qadissiya	Bread	4	3.9	2.2	77%
Wassit	Bread	2	1.9	1.2	58%
Baghdad	Bread	3	3.8	2.7	41%
Average			**3.2**	**2**	**60%**

TABLE 11 WHEAT YIELDS, FULL IRRIGATION 2004-2005

Governorate	Type of Wheat	Number of Sites	Average Yields (mt/ha)		% Improvement
			Demo Plot	Local Check	
Qadissiya	Bread	7	3.5	2.4	46%
Baghdad	Bread	6	5	3.8	32%
Average			**4.2**	**3**	**40%**

State Owned Enterprise wheat silo in Iraq.

SALT TOLERANT WHEAT

Wheat farmers in Thi-Qar observe improved production achieved using salt tolerant wheat cultivars

Saline soils negatively affect crop production in large areas of central and southern Iraq. In many, production is not possible under the current saline soil conditions. Newly developed salt-tolerant bread wheat varieties, Furat and Dijila, have been undergoing a selection process in Iraq for 12 generations, in order to develop and introduce these varieties to Iraqi farmers, so they can bring saline soils into production. These two varieties were introduced as part of the 2003 – 2004 and 2004 – 2005 Winter Crop Production demonstration projects, the first large-scale demonstrations of them in Iraq. In addition to the use of the improved varieties, the technology package included proper fertility and pest management practices, and multiple irrigations with water to promote root development.

The salt tolerant wheat cultivars produced yields that were much higher than the local checks; indeed, many farmers were not able to produce any wheat

Field trials using salt tolerant wheat.

using traditional practices. In 2003 – 2004, the demonstrations of Furat and Dijila cultivars produced similar yields (2.4 mt/ha and 2.5 mt/ha, respectively), and showed an improvement of 245% over the local check.

In 2004 – 2005, the demonstration program was expanded to include a site in Babylon, in addition to sites in Qadissiya, Baghdad, and Wassit again. Although the salt tolerant varieties again far outperformed the traditional practices, the overall yield of wheat in the area was poorer in the 2004 – 2005 season (an average of 1.8 mt/ha, compared to 2.5 for 2003 – 2004). This held true for the local checks as well.

TABLE 12 SALT-TOLERANT WHEAT YIELDS 2003-2004

Location	Number of Sites	Yield (mt/ha)		
		Furat	Dijila	Local Check
Qadissiya	2	1.4	1.6	0.6
Baghdad	6	2.5	2.7	0.9
Wassit	4	2.7	2.7	0.6
Average	**12**	**2.4**	**2.5**	**0.71**
% Improvement		**245%**		

TABLE 13 SALT-TOLERANT WHEAT YIELDS 2004-2005

Location	Number of Sites	Yield (mt/ha)		
		Furat	Dijila	Local Check
Qadissiya	1	0.8	0.9	0
Baghdad	1	1.75	3.08	0
Wassit	2	1.9	2.2	0.64
Babylon	1	1.1	1.5	0
Average		**1.5**	**2**	**0.37**
% Improvement		**373%**		

RICE - WHEAT RELAY CROPPING DEMONSTRATION

Researchers inspect a rice-wheat relay cropping field.

While wheat is considered a principal winter cereal crop in Iraq, rice is an important summer crop. The production of these two crops can be complementary; farmers can use lands on which rice is cultivated during the summer to produce wheat during the winter. Such a rice–wheat relay cropping system enables increased production per unit area of agricultural land, and enables the farmer to increase total productivity and income. In addition, planting wheat on land used to cultivate rice negates the need for many agricultural practices usually implemented for wheat cropping. This saves the farmer time and the cost of inputs, which can help improve yields and profits.

The rice–wheat relay cropping system involves sowing (broadcasting) wheat into a rice field after the last irrigation of the rice, and before harvesting the rice crop (in Iraq, this generally occurs in the second half of October). In such a system, the wheat seeds get the benefit of soil moisture from the irrigation, which helps them emerge more quickly. The rice plants also offer protection to the germinating wheat seeds from birds and unfavorable weather conditions. After the rice is harvested, the wheat seeds continue to benefit from residual fertilizers that were applied to the fields during rice cultivation, and from an already weed-free field, reducing or negating the need for herbicide, which saves the farmer the cost and time of herbicide application.

Rice in field trial with various technology packages.

Small studies conducted on limited rice–wheat relay cropping in Iraq show that the adoption of such a system leads to increases in farmers' income and decreases seasonal unemployment, since the farmers can cultivate during two seasons. In central Iraq, the system has been shown to reduce water needs of the wheat crop by 50%. However, the rice–wheat relay cropping system is used by only a very small number of farmers. In order to expand the use of this system and increase unit area productivity and yield quality, ARDI and the MOA designed and implemented a demonstration of a rice–wheat cropping system as part of the 2004 – 2005 Winter Crop Technology Demonstrations.

Rice-wheat demonstrations were conducted in these governorates.

ACTIVITIES

The demonstration project for the rice–wheat cropping system was conducted at eight sites in four governorate: Najaf, Qadissiya, Babylon and Wassit. Two sites already under cultivation with rice were chosen in each governorate. The area of each site was two hectares – one to demonstrate improved practices with cultivation of wheat after rice, and the other to be planted with wheat according to farmers' traditional practices.

The improved technology package used in the demonstration sites included:

- Use of improved wheat seeds, with preference for certified seeds;
- Sowing rates of 120 – 140 kg/ha, and sowing date of wheat right after last irrigation of the rice crop and before harvesting, in the second half of October;
- Appropriate use of fertilizers, if necessary because rice fields have not been adequately fertilized;

- Treatment of weeds with 1.2 kg/ha of herbicide (in the case of planting uncertified wheat seeds);
- Field irrigation, depending upon plant needs for water and the soil condition. Due to a lack of moisture at the correct times in the 2004 – 2005 planting season, the demonstration plots were irrigated 2-3 times each.

Before the demonstration project, a workshop was held with the demonstration technical team, which was composed of staff from the Ministry of Agriculture, the College of Agriculture at the University of Baghdad, and ARDI, in order to discuss the work plan. A second workshop was held by the technical team at the agricultural rice research station in Najaf; this workshop was also attended by the participating farmers and the heads of the agriculture directorates at the sites in Najaf, Qadissiya and Babylon. The matters discussed included the economic importance of rice-wheat cropping, and the data that should be collected to estimate plant growth and yields.

The technical team held extension field days to exhibit results to farmers and encourage widespread adoption of the new technology. At the end of the season, the technical team held field days at the Najaf, Babylon and Wassit sites. These field days, which were attended by many farmers and officials of the agriculture directorates of those governorate, included a tour of the demonstration and local check fields. Farmers observed the increases in yield gained by using the rice-wheat cropping system. The field days concluded with an open discussion to evaluate the results of the demonstration and the potential for expanding the use of the rice-wheat cropping system.

RESULTS

At harvest, ten random samples (replicates) of 1 m^2 were taken to determine yields. The estimated productivity of the plots was calculated using the average productivity of these replicates. The results are noted below.

TABLE 14 WHEAT YIELDS, RICE-WHEAT CROPPING 2004-2005

Governorate	Average Yields (mt/ha)		% Improvement
	Demo Plots	Local check	
Qadissiya	3.8	2.9	31%
Babylon	5	3.5	43%
Wassit	3.7	2.6	42%
Najaf	3.9	2.9	34%
Average	**4.1**	**3**	**37%**

The rice-wheat cropping system showed an average production of 4.1 mt/ha using improved technology, while the local check showed an average yield of 3.0 mt/ha using farmer practices. The productivity of wheat per unit area varied among locations for both the fields cultivated using improved technology, and those cultivated using farmer practices. This may be attributed to the type of cultivar used; some fields were planted with improved cultivars (Tammoz-2, Al-Iraq and IPA-99) while others were planted with non-improved cultivars (Mexipak and Abu-Garib). The highest yields were in Babylon governorate (an average yield of 5.0 mt/ha for improved technology and 3.5 mt/ha for farmer practices, using improved Tammoz-2 and Al-Iraq cultivars in both sets of fields),

while the lowest average yields were in Wassit (3.7 mt/ha for improved technology and 2.6 mt/ha for farmer practices, using non-improved Abu-Garib cultivars in both types of fields).

The increase in productivity per unit area in the demonstration fields planted with improved technology was accomplished in part as a result of using appropriate fertilizers at the correct quantities and application times. It was found that farmers used very limited amounts of phosphate fertilizers on their rice fields. In the fields planted with farmer practices, use of fertilizer on the rice crop did not exceed 80 kg/ha, and some farmers did not use any due to high market prices. This would affect the production of the wheat crop, and necessitated the use of additional fertilizers on the wheat crop on the fields planted with improved technology. In addition, the use of potassium sulfate had an additional positive effect on the crop planted with improved technologies, as a result of the benefit of potassium in photosynthesis and plant growth. In comparison, the fields planted with farmer practices received about half quantities of urea and phosphate fertilizers, and received no potassium sulfate, which likely contributed to reduced yields.

Beneficial insect on wheat.

The proper use of irrigation was another contributing factor to higher yields from the demonstration plots. These fields were irrigated three times: first in late December, for the second time in early March, and for the final time in early April. The irrigation was determined based on the shortage of rainfall in the 2004 – 2005 agricultural season. On the local check plots, the farmers irrigated their fields from two to four times, and not necessarily at the right times.

The benefit of using improved seeds to increase yields has been noted above. The use of these seeds is also beneficial because they are certified seeds, and therefore very clean and without weed seeds. Farmer saved seed of unimproved varieties generally contains weed seeds, necessitating the use of herbicide during the growing season. The use of rice–wheat cropping can improve the condition of the wheat seed produced on these fields; the rice fields on which the wheat is planted contain very few weed seeds and seeds of other wheat cultivars, so the wheat seed production will be homogenous. The sale price of such clean wheat seeds is higher, or if farmers choose to save the seed for their own use in the next season, the seed is of higher quality and will produce better yields.

BARLEY TECHNOLOGY DEMONSTRATIONS

Barley Demonstration Plot

As part of both the 2003 – 2004 and the 2004 – 2005 Winter Crop Technology demonstration projects, ARDI and the MOA implemented barley demonstration plots to exhibit an improved package of technologies to increase yields over the use of farmers' traditional practices. The demonstrations were implemented in low, moderate, and high rainfall areas.

ACTIVITIES

The demonstration plots were planted according to the improved technical package with assistance and supervision of MOA Baghdad, MOAI Sulaymaniyah and MOAI Erbil, the College of Agriculture and MOST. The improved practices and technologies included:

- Minimum tillage, if possible, of fallow land for weed control, two times;
- Chisel plowing for seed bed preparation or disking if needed in heavy clay soils;
- A harrow and/or drag used following the plowing to break up clods and flatten the seed bed;
- Modern drill used to place the seed at the correct depth in the soil, with a band of fertilizer laid in simultaneously underneath the seed;

Seed drill with seed and fertilizer dispensers.

- Use of improved varieties of certified seed treated with fungicide;
- A side dress of urea at tillering stage; and
- Herbicide application when necessary.

Production (yield) data were taken from both the production plots and the nearby local check plots planted with farmers' traditional practices for the purpose of comparison. Farmers attended field days to observe the improved yields and higher production from the fields planted with the improved technology package, and to learn more about this package in order to implement the practices in their own fields.

RESULTS

LOW RAINFALL AREAS

Low rainfall zones include areas with average annual rainfall from 200 to 350 mm/year. It is possible to grow barley under these conditions, although it is not normally possible to cultivate wheat. Farmers in the low rainfall areas of Ninewa governorate comment that they can expect a good crop of barley one year in five. In other years either low yields (less than 1.0 mt/ha) are achieved, or the crop is a complete failure. Farmers in these low rainfall, nonirrigated areas are typically poorer than farmers in the better moisture regimes in Iraq.

Barley demonstrations in low rainfall areas.

In 2003 – 2004, the demonstrations of the improved barley varieties Tadmor and Zambaka were successful in producing slightly higher yields than the local check. It must be noted that these demonstrations were planted late, well beyond the proper planting time, as the seed delivery was delayed. Nevertheless, the plots planted with the improved practices and the Zambaka improved variety showed average yields with an increase of nearly 15% over the local check (see Table 15).

TABLE 15 BARLEY YIELDS, LOW RAINFALL AREA 2003-2004

Governorate	Type of Barley	Number of Sites	Yield (mt/ha)		% Improvement
			Demo Plots	Local Check	
Ninewa	Tadmor	10	0.48	0.47	2%
	Zambaka	9	0.54		15%
Average			**0.51**	**0.47**	**9%**

In 2004 – 2005, the demonstrations of improved barley were repeated in Ninewa, and expanded to include demonstration sites in Sulaymaniyah and Erbil. The demonstrations in Ninewa were held on 14 sites, all planted with Tadmor cultivars and improved practices. In these demonstrations, the improved practices outperformed the farmer practices by 35%. In Erbil, a local black barley was planted to demonstrate improved practices, and in Sulaymaniyah a local white barley cultivar was used. These cultivars outperformed the Tadmor planted in Ninewa, but no local checks were planted to compare their performance against farmer practices in the same area (see Table 16).

ARDI held field days in Erbil and Sulaymaniyah, in coordination with the Ministries of Agriculture in those governorates, to demonstrate to farmers the higher production using improved practices. In Sulaymaniyah, 50 farmers

attended the field day, which was led by ARDI staff and the Director-General of Research and Extension at the MOA. In Erbil, 50 farmers and 10 MOA staff attended the field day.

MODERATE RAINFALL AREAS

Demonstrations of an improved technological package, including the use of improved barley varieties Reehan-3, Tadmor and Zambaka, were conducted in moderate rainfall areas of Ninewa in 2003 – 2004. A local check was also planted. The improved technology package planted with Tadmor showed an increase in yields of 57% over the local check. The improved technology package planted with Zambaka showed an increase in production of 26% over the local check (see Table 17).

In 2004 – 2005, the demonstration project was expanded to include sites in Tameem, Sulaymaniyah and Erbil, as well as sites in Ninewa. The improved technology package produced excellent results in Tameem (Tadmor cultivar) and Sulaymaniyah (white barley cultivar) with yields of 2.43 mt/ha and 2.38 mt/ha respectively. The local checks, in comparison, did very poorly, and were outperformed by an average of 114% by the improved technology sites (see Table 18).

Barley demonstrations in moderate rainfall areas.

TABLE 16 BARLEY YIELDS, LOW RAINFALL AREA 2004-2005

Governorate	Type of Barley	Number of Sites	Yield (mt/ha)	
			Demo Plots	Local Check
Ninewa	Tadmur	14	1.22	0.9
Sulaymaniyah	White barley	1	2.5	n/a
Erbil	Black barley	1	2	n/a

TABLE 17 BARLEY YIELDS, MODERATE RAINFALL AREA 2003-2004

Governorate	Type of Barley	Number of Sites	Yield (mt/ha)	
			Demo Plots	Local Check
Ninewa	Tadmur	3	1.9	1.2
	Zambaka	3	1.5	
Average			1.7	
% Improvement			**42%**	

TABLE 18 BARLEY YIELDS, MODERATE RAINFALL AREA 2004-2005

Governorate	Type of Barley	Number of Sites	Yield (mt/ha)	
			Demo Plots	Local Check
Tameem	Tadmur	3	2.43	1.9
Ninewa	Rihane-3	2	1.7	1
Sulaymaniyah	White barley	1	2.38	n/a
Erbil	Black barley	2	1.8	0
	Average		**2.08**	**0.97**
	% Improvement		**114%**	

HIGH RAINFALL AREAS

Summary for Wheat and Barley Demonstration Programs: The MOA/ARDI crop technology demonstrations were a successful step towards improving wheat and barley production in Iraq. A total of 3,200 farmers attended field days led by ARDI and MOA technical staff to observe the use of improved practices to increase wheat and barley yields.

The demonstrations of certified seed use underscored the importance of using good seed to increase yields. ARDI followed these demonstration projects with seed multiplication projects to increase the stock of certified seed available to Iraqi farmers, and a seed cleaning program to increase the productivity of farmers' saved seed.

TABLE 19 BARLEY YIELDS, HIGH RAINFALL AREA 2004-2005

Governorate	Type of Barley	Number of Sites	Yield (mt/ha)	
			Demo Plots	Local Check
Sulaymaniyah	White barley	1	2.3	n/a
Dahuk	Black barley	3	1.7	n/a
	Average		**2**	**n/a**

WHEAT SEED MULTIPLICATION

The MOA/ARDI Winter Crop Technology demonstrations in 2003 – 2004 and 2004 – 2005 demonstrated the importance of using improved technology, including improved wheat seed varieties, to increase wheat yields and farmers' income. With the Oil for Food program under the previous regime, certified wheat seed of such varieties as Cham and Acsad-65 was imported and distributed to farmers. Since the end of this distribution program in 2003, farmers have largely been using seed saved from their previous harvest to replant their fields. When seed is replanted like this, it deteriorates genetically in each succeeding season, and the practice reduces the quality and the quantity of the crop.

Wheat seed; healthy on left, Sunn pest damaged on the right.

In the summer of 2004, the MOA indicated that the lack of certified seed in Iraq was a major constraint to improving wheat production. Only a limited amount of certified seed was held in Iraq, by two seed companies (Mesopotamia and the

Iraqi Seed Company), and the Ministry of Science and Technology. To mitigate the effects of the near-total lack of high quality seed in the market, ARDI assisted an MOA-subsidized distribution program for 2004 – 2005. In addition, ARDI and the MOA cooperated to implement wheat seed multiplication programs to multiply certified wheat seed in 2004 – 2005 and 2005 – 2006.

ACTIVITIES

ARDI imported certified wheat seed for these programs and contracted with farmers who had the technical ability to cultivate wheat with proper practices that met standards for certified seed production. To ensure that the seed multiplication effort was producing high quality seed, trained ARDI inspectors visited the seed multiplication fields twice during the growing season to inspect for off-types, harmful weeds, and insect damage to the crop. Fields that failed these inspections were rejected from the program. The seed that was produced on fields deemed qualified was accepted as "Certified+1" seed, meaning seed that is one generation removed from the official certification level, but cultivated to maximize genetic and physical purity. The seed from nonqualified fields is usually of fairly good quality, and the farmers whose fields were rejected as not qualified likely planted much of the seed produced during the next planting season, or sold it to other farmers who realized higher yields than would have been achieved with several-generation old-saved seed.

In exchange for the original procurement of certified seed and the technical assistance during the multiplication process, the qualified farmers participating in the multiplication programs agreed to return to ARDI two tons of Certified+1 seed for each ton of certified seed they had received and planted. The farmers were free to either keep the remainder of the seed crop for their own use, or sell it to other farmers. In the 2005 – 2006 multiplication programs, ARDI also provided seed cleaning services to remove debris from the seed and ensure pure, grade 1 seed.

RESULTS

For the 2004 – 2005 winter wheat planting season, ARDI procured 20 tons of certified Cham 6 wheat seed (bread wheat) for multiplication. ARDI distributed the seed to five farmers in Dahuk, selected for their progressive farming practices. The farmers were instructed how to plant and treat the fields in order to produce a certifiable crop. Each farmer planted 30-60 ha of seed, for a total of 200 ha. After two field inspections, ARDI agronomists certified that 155 hectares had been cultivated up to standard. The average yield for qualified fields was 1.7mt/ha, resulting in an estimated 264 tons of Certified+1 seed for the following season. From that amount, the farmers returned to ARDI a total of 40 tons of Grade 1 seed. ARDI also purchased an additional 44 tons of grade 1 seed and 52 tons of grade 3 seed to use in production programs the following year. The grade 1 seed was used during the 2005 – 2006 Wheat Production program in Sulaymaniyah, and the grade 3 seed was used for the Small Village Wheat Production program in Dahuk. Farmers retained the remainder of their seed yield, either to sell or to use for the 2005 – 2006 planting year.

The MOA/ARDI Wheat Seed Multiplication projects in 2005 – 2006 aimed to multiply and increase the availability of improved durum wheat (Acsad-65 and Cham-5) and salt-tolerant wheat cultivars. For durum wheat multiplication, ARDI worked with 124 farmers in Dahuk and Erbil to plant a total of 340 mt of imported certified seed- 200 mt of Acsad-65 and 140 mt of Cham-5. During the two-phase inspection process, ARDI certified 1,600 ha of the planted area as acceptable for certified seed production. The total amount of Certified+1 seed produced on this accepted land was 2,096 mt; an additional 1,124 mt of seed were rejected as not up to Certified+1 standards, although much of it was still of good quality. ARDI provided seed cleaning services to all the farmers, including those with rejected fields. A total of 3,297 mt of seed were cleaned. ARDI collected 425 mt of the seed from farmers according to the contract. This seed was granted to a cooperative formed for agricultural input supplies; this

TABLE 20 CHAM 6 WHEAT SEED MULTIPLICATION 2004-2005

Site	Seed planted (mt)	Accepted area (ha)	Rejected Area (ha)	Yield on Accepted Area (mt/ha)
1	3	30	0	1.6
2	3.5	0	35	n/a
3	4	40	0	1.6
4	6	60	0	1.9
5	3.5	25	10	1.5
Total	**20**	**155**	**45**	

TABLE 21 WHEAT SEED MULTIPLICATION 2005-2006

Governorate	Number of Sites	Total Certified Seed Produced (mt)	Seed Collected by ARDI (mt)
Erbil	7	1,910	**425**
Dahuk	3	1,026	
Total	**10**	**2,936**	

Salt tolerant wheat seed demonstration areas.

cooperative will make the seed, in addition to extension services, available to farmers on a fee basis in the 2006 – 2007 wheat cropping season. The fee will enable the cooperative to recapitalize and continue procuring and multiplying certified wheat seed to increase its availability to Iraqi farmers.

The total amount of Certified+1 seed produced by this program, if it is all used as seed, will plant approximately 23,000 ha in the 2006 – 2007 wheat cropping season.

For salt tolerant wheat multiplication, ARDI used 14 mt of the salt tolerant wheat seed produced as part of the 2004 – 2005 Winter Crop Technology demonstration. These improved cultivars (Furat and Dijila) were planted in saline-soil areas of southern Iraq in Muthanna, Qadissiya, Baghdad, and Babylon governorates (see Table 22).

Most of the seed was planted in coordination with the MOST at 11 sites in Baghdad governorate. Unfortunately, due to security concerns, ARDI staff were not able to reach the sites after harvest, and the entire crop of the wheat seed remained with the farmers. It is hoped that the harvest will be used as seed, either by the farmers or sold to other farmers to increase the area planted to salt-tolerant wheat in the 2006 – 2007 winter wheat season.

(above) ARDI inspectors in a wheat seed multiplication field

Wheat cannot normally grow on highly saline soils (above). Salt-tolerant varieties enable farmers in high salinity areas to produce wheat (below).

The total amount of seed produced (not including Baghdad sites) was approximately 97 mt. If this is all used as seed next season, it will plant nearly 750 hectares of salt tolerant wheat. ARDI collected 13.7 mt of the seed to store for planting in the 2006 -2007 winter wheat season.

TABLE 22 SALT TOLERANT WHEAT SEED MULTIPLICATION 2005-2006

Governorate	Number of Sites	Seed Produced (mt)	Seed Collected (mt)
Qadissiya	2	30	4.3
Baghdad	11	n/a*	n/a*
Muthanna	1	32	5
Thi-Qar	2	35	4.4
Total	**16**	**97**	**13.7**

WHEAT PRODUCTION PROJECTS

SMALL VILLAGE WHEAT PRODUCTION PROJECT 2005 – 2006

In the 2005 -2006 planting season, ARDI implemented a Small Village Wheat Production project to help internally displaced persons, who had recently returned to their lands in the rural mountainous areas of Dahuk, to gain a source of food and/or income from wheat production. This area is suitable for wheat production, but the farmers lacked the resources to buy inputs, including wheat seed.

ACTIVITIES

ARDI provided 270 poor farmers (IDPs) with a total of 52 mt of grade 3 Certified+1 wheat seed, which was produced as part of the 2004 – 2005 Wheat Seed Multiplication program. Grade 3 means that the seeds are smaller and less uniform than the best grade 1 seed, but can still produce good yields.

Small village wheat production project was conducted in Dahuk.

Sunn pest damage wheat by injecting an enzyme that not only makes the seed bitter but smaller and less likely to germinate the following year.

RESULTS

Unfortunately, much of the wheat crop produced as part of this project was badly damaged by Sunn pest. These fields were based at the foot of mountains where Sunn pest overwinter, and as a result were the first fields to be hit by the Sunn pest as they moved down into the wheat fields. Approximately half of the fields were damaged to the extent that they could not be harvested for grain; these farmers instead used the fields to graze livestock. The other fields were harvested; half of these farmers chose to sell the yield to traders, and the others kept it for household consumption.

Despite the problems with Sunn pest, the farmers were extremely grateful to ARDI for the wheat seed. Without the seed, they said, they would have had no means to produce any type of crop this season.

Wheat field of a poor farmer in Dahuk governorate

WHEAT PRODUCTION PROJECT 2005 -2006 SULAYMANIYAH

ARDI used the 84 mt of grade 1, Certified+1 wheat seed produced in the 2004 – 2005 Wheat Seed Multiplication project to implement a large-scale wheat production program in Sulaymaniyah. This project demonstrated to Iraqi farmers the benefit of using improved seed to increase yields.

ACTIVITIES

ARDI worked with ten large-scale farmers in Sulaymaniyah to plant a total of 593.5 ha with the seed. The farmers achieved an average yield of nearly 1.3 mt/ha, with some farmers achieving yields above 2 mt/ha.

At the end of the growing season, ARDI held farmer field days, hosted in coordination with technical staff from the MOA Agriculture Research Center and the local Farmers Union Association. Area farmers were invited to the field

TABLE 23 LARGE SCALE WHEAT PRODUCTION SULAYMANIYAH 2005-2006

Site	Seed Received (mt)	Area Planted (ha)	Yield (mt/ha)
1	11.25	80	1.8
2	4.55	32.5	0.76
3	15	100	0.92
4	13.65	98.5	1.1
5	5.25	37.5	2.1
6	7	50	2
7	5.25	37.5	1.2
8	14	100	1.2
9	2.8	20	1.1
10	5.25	37.5	0.6
Total	**84**	**593.5**	
Average			**1.13**

Large scale wheat seed multiplication project occurred in Sulaymaniyah.

days; a total of 57 attended, with many taking time off from their work to attend. They were impressed with the improved yields from using the Certified+1 seed, and many expressed interest in investing in this improved seed. Many did note the general lack of availability of this seed, an ongoing problem that needs additional attention.

Local television newscasters filming the wheat harvest at a large scale field trial in the North.

WHEAT SEED CLEANING

Seed cleaner and field operations, fall 2005

ARDI's efforts to improve wheat production in Iraq, through technology demonstrations, seed multiplication projects, and production projects were all based on the premise that good, clean seed is the single most significant factor in improving the quantity and quality of wheat yields. The rest of the input package – fertilizer, pesticides, and other good cultural practices – will not help farmers if the seed planted in the ground is of poor quality.

Since the end of the Oil-for-Food program, under which the Government of Iraq (GOI) imported and subsidized certified wheat seed, many Iraqi farmers have not had access to certified seed and have been replanting their saved seed. The consequence of this practice is that up to 25% of their planting material is composed of weed seeds, lentils, weak grain and other types of nonproductive debris. This reduces the quality and quantity of wheat production.

If farmers do not have access to certified or Certified+1 seed, they can improve their saved seed through seed cleaning. Seed cleaning is a mechanical process in which the seed cleaner sorts the grains by size, thus grading the wheat seed while also removing impurities. Grade 1 is the designation for the biggest and most uniform seeds, which are therefore the highest quality. Grade 3 is the lowest grade, but it is also pure, highly productive wheat seed.

(above) Farmer saved seed, filled with unproductive debris
(below) Pure grade 1 cleaned seed

ACTIVITIES

2005 - 2006 PLANTING SEASON

In 2005, ARDI implemented a program to procure and distribute seed cleaning machines. This program gave Iraqi wheat producers access to machinery to rid their planting material of nonproductive matter.

In the summer of 2005, ARDI procured 164 seed cleaning machines (500 kg/hr capacity). These machines were chosen because they are small, mobile, inexpensive, and easy to use. ARDI worked with the MOA to determine the optimal distribution and location of the seed cleaners throughout the country, and coordinated with private entrepreneurs to operate the seed cleaners for farmers. Through a competitive bidding process, ARDI selected six NGOs to operate 164 seed cleaners under contract, free of charge to farmers. In addition, four cooperatives in rural areas each received a seed cleaner as an in-kind grant; these cooperatives charged a small fee to cover operating costs. ARDI provided comprehensive training in the operation and maintenance of the machines, and trained a total of 208 operators from all of the organizations which received the seed cleaners.

RESULTS

The seed cleaners were distributed to all 18 governorates; those areas with higher wheat production received a greater proportion of the cleaners (see Table 24). ARDI paid the operating costs for the machines to enable farmers to have their seed cleaned free of charge, in order to expose as many farmers as possible to the benefits of seed cleaning. A total of 7,406 farmers brought 35,307 mt of seed for cleaning, resulting in 31,738 mt of cleaned grade 1 seed suitable for planting. Surveys indicate that approximately 99% of this seed was retained by farmers and most likely planted. At a seeding rate of 130 kg/ha, this was enough to plant nearly 243,000 ha of land in the 2005 – 2006 planting season.

TABLE 24 RESULTS OF 2005-2006 SEED CLEANING PROGRAM

Governorate	# of Seed Cleaners	Farmers cleaning seed	Seed Cleaned (mt)	Grade 1 Seed (mt)	Hectares planted (estimate)*
Anbar	3	47	660	599	4,580
Erbil	19	1,622	6,373	5,679	43,436
Babylon	4	98	411	352	2,695
Baghdad	6	169	877	813	6,215
Basrah	2	60	281	239	1,827
Diyala	6	362	1,869	1,709	13,073
Dahuk	12	304	1,482	1,368	10,466
Kerbala	2	47	196	166	1,268
Muthanna	3	60	224	194	1,480
Najaf	3	63	285	248	1,898
Ninewa	44	1,368	11,252	10,065	76,983
Qadissiya	6	341	1,090	979	7,489
Salah al-Din	9	116	2,332	2,122	16,229
Sulaymaniyah	18	1,732	1,789	1,547	11,831
Tameem	14	504	4,379	4,147	31,714
Thi-Qar	3	83	464	370	2,828
Wassit	11	307	790	701	5,362
Missan	4	123	553	441	3,371
Total	**164**	**7,406**	**35,307**	**31,738**	**242,746**

*Estimate assumes 99% of grade 1 wheat seed is used as seed, and 130/ha seeding rate.

** Need estimated output from cooperatives

The photo demonstrates the effect of proper agronomic practices on the viability of wheat. The field on the left was cultivated with traditional methods and is highly contaminated with weeds.

2006 – 2007 PLANTING SEASON

ARDI's NGO and cooperative implementation partners operated the seed cleaners procured in 2005 for the 2006 – 2007 planting season. In the second season of operation, ARDI did not provide for the operating costs, and the organizations charged a fee averaging $5 per metric ton of seed cleaned. This type of fee-based business model for seed cleaning is sustainable, and will enable the organizations to maintain the cleaners and reinvest in their business in future seasons.

The success of the project attracted the attention of the US Military, and ARDI worked with them to procure and distribute additional seed cleaners for Iraq for the 2006 – 2007 planting season. The US Military funded the procurement of 173 seed cleaning machines, and USAID/ARDI funded the training and distribution costs. The seed cleaners will be operated under contract with the same implementing partners used for the 2006 – 2007 season. The 173 seed cleaners were distributed as indicated in Table 25.

The results of the seed cleaning for the 2006 – 2007 planting season will not be known until after the publication of this report.

TABLE 25 SEED CLEANER DISTRIBUTION FOR 2005-2006 PLANTING SEASON

Governorate	# of Seed Cleaners
Anbar	7
Erbil	17
Babylon	6
Baghdad	3
Basrah	2
Diyala	8
Dahuk	8
Kerbala	2
Muthanna	3
Najaf	3
Ninewa	50
Qadissiya	5
Salah al-Din	9
Sulaymaniyah	19
Tameem	13
Thi-Qar	3
Wassit	11
Missan	4
Total	**173**

WHEAT PRODUCTION – SUNN PEST CONTROL

Sunn pest (*Eurygaster Integriceps*) is a major problem for wheat production in Iraq. Crop losses can reach almost 100% in severe infestations. Even smaller infestations have serious economic consequences for wheat producers because the Sunn pest injects an enzyme into the wheat grain that renders the flour unsuitable for breadmaking if more than 2-3% of grains are affected. The MOT will not buy wheat from farmers that has more than a few Sunn pest damaged grains. Even a small infestation of Sunn pest can damage a farmer's entire crop.

Sunn pest insects are most prevalent in the mountainous wheat-producing areas in northern Iraq but are now found in all wheat growing areas. Sunn pest spend the summer, autumn and winter in the mountains, and in the spring migrate to the fields as the wheat crop is maturing. The females lay eggs on the upper surface of cereal leaves. When this new generation of Sunn pest hatches, the nymphs and then young adult insects begin feeding intensively on the wheat grain and leaves to store up adequate food reserves before migrating to the mountains for eight to nine months.

RESULTS

A total of over 6 mt of Sunn pest were collected. If these insects had migrated to the wheat fields in the area, they could have reproduced a large new generation of Sunn pest. The reduction of the Sunn pest population benefited more than 2,400 farmers who produce wheat on 12,000 ha near to the area of the Sunn pest collection.

SUNN PEST SUSCEPTIBILITY TRIALS

Though hand collection of Sunn pest is feasible, it is difficult to implement in mountainous areas. The main method of control in these areas is pesticide application to the wheat crop. In the 2006 wheat season, ARDI investigated alternative, nonpesticide control methods for Sunn pest control, including resistant wheat varieties, sticky traps and food traps, to determine effectiveness in reducing Sunn pest populations, and the feasibility of applying the methods on a large scale. ARDI also made general wheat field observations to collect information on Sunn Pest levels and migration patterns.

ARDI implemented five trials and observation series in northern Iraq:

PROJECT	LOCATION (GOVERNORATE)
Imported wheat varieties	Dahuk, Erbil, Sulaymaniyah
Local wheat varieties	Sulaymaniyah
Sticky and food traps	Dahuk, Erbil, Sulaymaniyah
General wheat field observations	Dahuk, Erbil, Sulaymaniyah

IMPORTED WHEAT VARIETIES TRIALS

ARDI tested five varieties of imported wheat to evaluate their level of resistance/tolerance to damage by Sunn pest, and the level of natural enemies. The trials were planted in Erbil, Dahuk, and Sulaymaniyah; one Iraqi wheat and one Iraqi barley variety were also planted in the trials for comparison purposes. The trials were designed to be unsprayed for Sunn pest. In Sulaymaniyah, cages were placed over the center of the variety plots to exclude Sunn pest, and to assess yield and other characteristics in the absence of the pest.

Data on levels of Sunn pest and beneficial insects were taken every 10-14 days, and various yield and grain parameters were taken at harvest. Unfortunately, Sunn pest levels at all three sites were too low to be analyzed. In addition, the trial in Dahuk was abandoned as it was mistakenly sprayed twice against Sunn pest by the research station. It was noted that Sunn pest began appearing in the fields on 18 March, 6 April, and 23 March in Dahuk, Erbil, and Sulaymaniyah, respectively.

LOCAL WHEAT VARIETIES

Evaluation of local wheat varieties was undertaken in Sulaymaniyah only. The trial objective was to evaluate seven local varieties of wheat and one of barley to determine the level of resistance/tolerance to damage by Sunn pest, and the level of natural enemies. The trial was unsprayed. As in the imported wheat variety trial, cages were placed over the center of the variety plots to exclude Sunn pest, and to assess yield and other characteristics in the absence of the pest. Data on levels of Sunn pest and beneficial insects were taken every 10-14 days, and various yield and grain parameters were taken at harvest. Unfortunately, Sunn pest levels were too low to be analyzed. It was noted that Sunn pest began appearing in the fields 23 March, and egg masses appeared on 29 April.

STICKY AND FOOD TRAPS

Evaluation of the effectiveness of two types of trap for monitoring Sunn pest levels and migration patterns was undertaken at two sites each in Dahuk and Erbil, and one site in Sulaymaniyah. One trap design was of wood, 30 cm x 40 cm mounted on 75 cm high stakes, colored red, yellow, green or brown, and covered with sticky material. The other trap design was a plastic bowl, sunk into the ground, colored white, yellow or blue, and containing a date paste food material.

At all sites, the traps were located in wheat fields. Trap catches were relatively low, but the yellow sticky traps tended to catch more Sunn pest than the other colors of the sticky traps. The brown sticky traps caught the least insects at all sites. No distinct peaks of catches were observed. Food trap catches were lower than those of the sticky traps, and the date paste did not act as an attractant. Counts were too low to distinguish any potential differences between the colors. It appears that Sunn pest were caught in these traps by accident, rather than any form of attractiveness.

The yellow sticky traps warrant further investigation, but not the food traps, at least with the date paste food attractant.

SUNN PEST OBSERVATIONS AT OVER-WINTERING SITES

ARDI observed Sunn pest during the latter part of 2005 and the spring and summer of 2006 in Dahuk and Sulaymaniyah, in order to record Sunn pest levels and migration patterns in the mountain overwintering areas. These data can help inform Sunn pest control efforts.

In Sulaymaniyah, Sunn pest numbers were highest in June and then decreased to much lower levels later in the year. However, at all observations the highest numbers were recorded at the highest altitudes. The decrease in numbers may have been due to migration to altitudes lower than 1,000m, but also there appeared to be high levels of parasitism and fungal infection. In June, when the highest numbers of Sunn pest were recorded, the levels of combined parasitism and fungal infection were highest at the lower levels and decreased with altitude, from 25.4 percent to 14.0 percent. These levels of natural control would have had a marked effect in reducing the numbers of overwintering adults. Later in the year, the percentage of natural control was much higher as greater proportions of the lower numbers of insects recorded were affected.

(above) Removing Sunn Pest from sticky trap. (below) Searching for Sunn pest in their overwintering location under the snow in the high altitudes.

In Dahuk, observations were made on the first mountain from March to July 2006, and on the second mountain in May and July 2006. On the first mountain different sites were used for each observation, but since the sites were all on the same shoulder of the mountain along a 6km arc, the data were grouped according to altitude. Records from altitudes below 900m were from valley bottoms close to the mountain. Insects were counted in 5 x 1m2 areas at each observation. Insects recorded in March were the remnants of the overwintering population. Large numbers of new adults were already at high altitudes in June, moving slightly higher in July. On the second mountain, only two counts, on 18 May and 11 July, were made at elevations of 1,216m and 1,239m. No Sunn pest were recorded on either occasion at either altitude.

GENERAL WHEAT FIELD OBSERVATIONS

Wheat fields were monitored for levels of Sunn pest at seven sites in Dahuk and one site in Sulaymaniyah. The objective was to assess the incidence and timing of appearance of migrating old adults, eggs, nymphs, and new adults. Insects were counted in 10 x 1 m2 sampling units selected at random on each occasion at each site.

In Dahuk governorate as a whole, levels of Sunn pest were variable. In certain areas the Sunn pest population reached high levels; for example, in one location levels up to 42 Sunn pest per square meter were recorded. The FAO spray threshold for Sunn pest in Iraq is 6-12 nymphs or 2-3 adults per square metre. In these areas the wheat crop was both sprayed by farmers themselves and aerially treated by the military from 16 to 28 May at the request of the MOA.

However, this same location also reported on 12 June that Sunn pest damage was much less in the 2005 – 2006 season than in 2004 – 2005, at 5-10% compared to 90%. Reasons for this were given as better pest monitoring and treatment at the appropriate time; the use of a more effective pesticide (alpha-cypermethrin instead of dimethoate); and hand collection of overwintering adults in the mountains at the end of the 2004 – 2005 season.

Information on which monitoring sites were actually sprayed is not clear, but it appears that all sites, with the exception of one village, were treated. The sites where ARDI conducted hand collection in late 2005 is approximately 35 – 55 km. to the east-northeast and northeast, and in a second location approximately 45 – 60 km away, also to the east-northeast and northeast, the distances and direction depending on the monitoring site.

In Sulaymaniyah, little background information on general Sunn pest levels and pesticide treatments is available, and only one site was monitored. This site was located approximately 37 km south-southeast of where Sunn pest was hand collected in late 2005, although there are mountains up to 2,000 m high between the site and the collection site. The site was also approximately 17km north-northwest of the mountain at which Sunn pest was also hand collected in late 2005.

Sunn pest levels at this site were lower than the average in Dahuk. Since only one site was monitored, it is difficult to say whether or not the hand collection of Sunn pest at the overwintering sites in late 2005 had an effect on Sunn pest levels in 2006.

RICE TECHNOLOGY DEMONSTRATIONS

Rice grown in Anbar governorate.

Rice is a popular crop for cultivation in Iraq. It is a staple of the Iraqi diet, and farmers produce it in nearly every region of the country. The area annually planted with rice in Iraq amounts to approximately 200,000 hectares, and is increasing each year. This area is distributed as 10,000 hectares in the northern part of Iraq, 100,000 hectares in the central region (Euphrates basin), 50,000 hectares in the south-central region (Tigris basin), and 40,000 hectares in the southern region.

Rice productivity in Iraq is still low as compared to the world average. Production ranges between 2.4 – 3.2 mt/ha for the local aromatic variety (Anbar). This low productivity does not meet increasing consumer demand.

The low productivity of Iraqi rice cultivation can be directly tied to the inefficient soil and crop management practices used by farmers. In order to improve rice production, in 2004 and 2005 ARDI and the Ministry of Agriculture

implemented a Summer Crop Production Program for rice. The objectives of the program were to:

1. Increase rice production by implementing a package of improved agricultural practices on multiple production plots, including improved varieties and cultivation practices;
2. Increase the economic returns for rice farmers; and
3. Provide a training program to the farmers and extension agents on modern rice production practices through workshops and field days.

The program introduced two varieties, Yasmin and Anbar-33. Yasmin is an aromatic and high-yielding rice variety with great potential and Anbar-33 is an improved variety that builds on traditional Anbar varieties that are in high demand by Iraqi consumers.

The improved technology package introduced as part of the demonstration project was developed by the MOA, and includes:

- Land preparation: mechanical plowing and leveling;
- Use of improved seeds, at a sowing rate of 120 kg/ha, planting mid-June;
- Irrigation through flooding and drying method at appropriate times in the growing cycle;
- Appropriate use of chemical fertilizers before and after planting;
- Weed control though the use of herbicide Stam F34;
- Mechanical harvesting.

FARMER FIELD DAYS

Farmer field days are an important part of the MOA/ARDI crop technology demonstration programs. These field days extend the reach of the program to many farmers, introducing them to new technology to use on their own fields to increase yields and income.

In the 2004 Rice Crop Technology Demonstration, 344 farmers attended field days. In the 2005 Rice Technology Demonstration, this number increased to 1,450.

RICE PRODUCTION – TECHNOLOGY DEMONSTRATION SUMMER 2004

ACTIVITIES

In the summer of 2004, ARDI and the MOA cooperated to implement rice demonstrations with the above-mentioned improved technology package in four governorates in central and southern Iraq: Najaf, Qadissiya, Diyala, and Wassit. In each governorate except Wassit, the demonstrations were established on one-hectare area plots. Half the plot was cultivated according to improved practices (demonstration), and the other according to traditional farmer practices (control) for the purpose of comparison. In Wassit, a 1.5 ha site was established with improved practices at the agriculture research station there.

RESULTS

The demonstration plots planted with improved practices showed an average increase in yield of 37% over plots planted with traditional farmer practices. The largest increase was achieved in Diyala, where use of Meshkab-2 variety and the improved package of technology showed an improvement in yield of 78% over traditional farmer practices.

In the test plot planted at the agriculture research station in Wassit, the yield of the Anbar variety of rice was only 3.3 mt/ha. This low production was due in part to a fuel shortage, which prevented proper irrigation of the rice crop.

TABLE 27 RICE YIELDS - DEMONSTRATION AND LOCAL CHECK PLOTS 2004

Governorate	Variety	Number of Sites	Yield (mt/ha)		
			Demo Plot	Local Check	% Improvement
Najaf	Anbar	4	4.7	3.2	47%
	Yasmin	3	5.3	4.4	22%
Qadissiya	Anbar	3	4.2	3.9	7%
	Yasmin	4	5.8	4.1	43%
Diyala	Meshkab 2	1	5.8	3.2	78%
Average			**5.2**	**3.8**	**37%**

The main purpose of the demonstration project was to introduce the new technology package to farmers, and farmer field days were an important element of the project. These field days were held at the time of flowering of the crop. Area farmers were invited to observe the fields, and to discuss with agriculture managers and staff from agriculture directorates in each governorate the technology package and how to implement it on their own fields. A total of 344 farmers attended the field days (one each in Qadissiya and Babylon, two in Najaf).

In addition, many workshops were held before and during cultivation and harvest with staff from the MOA and College of Agriculture – Baghdad University, to discuss implementation of the demonstrations and the technology used. The most important workshop was held in the middle of the season, at which staff from the research centers delivered lectures on proper irrigation and fertilization techniques to maximize rice yields in Iraq, and the role of extension in transferring these techniques to farmers. Many staff from the research centers and MOST attended the workshop, in addition to professors and the Dean of the College of Agriculture – Baghdad University.

TABLE 28 RICE YIELDS, RESEARCH SITE PLOTS 2004

Governorate	Variety	Number of Sites	Yield (mt/ha)	
Wassit	Anbar	1	3.3	n/a

RICE PRODUCTION – TECHNOLOGY DEMONSTRATION SUMMER 2005

ACTIVITIES

In the 2005 rice cultivation season, MOA and ARDI expanded the rice technology demonstrations to locations in eight governorates: Najaf, Qadissiya, Wassit, Diyala, Muthanna, Babylon, Sulaymaniyah, and Erbil. In each governorate, two or three farmers were selected to establish demonstration plots. A total of 17 sites were established. At each site the farmers planted one hectare for improved practices (demonstration) and one hectare for traditional farmer practices (control).

RESULTS

The technical teams collected data on growth and productivity at each site, from both the demonstration sites and the local checks. This enabled a comparison between the traditional practices and improved practices, to demonstrate the

TABLE 29 YIELDS ON DEMONSTRATION SITES (MT/HA), RICE TECHNOLOGY DEMONSTRATIONS 2005

Governorate	Variety	Number of Sites	Yield (mt/ha)		% Improvement
			Improved Practices	Farmer Practices	
Najaf	Anbar 33	3	3.6	2.7	36%
	Yasmin	3	6.4		139%
	Anbar Baghdad	3	3.4		27%
Qadissiya	Anbar 33	3	3.8	3.2	22%
	Yasmin	3	5.6		77%
	Anbar Baghdad	3	3.9		24%
Muthanna	Anbar 33	2	4	3.5	14%
	Anbar Baghdad	2	3.9		11%
Wassit	Anbar 33	3	3.9	3	29%
	Yasmin	3	5.8		91%
	Anbar Baghdad	3	4.4		45%
Diyala	Anbar 33	3	3.5	3.2	9%
	Yasmin	3	3.4		5%
	Anbar Baghdad	3	4.4		36%
Babylon	Anbar 33	3	5.1	4	27%
	Yasmin	3	6.7		67%
	Anbar Baghdad	3	5.2		30%
Erbil	Kurdi	2	2.7	2.6	2%
	Sadri	2	2.8		6%

higher productivity that can be achieved by adopting the improved practices (see Table 29). The biggest gains in yields were achieved with the use of Yasmin variety of rice, which when planted with the improved technology package showed yield improvements of an average of 75% over the local checks.

Field days were held at all seven sites. Area farmers were invited to attend these field days, which were led by the technical teams comprised of staff from the MOA, the College of Agriculture, and ARDI. A total of 1,450 area farmers attended the field days to observe the results of the improved cultivation methods used on the plots. Since each site contained a plot planted with improved practices and one planted with traditional practices, it was easy for farmers to see the difference in the fields, and observe the increased production in the improved practices plot. The technical teams presented information about the improved practices, and the area farmers learned more about how to implement these methods on their own fields. These field days extended the reach of the 2005 rice production program by encouraging these area farmers to adopt the improved cultivation practices to increase production.

SORGHUM PRODUCTION

Sorghum is not extensively grown in Iraq, but it is a potential low cost feed source for both poultry and livestock. Poultry farmers currently rely on domestic wheat sources and expensive maize imports for feed. Sorghum is also an excellent green forage option for livestock, the production of which is also an important economic activity in Iraq.

Sorghum production trials were conducted in Baghdad, Missan, Babylon, Wassit, Qadissiya, Thi-Qar, Muthanna, Tameem, Sulaymaniyah, and Basrah

ACTIVITIES

In order to test the performance of sorghum hybrids in Iraq, ARDI performed trials on 13 imported sorghum hybrids in different agro-ecological zones in Iraq in 2005. ARDI procured and imported 13 hybrids of highly productive sorghum that are known to perform well in ecological regions similar to those in Iraq. These hybrids were thought to be adaptable to the Iraqi environment, especially in moderately saline and water stressed areas.

Mature sorghum showing well formed inflorescence.

ARDI performed varietal trials in ten governorates in order to identify the best performers in different regions of Iraq. These trials were conducted on plots in Baghdad, Missan, Babylon, Wassit, Qadissiya, Thi-Qar, Muthanna, Tameem, Sulaymaniyah, and Basrah. Two plots were planted in each governorate except Sulaymaniyah, where one plot was planted. Each plot was planted with all 13 hybrids, and two domestic synthetic varieties (Inkath and Rabeh) as a control.

Plots consisted of three rows, each 6 meters long, with spacing of 75 cm between the rows and 10 cm between plants. Seeds were sown at a depth of approximately 2 cm. The seeding rate was about 100% more than the desired number of plants harvested per plot. Plots were later thinned to desired test plant populations of 133,000 plants/ha. Seedbed preparation was good at all locations. Seeds were treated before sowing with Thiram (fungicide), and Cruiser (systematic insecticide against stem borer at a rate of 10 ml/ 1kg of seeds). Sowing dates ranged from July 18 – 30, 2005. Hybrids were planted following a Randomized Complete Block Design with three replications (see Table 30). Phosphorus, Potassium and Nitrogen fertilizers were applied in all locations. Weeds were controlled by cultivation, hand weeding and herbicide. Only herbicide currently registered for use on sorghum were used in these trials. All of the experimental plots were irrigated at sowing days.

Five workshops were arranged during the growing season, concerning breeding methods for sorghum plants, physiology, fertilization, weed control, and statistical analysis and methods for experimental procedures on farmer's fields. Eight study tours were arranged for the experimental station's staff of the Ministry Of Agriculture, and undergraduate and post-graduate students of College of Agriculture and Technical Institutes.

Teams of ARDI and MOA staff monitored the plots and recorded the following data for each of the hybrids, plus the local varieties: field emergence, number of days from planting to flowering, plant height, head length, grain weight, grain yield, and grain yield at 15% moisture. These characteristics are useful in evaluating the overall performance of the hybrid. Yield is one of the most important measurements, as high yield is the objective of sorghum production, and also acts as a "sink" for other performance characteristics.

TABLE 30 PERCENT IMPROVEMENT OVER TRADITIONAL PRACTICES, BY RICE VARIETY

Variety	% Increase Over Traditional Practices
Anbar 33	23%
Yasmin	76%
Anbar Baghdad	29%
Kurdi/Sadri	28%

RESULTS

There were significant differences between yields in hybrids and in all locations. In the table to the right, the yields are extrapolated from the yield of the plants.

The most successful trial was achieved in Sulaymaniyah, where the hybrid sorghum plants produced an average of 8.4 mt/ha. There were five hybrids (5, 6, 8, 11, 13) that performed better than the local checks, which also performed well (yields of 9.3 mt/ha and 8.1 mt/ha). This suggests excellent conditions for sorghum production in Sulaymaniyah.

The most successful hybrid overall was Hybrid 13, which produced an average of 5.8 mt/ha over all locations. This hybrid outperformed the local checks in all locations except Babylon and Basrah. Overall, the hybrid genotypes outperformed the local checks by 18%. The improvements gained using the hybrid seed was most striking in Muthanna (73% improvement) and in Tameem (86% improvement).

It must be noted that the results of this report are based on only one season of testing. Another (and ideally two) trial years are necessary to confirm these results.

TABLE 31 AVERAGE YIELDS OF SORGHUM HYBRIDS AND LOCAL CHECKS, BY GOVERNORATE (MT/HA)

Location	Hybrid 1	Hybrid 2	Hybrid 3	Hybrid 4	Hybrid 5	Hybrid 6	Hybrid 7	Hybrid 8	Hybrid 9	Hybrid 10
Baghdad	7.3	4.4	5.6	4.9	4	3.9	4.2	4.1	5.1	5.1
Babylon	4	3.2	4.4	3.7	3.7	3.7	3.9	3.9	3.2	4.5
Wassit	4.7	4.9	5	5.5	6	5.5	5.6	5.7	6.5	5.2
Qadissiya	3.3	3	2.9	1.9	2.7	3	1.6	2.8	3	3.5
Muthanna	3.9	4.1	3.5	3.9	4.2	4.9	5.1	4	3.1	4.1
Thi-Qar	5.6	5.5	4.8	4.4	4.9	3.9	6.7	5.6	4.7	3.7
Basrah	5	8.1	7.7	5.4	4.9	4	4.6	5.1	4.7	4.8
Tameem	8	7.6	7	6.1	7	6.5	7.3	6.4	5.3	5.8
Sulaymaniyah	7.5	8.1	7.6	8.7	9.4	10.1	6.7	9.6	6.1	7
Average – Genotype	**5.5**	**5.4**	**5.4**	**4.9**	**5.2**	**5**	**5.1**	**5.2**	**4.6**	**4.9**

Location	Hybrid 9	Hybrid 10	Hybrid 11	Hybrid 12	Hybrid 13	Average Hybrids	Local Check	Local Check	Average Local check
Baghdad	5.1	5.1	3.6	6.7	5.5	5	5	4.8	4.9
Babylon	3.2	4.5	4.1	3.4	3.9	3.8	5.7	4.3	5
Wassit	6.5	5.2	5.3	5.1	6.3	5.5	6.1	6.2	6.1
Qadissiya	3	3.5	2.8	3.1	3.6	2.9	2.5	2	2.3
Muthanna	3.1	4.1	3	2.8	3.1	3.8	2.3	2.1	2.2
Thi-Qar	4.7	3.7	6.5	5.7	6.1	5.2	3.9	5.7	4.8
Basrah	4.7	4.8	3.7	6.3	5	5.3	5.3	5.1	5.2
Tameem	5.3	5.8	6.7	6.8	8.6	6.9	3.9	3.4	3.7
Sulaymaniyah	6.1	7	9.7	8.4	9.8	8.4	9.3	8.1	8.7
Average – Genotype	**4.6**	**4.9**	**5**	**5.4**	**5.8**	**0**	**4.9**	**4.6**	**0**

IMPROVING MAIZE PRODUCTION

Maize seed hybrids.

There is a potentially large domestic market for maize in Iraq, driven by poultry producers who currently rely on wheat for feed. Maize is a more nutritious feed for poultry, but due to low productivity of maize in Iraq, poultry producers have to buy expensive maize imports to include it in their feed rations. An increase in maize production would provide poultry producers with a source of less expensive domestic maize, which would in turn provide a larger market and higher income for Iraqi maize producers.

The current productivity of maize in Iraq is extremely low by international standards, averaging about 1 – 1.5 mt/ha, and therefore is not always a profitable activity for producers. This is largely due to the use of local open-pollinated varieties, as opposed to hybrids. Hybrids offer farmers increased yields, wider adaptability and reliability of both performance and quality, by exploitation of heterosis (hybrid vigor).

Hybrid maize seed production requires relatively high investments compared to other crops, such as wheat, and this is reflected in the higher price of the seed. The production of hybrid maize seed requires the production of inbred maize seed over several seasons, and then crossing to produce suitable, productive hybrid seed. In addition to the capital investment to create inbred lines, this requires a good deal of skill and knowledge of plant breeding.

ARDI took a dual-track approach to increasing maize production in Iraq through the introduction of hybrid maize seed. ARDI procured hybrid maize seed from international sources to test performance and establish suitability in different regions of Iraq through varietal testing. Once suitability was established, ARDI conducted production programs to show farmers the benefits of using hybrid maize seed, and to stimulate private sector interest in importing and selling hybrid maize to increase farmers' access to hybrid seed in Iraq.

At the same time, ARDI worked with the MOA and the private sector to lay the foundation for a hybrid maize seed industry in Iraq through production of stocks of inbred maize seed for hybrid maize seed production. ARDI imported inbred maize seed from public sources in the US, established nurseries to build the stock of this seed, and began the process of crossing to create suitable, productive hybrids.

The following sections will first discuss ARDI's work with imported hybrid maize seed, and secondly ARDI's efforts to build a hybrid maize seed industry in Iraq.

(Opposite page) Maize is a tall, annual cereal grain that bears fruit on ears (female) that are fertilized by pollen from the male tassels at the apex of the bamboo-like stem.

HYBRID MAIZE VARIETAL TRIALS

During the summer 2004 and spring 2005 maize cropping seasons, ARDI and the MOA tested 19 imported hybrids, in addition to three local varieties, to determine performance levels and establish suitability for use in various regions of Iraq. The imported hybrids were selected for testing based primarily on maturity group of FAO 500-600 and their performance in a similar environment in Texas. The Ministry of Agriculture and College of Agriculture/University of Baghdad administrated the project, supported by financial and technical assistance from ARDI.

The objectives of the MOA/ARDI 2005 varietal trials were to:

- Provide data so that in subsequent years the best suitable genetics can be created to produce hybrid maize. This is important because in 2003, local seed hybrids and synthetic varieties from Iraqi seed companies and experimental stations were lost to looting.
- Increase farm crop production in subsequent years by introducing highly productive maize hybrids from the United States, which have proven previously to be adaptable to the Iraqi environment;
- Provide a training program for new graduates and post-graduate students by improving their skills in conducting research field work in farmers' fields;
- Develop and improve the capacity of the experimental station staffs of the Ministry of Agriculture and the College of Agriculture for technology development and extension.

Maize trial in a Complete Randomized Block Design.

Using a reliable water source for the field trial.

ACTIVITIES

In 2004, testing sites were established in five governorates (Baghdad, Tameem, Babylon, Wassit, and Qadissiya), with two testing sites in each governorate. These locations were chosen because they represent a range of agro-ecological zones, enabling researchers to analyze the performance of the hybrids and establish suitability for a variety of zones throughout Iraq. In 2005, ARDI and the MOA established a second round of trials for 16 of the hybrids and two different local varieties in the same locations, with an additional location in Sulaymaniyah. This second round of testing was important because in any varietal testing project it is essential to replicate the trials in order to confirm results.

The trials were conducted following a Complete Randomized Block Design with six replications. Plots consisted of six 75 cm rows, five meters long, and spacing of the plants at 15 cm within a row. Phosphorus, potassium and nitrogen fertilizers were applied in all locations.

Seeds were treated before sowing with Thiram (fungicide), and Cruiser (systematic insecticide against stem borer) at a rate of 10 ml/kg of seeds. Phosphorus, potassium and nitrogen fertilizers were applied in all locations. Weeds were controlled by cultivation, hand weeding, and herbicide. All experimental plots were irrigated at 7-10 days intervals.

Hybrid maize harvest.

In the first round of testing the plots were harvested in November and December 2004, and in the second round of testing harvest occurred in June 2005. In 2004 the crop was harvested by taking ten plants from the two center rows, then drying them to 15.5% moisture. At a later date, after drying, the ears were shelled and grain weight was determined, and converted to a mt/ha value.

In 2005 the entire two center rows were harvested and weighed. Moisture measurements were taken in the field to determine maturity and yields were calculated in mt/ha using the following formula:

Yield = wet weight*factor(118.343) or
(94.6745)*(100 - % actual moisture)
width in meters / length in meters/number of rows harvested.

Note: factor (118.343) used when using only grain, factor (94.6745) used when using grain with cobs.

RESULTS

Based on the results of these two seasons of testing, it is clear that the hybrids performed well in all locations in which they were tested. The best imported hybrids produced over 30% more than the local synthetic varieties (see Table 32).

An important element of these varietal trials was to provide training for new university graduates from agricultural colleges and technical institutes and for

MOA research and extension staff. To this end, five workshops were arranged during each growing season, concerning breeding methods of maize plants, physiology, fertilization, weed control of maize, and methods of statistical analysis and experimental procedures on farmer's fields. In addition, fifteen study tours were held over the course of the two growing seasons to observe the experimental plots. Over 1,000 maize farmers, students of the College of Agriculture and Technical Institutes, and MOA staff attended these field days.

TABLE 32 AVERAGE TOTAL YIELD (MT/HA) OF CORN GENOTYPES IN SUMMER SEASON 2004

Genotype	Baghdad 1	Baghdad 2	Babylon 1	Babylon 2	Wassit 1	Wassit 2
Hybrid 1	6.89	10.54	7.96	7.24	6.96	6.96
Hybrid 2	8.17	9.86	7.46	7.64	8.39	8.39
Hybrid 3	10.38	9.63	7.1	8.57	10.58	10.58
Hybrid 4	7.32	9.25	7.67	7.24	9.83	9.83
Hybrid 5	9.66	9.36	6.62	6.65	8.38	8.38
Hybrid 6	7.33	8.68	6.11	7.32	7.93	7.93
Hybrid 7	9.68	12.39	7.8	7.72	10.6	10.6
Hybrid 8	8.33	10.38	7.62	8.31	10.86	10.86
Hybrid 9	8.29	10.4	7.51	7.61	9.53	9.53
Hybrid 10	9.56	10.29	7.2	8.71	8.73	8.73
Hybrid 11	7.51	8.19	8.02	9.56	9.84	9.84
Hybrid 12	8.48	8.08	6.86	6.91	7.83	7.83
Hybrid 13	7.52	9.94	6.43	6.98	7.88	7.88
Hybrid 14	7.51	8.46	5.86	8.62	8.53	8.53
Hybrid 15	5.9	9.34	8.37	8.98	6.81	6.81
Hybrid 16	7.28	9.89	7.02	8.36	7.94	7.94
Hybrid 17	6.76	6.32	--	8.67	7.84	--
Hybrid 18	6.58	7.87	--	8.82	8.48	--
Hybrid 19	5.73	9.23	--	8.55	7.99	--
Hybrid 20	5.74	7.26	--	9.34	8.46	--
Hybrid 21	7.38	7.97	--	8.49	8.93	--
Local 1	5.85	7.34	6.38	7.15	7.15	7.15
Local 2	6.88	7.65	6.81	7.81	9.11	7.81
Average by Location - Hybrid	**7.71**	**9.21**	**7.23**	**8.11**	**8.68**	**8.79**
Average by Location- Local	**6.37**	**7.5**	**6.6**	**7.48**	**8.13**	**7.48**

Note: All yield data is expressed in tons of grain per hectare at 15.5% moisture, and weight measurement is in mt/ha.

Skilled workers planting hybrid based seed according to a set research design.

Tameem 1	Tameem 2	Qadissiya 1	Qadissiya 2	Average by Genotype
13.34	12.78	8.89	9.08	**9.06**
12.33	11.96	9.28	10.38	**9.39**
11.46	10.98	11.75	10.97	**10.2**
12.01	12.39	10.42	12.04	**9.8**
11.73	12.56	9.26	12	**9.46**
11.51	10.39	8.31	11.08	**8.66**
11.78	12.19	10.13	11.55	**10.44**
11.01	11.01	12.92	9.86	**10.12**
10.86	10.44	10.46	9.78	**9.44**
11.98	9.88	10.37	10.56	**9.6**
11.06	10.62	11.04	10.68	**9.64**
10.95	11.21	8.94	7.99	**8.51**
10.89	12.11	8.61	9.42	**8.77**
10.44	10.98	10.27	9.26	**8.85**
10.52	12	8.93	10.58	**8.82**
10.19	11.01	7.9	10.04	**8.76**
10.09	13.39	7.18	--	**8.61**
11.21	12.04	6.96	--	**8.85**
9.84	10.04	5.41	--	**8.11**
11.53	14.24	7.96	--	**9.22**
10.04	12.32	6.84	--	**8.85**
9.48	7.75	9.26	8.86	**7.64**
11.29	11.94	9.11	9.24	**8.77**
11.18	**11.64**	**9.13**	**10.33**	
10.39	**9.85**	**9.19**	**9.05**	

Incomplete pollination.

TABLE 33 AVERAGE TOTAL YIELD (MT/HA) OF CORN GENOTYPES IN SUMMER SEASON 2005

Genotype	Baghdad 1	Baghdad 2	Babylon 1	Babylon 2	Wassit 1	Wassit 2
Hybrid 1	4.6	8.83	6.5	6.5	9.4	10.82
Hybrid 2	6.6	8.41	5.1	5.1	11.62	11.83
Hybrid 3	6.8	8.5	5.81	5.8	7.9	11.17
Hybrid 4	11.37	10.4	6.7	6.8	9.51	12.77
Hybrid 5	8.8	9.9	4.9	4.9	9.9	13.5
Hybrid 6	7	8.89	5.6	5.6	8.11	9.82
Hybrid 7	7.5	8.63	4.1	4.1	13.34	12.7
Hybrid 8	8.7	11.01	7.2	7.2	10.89	14.22
Hybrid 9	7.5	9.2	5.6	5.6	10.8	13.92
Hybrid 10	5.3	6.3	4.6	4.7	9.11	13.81
Hybrid 11	5.99	6.6	4.5	4.5	9.7	13.47
Hybrid 12	5.7	10.2	5.8	5.7	9.4	9.5
Hybrid 13	6.99	10.4	5.1	5.4	8.3	10.61
Hybrid 14	3.5	7.15	3.8	3.8	9.7	10.65
Hybrid 22	5.6	10	7.3	7.3	12	11.11
Hybrid 23	5.3	10	4.7	4.7	12	13.03
Local 1	5.6	6.1	5.3	5.3	10.31	11.62
Local 2	5.3	5.2	5.9	5.9	6	10.06
Average by Location – Hybrids	**6.7**	**9.03**	**5.46**	**5.48**	**10.11**	**12.06**
Average by Location- Local	**5.45**	**5.65**	**5.6**	**5.6**	**8.16**	**10.84**

Note: All yield data is expressed in tons of grain per hectare at 15.5% moisture, and weight measurement is in mt/ha.

Tameem 1	Tameem 2	Qadissiya 1	Qadissiya 2	Sulaymaniyah 1	Sulaymaniyah 2	Average by Genotype
8.14	5.53	11.3	8.2	5.21	5.81	**7.57**
8.07	5.3	8.7	6.4	6.83	5.56	**7.46**
8.1	4.01	9.8	7.1	5.73	4.85	**7.13**
7.29	4.04	11.4	8.2	5.6	5.22	**8.28**
8.45	4.7	8.3	6.92	5.63	5.78	**7.64**
8.52	4.5	8.6	7.5	5.69	6.62	**7.2**
9.14	4.32	9.5	8.2	5.64	5.52	**7.72**
9.15	4.99	12.9	8	6.6	5.22	**8.84**
7.56	5.86	10.2	8.2	5.69	5.69	**7.99**
8.29	4.49	8.33	6.3	5.44	3.89	**6.71**
7.34	5.11	8.39	5.6	4.43	4.59	**6.68**
7.38	5.11	8.33	6.9	6.53	6.34	**7.24**
7.95	4.92	8.4	7.2	5.46	6.12	**7.24**
7.39	6.16	6.1	5	4.91	4.71	**6.07**
8.91	6.07	12.1	7.22	5.58	5.67	**8.24**
6.85	5.35	10.8	5.7	5.46	6.07	**7.5**
7.19	4.65	10.9	4.3	4.32	3.23	**6.57**
5.48	3.71	9.3	4.45	3.57	2.85	**5.64**
8.03	**5.03**	**9.57**	**7.04**	**5.65**	**5.48**	
6.34	**4.18**	**10.1**	**4.38**	**3.95**	**3.04**	

ON-FARM HYBRID MAIZE PRODUCTION

After two seasons of testing to establish suitability of the imported hybrids, ARDI and the MOA expanded the hybrid maize production program to promote production on a larger scale, on private farms. The objectives of these farm-level production projects were to demonstrate to farmers the economic feasibility of large-scale maize production in Iraq and stimulate interest in local agribusiness to produce or import hybrid maize to replace low-yielding Iraqi varieties. These production demonstrations also provided the MOA and ARDI researchers with additional information to establish suitability of hybrids in different regions, and provided ARDI with an opportunity to stimulate interest in private sector agribusiness for hybrid maize importation and retail.

TABLE 34 ON-FARM HYBRID MAIZE PRODUCTION PROJECT 2005

Governorate	Number of Farmers	Seed Distributed (mt)	Area planted (ha)	Yield Hybrid Seed (mt/ha)
Diyala	250	5	250	n/a*
Babylon	400	8	350	n/a
Wassit	400	8	350	n/a
Qadissiya	250	5	250	n/a
Missan	150	3	150	4.7
Kerbala	120	3	120	n/a
Tameem	274	8	273	9
Total	**1,844**	**40**	**1,743**	**--**

*Plots in Babylon, Wassit, Qadissiya and Kebala were supervised by the MOA, and production data was not delivered to ARDI

HOW INBRED MAIZE LINES ARE CREATED:

STAGE 1

1. Selection of a desired characteristic: A population of maize plants is planted. A plant with a particular positive characteristic is targeted- it may exhibit insect or drought resistance, high yield, or good root quality.
2. Prevention of outside pollination: Before the plant flowers, its reproductive organs are protected from outside pollination. Bags are placed over the "silks," the part of the female reproductive system that receives pollen, and the "flower," the part of the male reproductive system that produces pollen.
3. Self-pollination: When the maize plant flowers, pollen is collected in the pollen bag and is used to pollinate the silk on the same plant.
4. Collection of seed: The mature ear of the maize plant contains seeds that were produced through the self-pollination described in step 3. These seeds are collected for Stage 2.

2005 SUMMER MAIZE SEASON

ACTIVITIES

In 2005, ARDI worked with the MOA to establish maize production sites in Diyala, Tameem, Babylon, Wassit, Qadissiya and Kebala governorates, on the lands of nearly 1,844 maize producers. Based on the results of the varietal tests in 2004 and 2005, ARDI procured 40 mt of hybrid maize seed of the same family of hybrids as those that were tested and performed well. ARDI implemented the demonstration sites in Missan and Tameem, while the MOA supervised the distribution and planting of seed in Diyala, Babylon, Wassit, Qadissiya and Kebala governorates (see Table 34 on prior page).

ARDI also cooperated with Syngenta, a private sector agricultural input supply company to implement the 2005 production program. ARDI procured the seed from Syngenta, which then provided farmers with private sector extension. Syngenta representatives worked with the farmers to supervise application of herbicide and seed treatment with insecticide and fungicide.

RESULTS

ARDI collected production data from the sites in Missan and Tameem; the other sites were supervised by the MOA, and they collected and kept production data from those sites. The yields from the hybrid maize sites were much higher than production from local maize varieties, which is estimated to be approximately 1 – 1.5 mt/ha. In Missan, farmers achieved an average yield of 4.7 mt/ha using hybrid maize, and in Tameem farmers were able to produce 9 mt/ha, over six times the productive capacity of local maize.

2006 SUMMER MAIZE SEASON

In 2006, ARDI implemented a second hybrid maize production project in coordination with Iraqi private sector entities including an NGO and a cooperative. It was important to begin building private sector interest and capacity for hybrid maize seed procurement and sale, because until a hybrid maize seed industry can be built up in Iraq, it will be necessary to import hybrid maize seed from international seed companies. This requires the establishment of Iraqi agribusinesses to import and sell the seed; these agribusinesses can also be a source of private extension services for farmers to help them increase their maize yields.

ACTIVITIES

For the summer 2006 maize cropping season, ARDI partnered with an Iraqi NGO to work with 100 maize farmers in Anbar, Baghdad, and Tameem governorates. ARDI procured 25 tons of high quality maize seed, which the NGO distributed to the farmers. Each farmer planted 10 – 15 ha of land to maize, for a total of 1,250 ha. The NGO provided technical assistance to the farmers throughout the cropping season to introduce modern cultivation techniques for maize, including the proper use of fertilizers and pest control. The maize crop will not be harvested until after the publication of this report, but the producers can expect yields of 7 – 10 mt/ha, for a total production of 10,000 mt of maize. In exchange for the hybrid seed and technical assistance, the farmers will return to the NGO a portion of their harvested grain at the end of the season. This will

capitalize the NGO for the next cropping season, so that it can again make hybrid seed and other inputs available for farmers to purchase. By accepting in-kind payment of grain at the end of the season, the NGO will enable farmers who could not otherwise afford the up-front cost of seed and inputs to use high quality inputs and increase their production and income.

ARDI procured an additional 25 mt of hybrid maize seed to capitalize a cooperative formed for hybrid maize seed procurement and sale. The cooperative will establish a similar program to work with farmers in Tameem, Erbil, Dahuk, and Ninewa in the cropping season after this report is published.

ARDI found that there was additional interest in the private sector in establishing agricultural input supply companies for the sale of hybrid maize seed and other inputs, and providing private extension services to farmers. In June, ARDI held a workshop for six NGOs interested in establishing businesses for seed cleaning and agricultural input supply. These NGOs worked with the ARDI Agronomic Crop Production specialist to learn the steps necessary to establish a successful business. ARDI worked with these NGOs to create business plans, which the NGOs are now following to establish their businesses. The development of agricultural input supply from the private sector will increase farmers' access to high quality, productive inputs that will enable them to increase their production and income.

HYBRID MAIZE SEED PRODUCTION – INBRED MAIZE

At present, the only source of hybrid maize seed for Iraqi farmers is through international seed companies. There is no domestic hybrid maize seed industry in Iraq to provide farmers with a source of productive, suitable hybrid maize seed. From 2003 to 2006, ARDI worked with the MOA and the private sector to establish such a hybrid maize seed industry. This involved the donation of

HOW INBRED MAIZE LINES ARE CREATED: (CONTINUED)

STAGE 2

1. Selection of the desired characteristic: The seeds produced at the end of Stage 1 are planted. When the maize grows, the plants with the desired characteristic are selected.
2. Self-pollination: These plants are self-pollinated in the same process described in Stage 1.
3. Collection of seeds: The seeds are collected from the mature ears, and the cycle continues through multiple seasons.

At the end of multiple cycles, the seeds that are produced contain the characteristic that was isolated through the inbreeding process. These seeds represent an inbred maize line. This inbred seed can continue to be replicated without the process of manual self pollination; large plots can be planted with inbred seed and allowed to self-pollinate within the plot, provided that the inbred maize seed is planted with a buffer of at least 1km from other maize plants, to ensure no cross-pollination occurs.

Crossing these inbred creates strong, vigorous maize seeds with desirable characteristics. However, these hybrids will not reproduce true to type, so it is necessary to maintain stocks of inbred maize seed to continue the process of crossing for hybrid production.

inbred maize seed from public sources in the US and the establishment of nurseries to increase the stock of the seed over several seasons. ARDI worked with the private sector to hand off this hybrid maize seed production program to a local cooperative, which will now be responsible for maintaining stocks of inbred maize seed and creating suitable hybrids through crossing.

INBRED MAIZE TRIALS 2004, 2005, 2006

In 2004, ARDI procured ten inbred lines of maize seed from the public sector in the United States. ARDI gave the seeds to the MOA, and continued to work with researchers at the MOA to propagate the lines. The seeds, which numbered approximately 100, were planted in a nursery at a MOA research station in Baghdad, in order to multiply the lines and increase the supply of the inbred seeds. In addition, some of the inbred plants were crossed to produce hybrids. This testing is important to determine the productivity of different maize hybrids in Iraq, and select the most productive to increase yields. The process was conducted as described in the side bars (on prior page).

ARDI provided technical assistance to MOA researchers in the form of a Maize Production Workshop, which aimed to increase knowledge about seed breeding, and in particular, the production of maize seed. Staff from the State Board for Agriculture Research attended the workshop.

At the end of the season, ARDI harvested the inbred maize seed, which was kept and planted the next season to continue the process of increasing the stock of available inbred maize seed, and to begin the process of creating and testing suitable hybrid maize crosses.

In the 2005 spring cropping season, ARDI again established a nursery using the inbred maize seed produced in 2004. In this season, ARDI made a decision that a private sector entity was most appropriate to continue work to establish a hybrid maize seed industry, through inbred maize seed production and hybrid crossing after the end of the ARDI program. At harvest, the nursery produced 5.5 kg of inbred maize seed. ARDI staff also began crossing inbred seed to create hybrids, to test the suitability of the various hybrid crosses.

In the 2006 season, ARDI began work with a cooperative formed for inbred maize seed production and hybrid crossing. The cooperative was granted the stock of inbred maize seed built up over the 2004 and 2005 cropping seasons. In addition, ARDI provided technical assistance to plant the nurseries for the 2006 summer cropping season, and to begin crossing hybrids again to continue testing suitability. This cooperative will continue to build and maintain stocks of inbred maize seed, and will eventually begin producing hybrid maize seed on a commercial level for sale to farmers. This will provide farmers with a domestic source of hybrid maize seed, in addition to sources from international seed supply companies.

POTATO PRODUCTION

Potato field with new center pivot irrigation system.

Despite increasing domestic consumption of potatoes in Iraq, and technological developments to improve potato productivity over the last 30 years, potato production has remained lower than in other countries. Iraq currently imports potatoes from neighboring countries, including Iran, Turkey, and Syria.

There is therefore an opportunity for Iraqi farmers to adopt improved technologies to increase production, meeting domestic demand and decreasing potato imports. As part of the 2004 – 2005 Winter Crop Technology project, ARDI and the MOA cooperated to implement a demonstration of improved cultivation methods for potatoes, including the use of hybrids, appropriate cost-effective use of chemical fertilizers and pesticides, mechanical planting, and furrow planting. The data from the harvested demonstration plots indicate that the improved methods, particularly the use of the El Paso hybrid, resulted in higher yields and larger tubers.

Désirée potato

ACTIVITIES

Demonstrations were established in eight locations in regions where potatoes have traditionally been cultivated: Baghdad (four locations), Ninewa (two locations), and Tameem (two locations). Each demonstration site had a total area of two hectares; one hectare was planted with improved practices (demonstration) and one hectare was planted with farmers' traditional practices (control).

The demonstration plots were planted with two varieties imported from the Netherlands: Désirée class E and El Paso class A. The local check plots were controls.

Flowers of the eggplant (below) are similar to the potato (above) and tomato.

The potato, tomato, and eggplant are all part of the *Solanaceous* species in taxonomy.

In addition to the use of these improved varieties, the following practices were also applied:

- Soil preparation with plowing, disking + rotivating + furrowing;
- Seeding rate of 3mt/ha, with furrows;
- Tubers treated with mixture of fungicide + bactericide immediately before planting;
- Fertilizer applied according to proper methods, including a foliar treatment;
- Weed control with Sincor or patoran preplanting, 500 gm/ha;
- Pest and disease control with locally purchased pesticides to control insects and bacterial and fungal diseases;
- Harvest: The farmers began cutting the foliage when the lower leaves of the plant started to turn yellow and fall to the ground, which is considered the first sign of maturity. The cutting was done either by hand or by mower, for large areas. After this point, the farmers harvested the

potatoes either by tractor or by mechanical harvester.

The potato demonstrations were supervised by a team from the MOA, the College of Agriculture at the University of Baghdad, and ARDI. This team held a workshop early in the demonstration process to discuss project objectives. Research staff also lectured on the nature of different potato hybrids, and weeds and fertilizers.

Potato field data collection to evaluate the impact of proper fertilizer and pesticide use.

During the growing season, field days were held to give area farmers the opportunity to observe the higher levels of production achieved using improved technology on the demonstration plots. Field days were held at the Baghdad and Tameem demonstration plots in May, with a total of over 100 participants. Staff from the College of Agriculture and the Agriculture Directorate discussed the new methods with the farmers, who were very interested in adapting the new technologies to increase their own production. MOA and ARDI technical staff noted that farmers can adopt some of the improved techniques to increase their profits at no cost. For example, some farmers in the demonstration overused chemical fertilizers and pesticides in their plots; in some cases, the farmers used more than double the recommended quantity of fertilizer. The extra amounts cost money but do not contribute to increased production. If farmers simply decrease the amounts of pesticides and fertilizers to recommended quantities, they will decrease their input cost and increase their profits.

RESULTS

The average yield of the El Paso variety planted with improved practices (two plots) was 15.9 mt/ha, compared to the average yield of 9.7 mt/ha for the Désirée hybrid planted with improved practices (six plots), and 7.3 mt/ha for the Désirée hybrid planted with farmers' practices (eight plots). The El Paso hybrid

Désirée potato plant

Potato tuber

Potato sprouting

showed good results against diseases. No infection was recorded in either location. El Paso is the most favored hybrid in the Iraqi market and has been tested for six successive seasons by private and public sector importers.

The potato yields were graded according to three sizes: 25-33mm, 35-55mm, and greater than 55mm. The El Paso variety tubers were consistently large; 60% of the tubers were larger than 55mm, and 26% were in the 35mm – 55mm range. In comparison, the Désirée hybrids planted with improved practices yielded 27% in the 55mm+ range, and 37% in the 35mm – 55 mm range. The Désirée hybrids planted with farmers' traditional practices yielded 28% in the 55mm+ range, and 35% in the 35mm – 55 mm range.

The plots planted with improved practices showed no signs of disease or pests, while every plot planted with farmers' traditional practices was affected by disease and/or pests. Four plots were affected by Potato Leaf Roll Virus (PLRV), five by Potato Virus M (PVM), and one by early blight (two plots had both PLRV and PVM).

2.2 INFRASTRUCTURE FOR AGRICULTURAL SECTOR MECHANIZATION

Agriculture Mechanization Rehabilitation project served 17 governorates.

INTRODUCTION

The production of such major crops as cereals and legumes in Iraq is largely mechanized. Some farmers own their own tractors or combines, and those who do not rent services from other farmers for cultivation and harvest. When equipment breaks down, it affects both the owner and other farmers who depend on this equipment for agricultural production. The poor condition of Iraq's tractor fleet, and the lack of repair and maintenance services in general for agricultural machinery, have led to significant losses in agricultural production, since farmers do not have sufficient access to agricultural machinery during key times in the cropping season.

To improve access to agricultural machinery, ARDI implemented an Agriculture Mechanization Rehabilitation project to repair 4,719 tractors and 18 combines during 17 of Iraq's 18 governorates in 2005 and 2006. ARDI also provided vocational training to a total of 216 Iraqi mechanics to build capacity for agricultural machinery repair and maintenance services, especially in rural areas.

REPAIRING TRACTORS AND COMBINES

One of the major obstacles to developing a modern agricultural system in Iraq is the shortage of properly functioning agricultural machinery. Although accurate estimates are not available, the MOA and FAO have reported that about 78,000 tractors and 5,600 combines are operating in Iraq. Tractors were procured and distributed to farmers at subsidized prices under the Oil-For-Food program, but much of this stock was sold across the border. The remaining stock is aging (about 80% is at least 16 years old) and operating at less than rated or design capacity. Manufacturer Massey Ferguson estimated that half of the 17,000 tractors it has sold in Iraq need repair.

The poor condition of the tractor and combine fleet has reduced farmers' access to agricultural machinery during key points of the cropping season, which has resulted in reduced yields and production, primarily for wheat and barley, but

TABLE 35 MECHANIZATION PROJECTS 2005-2006

Activity	Number of Projects	Projects Primary Beneficiaries
Tractor/Combine Repair	5	1 Case New Holland repair program (private sector)
		2 Massey Ferguson repair programs (private sector)
		1 multibrand tractor and combine repair program (private sector)
		1 mechanization monitoring program (private sector)
Mechanics Training	6	5 vocational training courses in agricultural mechanics and welding (private sector)
		1 Case New Holland mechanics training (private sector)

also for legumes and vegetable plots. Inoperable tractors can constrain production in several ways, for example, by restricting plowing depth or limiting coverage area. Reduced production, in turn, lowers farmers' income.

The goals of this program were to repair approximately 5,000 tractors and return them to use for agricultural production, improving the agricultural sector's capacity to satisfy domestic food demand. This will increase rural income and employment, and eventually contribute to developing export markets for several crops.

(above and below) Tractors in a field awaiting inspection for consideration for repair.

ACTIVITIES

In 2005, ARDI initiated the Agricultural Mechanization Rehabilitation program, which focused on repairing and returning to use for agricultural production approximately 5,000 tractors of two dominant international brands in Iraq: Case New Holland, which owns the Fiat 780 brand of tractors, and Massey Ferguson. Both these companies have US parent companies. Focusing on these two brands simplified the work plan and ensured economies of scale. In 2006, ARDI also implemented a grant to repair approximately 5,000 additional tractors and combines of local brands.

Tractors at one of the workshops awaiting repair.

SUCCESS STORY:
AGRICULTURE SECTOR MECHANIZATION PROJECT SPARKS NEW BUSINESS FOR REPAIR WORKSHOPS

In late summer 2006, as the ARDI Agriculture Sector Mechanization project drew to a close, word of the project's tractor repairs spread rapidly to tractor owners who had not participated in the program. In Erbil, some of these owners who wanted repairs for the own tractors went to the CNH distributor repair workshop, willing to pay for CNH branded parts and repairs. The distributor was using its entire inventory for the repair project, but at least 30 tractor owners purchased nonbranded parts available on local markets, and then brought their tractors to the distributor and paid its trained technicians to perform the repairs.

This demand for professional repair services was an encouragement to the distributor to stock CNH-brand parts and to continue to provide repair service. It also highlighted the need to increase capacity for repair and maintenance services in Iraq.

This program is an example which demonstrates the effective use of development funds to encourage sustainability of program objectives through private sector investments.

ARDI and the MOA agreed that the mechanization rehabilitation effort should be led by the private sector. ARDI worked with CNH and MF to select local distributors who would implement the repair program for those brands of tractors, and with a local NGO to implement the program to repair tractors and combines of local brands.

During the first phase of the program, ARDI and the MOA generated a database of tractors throughout Iraq that were in need of repair. The MOA placed announcements in local media to let farmers know they could apply for an inspection at their local district office. It then screened applications to eliminate tractor owners who were using their tractors for nonagricultural purposes, such as hauling bricks. In most cases, farmers were responsible for bringing their tractors to the inspection station. Teams of engineers inspected inoperable tractors and combines (equipment that is unable to operate at or near design capacity), and estimated the repair requirements of each. The engineers then developed databases of all inspection records to determine the parts needed for each repair, as well as the costs. The vehicles that were most cost-effective to repair were selected from this database.

TABLE 36 TRACTORS AND COMBINES INSPECTED AND CONSIDERED FOR REPAIR

Model Distributor/NGO	Governorates	Machines Inspected	Machines Considered for Repair
Case New Holland (MICTA)	Anbar, Babylon, Baghdad, Dahuk, Diyala, Erbil, Kerbala, Missan, Muthanna, Najaf, Ninewa, Qadissiya, Salah al-Din Sulaymaniyah, Tameem, Thi-Qar, Wassit	5,021	4,143 tractors 625 combines
Massey Ferguson (Zozik)	Dahuk, Erbil, Ninewa, Sulaymaniyah, Tameem	4,258	2,758 tractors
Massey Ferguson (Al-Khorayef)	Anbar, Babylon, Baghdad, Diyala and Salah al-Din	2,666	985 tractors
Antar (a local brand) and others (Khabor)	Dahuk	116	98 tractors 18 combines
Total	**17**	**12,061**	**8,627**

Once the list of machines to be considered for repair was compiled, ARDI worked with the distributors to narrow this list to minimize parts inventory problems and improve the cost efficiency of the repair process. ARDI limited Case New Holland repairs to a single pervasive model, while several Massey Ferguson models were included because most of this manufacturer's models used the same parts. ARDI negotiated repair cost estimates with the distributors,

who then ordered the required parts, almost all of which had to be shipped into Iraq from international sources.

The distributors and the NGO then established workshops for the repairs. Some of these workshops were owned by the distributors, while others were joint ventures or independents contracted for repairs. The distributors and the NGO contacted the equipment owners whose repairs were accepted, and transported their tractors to the workshops. The repaired tractors were then delivered back to their owners.

TABLE 37 TRACTORS AND COMBINE REPAIRS AND THEIR COSTS

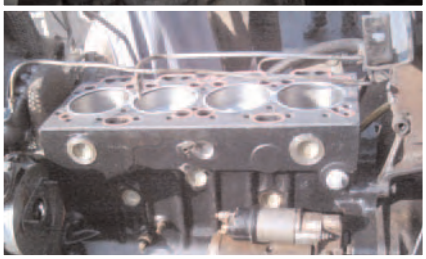
Model Distributor/NGO	Vehicles Repaired	Average Cost to Repair
Case New Holland (MICTA)	2,742 tractors	$4,664
Massey Ferguson (Zozik)	1,725 tractors	$4,157
Massey Ferguson (Al-Khorayef)	156 tractors	$5,400
Antar (a local brand) and others	98 tractors	$630
Khabor	18 combines	
Total	**4,739**	

The repairs ranged from engine and transmission overhauls and replacements to the replacement of starter motors and brakes. Although workshop repair times varied, most repairs were completed within three days. All repairs of CNH and MF tractors were made at no cost to the farmer. In the case of repairs made to local brand tractors, farmers paid, on average, 29% of the repair costs.

Independent monitors from a private company supervised the repair process. They verified that each tractor (identified by chassis and engine number) brought to the workshop had been inspected and was eligible for repair. They also observed the repair process to track the work and replacement of parts against the needs identified during the inspection. The monitors also confirmed the satisfactory completion of repairs.

The full set of rehabilitated tractors will be used for the first time in the 2006 – 2007 planting season, which will occur after the publication of this report, so it is difficult to determine the full impact of the rehabilitation project. Anticipated results include:

- Increased revenues for farmers from expanded cultivation and increased production. The repaired tractors should enable the cultivation of an additional 45,000 hectares of land (including both area expansion and a more intensive and timely cultivation of existing land). The additional value of this production over five years (assuming one crop of wheat per year)



is an estimated $23,745,487 (net present value, discounted at 10%).

- Increased revenues for farmers from increased contract services. Assuming that farmers can rent out their tractors for 190 days a year and charge for plowing, seeding, cultivation, harvesting, and transport, the total revenue from contract services will be $81,206,362 over five years (net present value, discounted at 10%).

The ARDI Agriculture Sector Mechanization project has also led to the development of a repair shop network and distribution network in Iraq for new tractors, combines, and other agriculture implements. The workshops that were set up by the Massey Ferguson and Case New Holland distributors will continue to offer agricultural machinery repair services, and will also sell new machinery. ARDI implemented a complementary program in rural mechanic training to build capacity for repair and maintenance services for agricultural machinery, which is described in the next section.

TRAINING

Tractor owners in rural areas rely on local workshops for repair and maintenance services. These workshops are run by self-trained mechanics who often lack the facilities, appropriate equipment, and skills to provide effective repair services. As a result, machine owners often have to travel to urban centers for repairs and servicing, which takes the machines out of operation for longer periods than if repair facilities were available locally. During critical planting and harvesting times, these delays and the resulting lack of access to agricultural machinery can significantly reduce on-farm productivity.

TABLE 38 MECHANICS AND WELDERS TRAINED

Training Location	Mechanics Trained	Welders Trained	Total
Sulaymaniyah	21	21	42
Dahuk	19	27	46
Erbil	12	16	28
Tameem	27	31	58
Turkey	42	0	42
Total	**121**	**95**	**216**

Building the capacity of rural mechanics was an essential step in improving the availability of agricultural machinery repair and maintenance services to tractor owners, to reduce production losses. ARDI worked with local companies and NGOs to implement five training courses for a total of 174 rural mechanics and welders from Sulaymaniyah, Dahuk, Erbil, and Tameem. Each training course had separate sessions for mechanics and welders. The training for mechanics covered work hazard protection, diesel motors, water cooling, oil and air cycling, troubleshooting, and preventive maintenance and testing, among other topics. Welder training included work hazard protection, arc, gas, and electric welding, welding strings, equipment, ox-acetylene welding, and maintenance and testing. At the end of each training session, ARDI granted the mechanics and welders basic toolkits that contained the equipment necessary to run an effective repair shop.

In addition, ARDI worked with the Case New Holland distributor in Turkey to provide advanced training for 42 Iraqi mechanics. This distributor heard of ARDI efforts to increase the capacity of Iraqi mechanics through the ARDI Agriculture Mechanization project, and offered the five-day course at no cost as part of its effort to build a market presence in Iraq. ARDI paid for transportation, accommodation, and meals.

The training covered a standard advanced training program for mechanics, primarily for CNH equipment, although many of the fundamentals are applicable to other international tractor brands. These mechanics are employed at workshops at which they will be able to offer improved repair and maintenance services to tractor owners.

RESULTS

The ARDI training effort increased the capabilities of mechanics and welders in four governorates to provide improved repair and maintenance services for agricultural machinery. The 216 rural mechanics and welders trained under ARDI will work in approximately 210 workshops, each of which represents a new small business opportunity in a rural village. Each workshop should be able to offer improved services to a minimum of 100 clients, for a total beneficiary population served of 21,600 tractor owners. Given that many tractor owners contract their services to other farmers during the planting and harvesting seasons, the total impact on farm families will be higher.

The training should also lead to improved equipment operation and greater income for the trained mechanics and welders. The provision of suitable workshop tools and equipment, as well as the increased skills of mechanics and welders, will also strengthen the network of rural independent mechanics and improve the operating performance of the agricultural equipment fleet.

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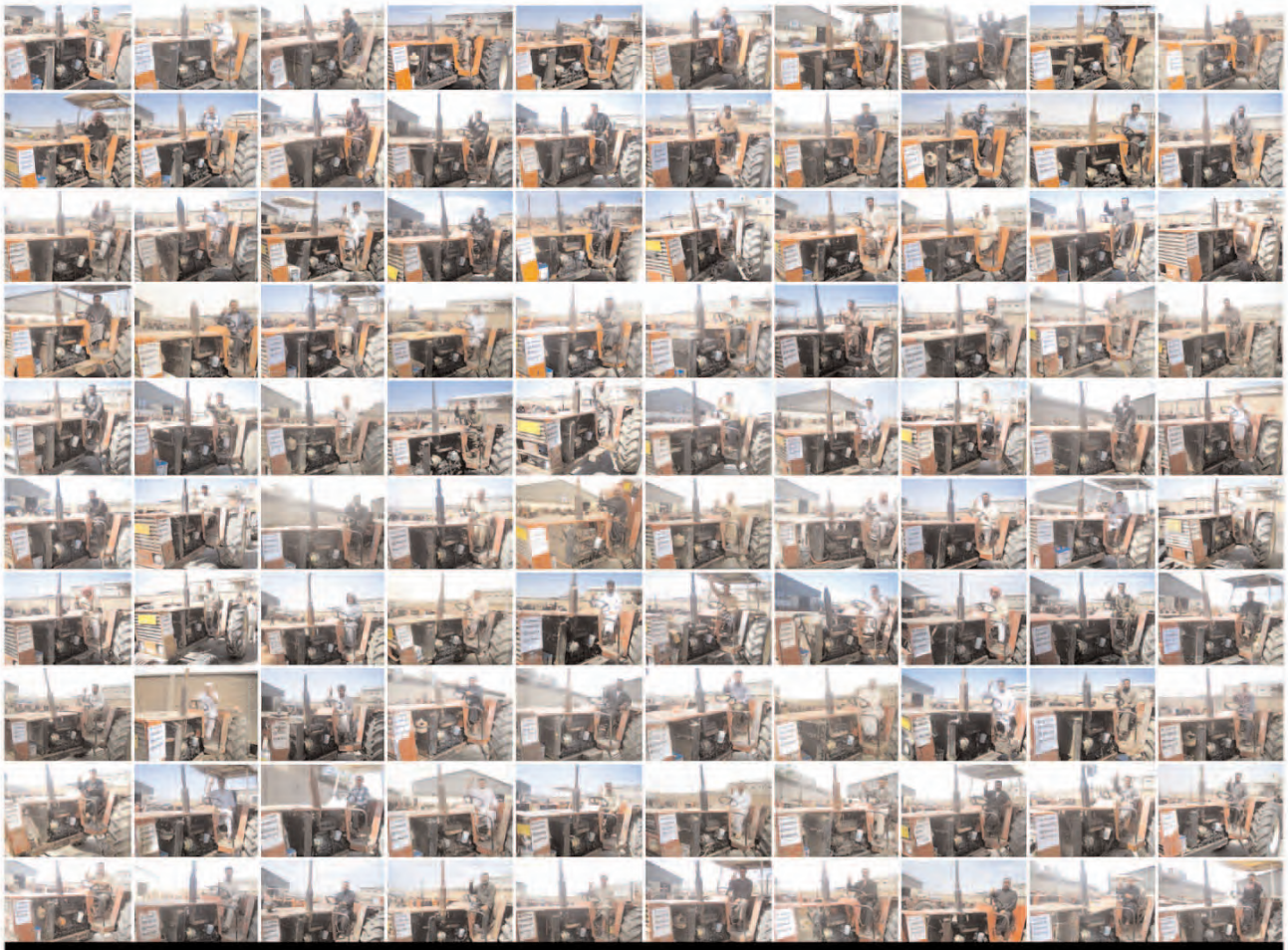
FROM THE AMERICAN PEOPLE



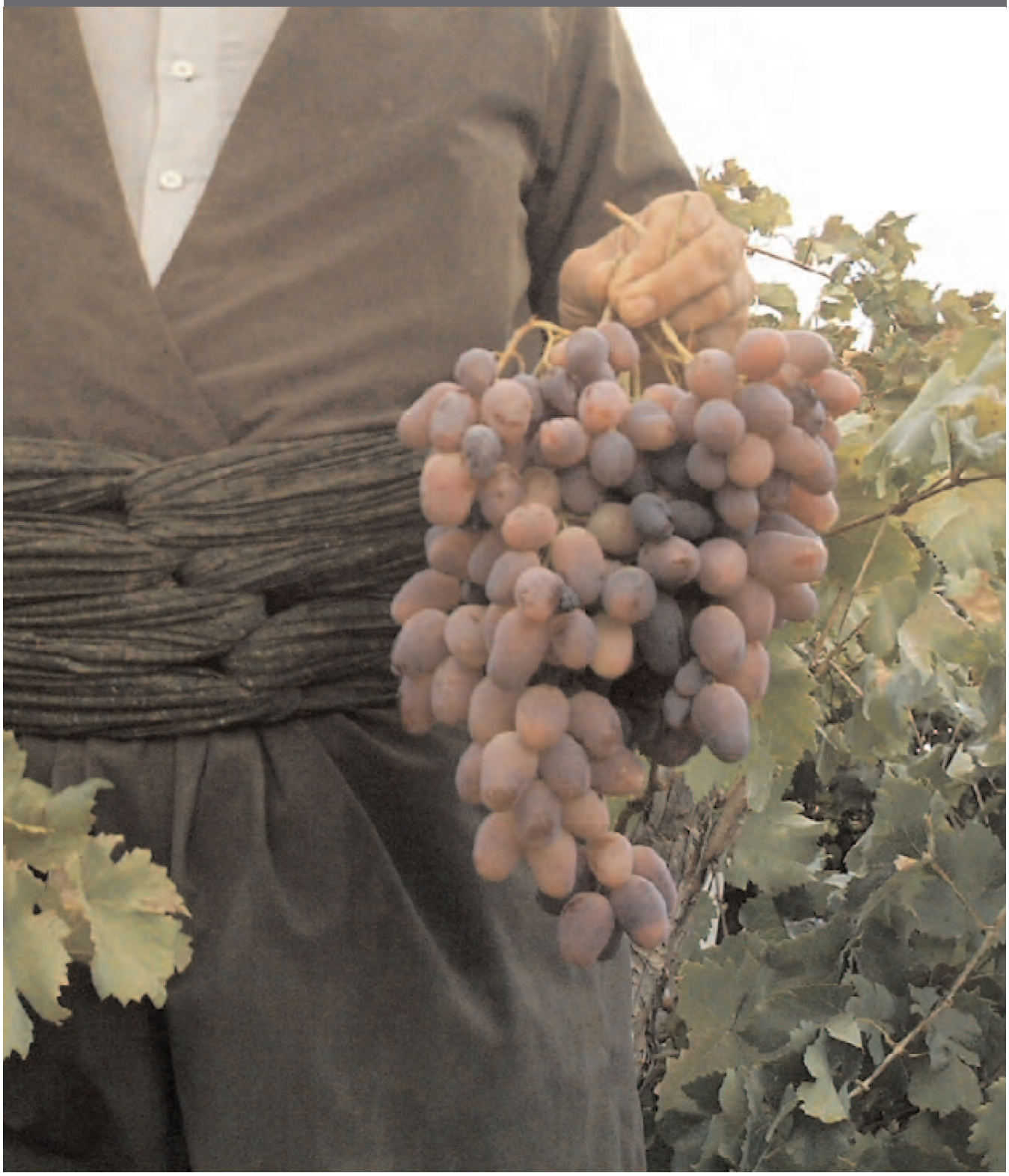
ARDI AGRICULTURE RECONSTRUCTION AND DEVELOPMENT PROGRAM 2003~2006

Mechanization

The ARDI Mechanization Program impacts Iraqi farmers in several ways. It insures that the farmer has the primary tool he needs to keep his farm running for years to come, it offers the opportunity for additional income by having the tools to bring previously fallowed land into service and it provides a means to transport his harvest to market where optimum prices are available. The ARDI Mechanization Program repaired thousands of tractors throughout the nation, trained mechanics and established, through this program, more than a dozen new workshops across the country.

DAI

2.3 PHYSICAL AND TECHNOLOGICAL IMPROVEMENTS



High value agriculture projects were conducted in all 18 governorates.

There are over 30 different vegetables and 25 different fruits grown in significant quantities in Iraq. For the most part, these vegetables and fruits are grown using traditional practices and provide meager income for thousands of subsistence farmers. There is almost no large-scale, modern production of vegetables and fruits in Iraq, and virtually no postharvest handing or storage facilities. Consequently, Iraqi products are generally of lower quality than imports and are only available at harvest. The combination of low quality and market gluts at harvest means that Iraqi horticulture producers are supplying the least remunerative segment of the Iraqi market. This can only be changed by building a modern horticulture industry.

ARDI has mainly worked through NGOs to reach small horticulture producers, to increase productivity and income. There were two approaches to the problem: 1) supplying improved seeds for vegetables and grafted plantlets for fruits; and 2) extending improved practices through demonstration plots and orchards, especially the correct density of planting, the use of improved varieties, increased use of fertilizers, appropriate pest and disease control, and better quality control at harvest.

TABLE 39 HIGH VALUE AGRICULTURE PROJECTS AND PRIMARY BENEFICIARIES

High-Value Product	Number of Projects	Projects Primary Beneficiaries
Dates	8	3 to establish 17 mother orchards for the Ministry of Agriculture (MOA) 2 to establish 16 nurseries (MOA) 3 to restore orchards (farmers)
Olives	2	1 for 16 high-oil olive demonstration orchards (MOA) 1 to establish orchards (farmers)
Grapes	6	1 to benchmark varieties (MOA) 1 to collect cuttings for nursery stock (MOA) 3 to establish private sector nurseries (private sector) 1 to produce vineyards with trellising and irrigation systems (farmers)
Fruit Orchards	8	1 apple orchard census (MOA) 2 to establish and rehabilitate peach and apple orchards (farmers) 1 to establish fruit orchards (farmers) 4 to establish and rehabilitate fruit orchards (farmers)
Horticulture	1	1 national horticultural conference (MOA, farmers, private sector, NGOs)
Tomatoes	3	1 to improve tomato production (farmers) 2 to expand hybrid variety tomato production (farmers)
Beekeeping	14	5 beekeeping and honey production projects (communities) 1 carpenter training workshop on beehive making (agrobusiness) 2 to support research and extension (MOA) 6 to establish and develop beekeepers associations (see Section 3.2)

DATES

Traditional small scale date merchant with hand woven vine and palm frond baskets. The paper lining in some baskets protects the delicate skin of the fruit from injury.

Hundreds of thousands of farmers in central and southern Iraq depend on the cultivation of date palms as a source of income. There is high demand for dates by Iraqi consumers, and commercially desirable varieties can bring a good income to date palm farmers. In addition, many other crops such as pomegranates and citrus grow well in the shade that date palm orchards provide, increasing the benefits of cultivating these trees.

At one time, Iraq exported a large portion of its date production, and its exports accounted for 30% of the world's date supply. Iraq was also famous for its high-end date varieties, which are prized around the world for their high sugar content and superb flavor and texture.

Date palm production suffered greatly during the previous regime, when over half of the date palm orchards were destroyed. This problem was compounded in the south by improper drainage and the desiccation of the marshlands. Economic sanctions made it difficult for date producers to find markets; as a result, many have left their orchards to look for other jobs, and those remaining are unable to care for their orchards properly.

Over the past few years, large numbers of date palm trees have aged beyond productivity, died, or been badly damaged. The number of viable date palm trees

Date palm projects.

in Iraq today (16-19 million) is less than half of what it was a decade ago (32-35 million). In addition, the MOA has estimated that around half of these trees are past their prime production and need to be replaced. This situation has led to decreases in date palm production in Iraq, forcing local markets to import date fruits. In addition, farmers do not have access to high-quality, commercially desirable date palm varieties that could be used to replenish their orchards and improve production.

Iraq's date palm farmers face two major problems: the high cost of offshoots to use as new planting material, and a shortage of stock of the most desired date palm varieties. The average price of offshoots ranges from $5 for the most common varieties (these are often used for animal feed) to around $40 for the most prized varieties that are sold for human consumption. It is often difficult for Iraqi date producers to obtain offshoots of any variety, because many farmers would rather prune offshoots as soon as they appear to increase yields of fruit, rather than allow the offshoots to grow and sell them to other farmers.

ARDI worked with both the MOA and individual date producers to help restore date palm production in Iraq. ARDI increased the MOA's capacity to supply Iraqi date producers with high quality date palm offshoots by supporting the construction and establishment of date palm mother orchards and nurseries in all date producing governorates. ARDI also assisted individual date producers to replenish their existing orchards with high quality date palm offshoots of commercially desirable varieties, helping them to increase their production and income.

ESTABLISHING MOTHER ORCHARDS IN THIRTEEN GOVERNORATES

In 2003, the MOA established a National Date Palm Improvement Program with two objectives: protecting the over 600 varieties of date palm in Iraq from genetic deterioration or eventual extinction, and increasing Iraqi date palm producers' access to high quality, commercially desirable date palm varieties. In support of these objectives, the State Board for Date Palm Development is establishing 21 date palm mother orchards in the 13 governorates where dates are commonly cultivated. This will ensure that date producers have at least two sources of low-cost offshoots in each of the governorates. ARDI provided support to establish seventeen of these orchards, in 2004 and 2006.

ACTIVITIES

The most reliable method for establishing or replenishing a date palm orchard with new trees is by planting offshoots, which are exact genetic copies of the original adult, and carry the same characteristics, including those of the fruit they produce. An offshoot is essentially a "daughter tree" which grows from a bud produced at the base of a mature tree. A mother orchard is a "gene bank" of date palm varieties. The mother trees produce offshoots which are then purchased by farmers and planted into new orchards. Because the offshoots are exact copies and grow true to type, the farmer can be sure that the investment made in the offshoot will yield results in terms of commercially valuable date fruits.

To help the MOA establish mother orchards in date producing governorates, ARDI provided 40,000 date palm offshoots to 17 mother orchards in 2004, and

another 40,000 in 2006. These offshoots will become mother plants, and the orchards will be maintained to preserve these varieties and produce new offshoots to sell to farmers at a low cost.

TABLE 40 DATE PALM SEEDLINGS SUPPLIED, 2004-2006

Governorate	Hectares	Seedlings
Anbar	10	4,000
Babylon	15	6,000
Baghdad	20	8,000
Basrah	30	12,000
Diyala	10	4,000
Kerbala	15	6,000
Missan	15	6,000
Muthanna	15	6,000
Najaf	15	6,000
Qadissiya	15	6,000
Salah al-Din	10	4,000
Thi-Qar	15	6,000
Wassit	15	6,000
Total	**200**	**80,000**

The MOA provided land for the orchards, and to ensure the success of the MOA's orchards, ARDI also provided infrastructure support, including drip irrigation systems in the 17 orchards established in 2005, and reservoir basins, pump houses, and miscellaneous equipment in the majority of orchards that were not yet fully functional. The following equipment was supplied:

TABLE 41 DATE PALM MOTHER ORCHARD INFRASTRUCTURE SUPPLIED

Item	Number
Reservoirs	15
Pumps, 30 hp	7
Wells and pumps	5
Pump houses	15
Generators, 60 kVA	5
Drip kit systems*	40
Installation drip systems*	40

* One drip kit system was required for each 2.5 ha of orchard. The 17 orchards comprised 200 hectares.

Once the infrastructure was in place, the offshoots were treated with rooting hormones and fungicide, and 400 seedlings were planted per hectare in each orchard. The young seedlings were irrigated using the drip kit systems.

Each "mother tree" will be used to produce three or four offshoots ("daughter plants") per year, which can be separated to create new palm trees. Once the offshoots are established, the MOA will collect them and care for them in nurseries until they reach maturity and can be planted. Most of the offshoots will

be sold to farmers at greatly reduced prices. However, a portion of the offshoots will be sent to the MOA's date palm nurseries for a year before being transferred to private farms. This will allow the offshoots to grow a stronger root system before they are transplanted to farmers' fields, and increase the success rate of transplants.

Date palm offshoots ready for distribution to the farmer.

Palm offshoot in ground and wrapped in palm frond to protect it from sun and wind.

RESULTS

Each of the 80,000 mother trees ARDI supplied will produce a minimum of three offshoots per year, for a net expected increase of 240,000 offshoots annually. This will help assure date farmers in 13 governorates of local access to new date palm stock at affordable prices.

MOA will take 170,000 of the new offshoots each year and plant them in nurseries, thus providing about 4.25% of the needed replacement stock (the MOA estimates that about 4 million of the country's aging date palm trees should be replaced immediately). The remaining 70,000 seedlings will be transferred directly to producers' fields, providing 1.75% of the needed replacement stock each year. Thus, ARDI's assistance will replace 6% of the aging stock in Iraq annually, beginning in 2006/2007. When the plants mature, the value of production added per year for the 15,288 tons of dates produced is $8.2 million (in 2000 dollars)

Iraq's export markets also stand to gain. The total value of date exports from Iraq in the year 2,000 was approximately $230 million, so the replacement of the aged date palm orchard at a rate of 6% per year will have an increasing effect on maintaining or increasing the value of the export market with each succeeding year.

IMPROVING DATE PROPAGATION THROUGH NURSERY ESTABLISHMENT

The MOA's national date palm improvement program also includes the establishment of nurseries, in which date palm offshoots produced in the mother orchards can be cultivated for a year before being sold to farmers, to increase rates of successful transplant to farmers' orchards. The nurseries were established in 2005, and the MOA requested that ARDI procure offshoots to be cultivated in the nurseries while the mother orchards were being established. ARDI provided funds for the purchase of 48,385 date palm seedlings for the nurseries, which will be cultivated for one year before being sold at low cost to date producers. ARDI also provided the MOA with drip irrigation systems for all 16 nurseries, and reservoir basins, pump houses, and miscellaneous equipment for the majority of nurseries, which were not so equipped. The following was supplied:

TABLE 42 DATE PALM NURSERY INFRASTRUCTURE SUPPLIED

Item	Number
Reservoirs	14
Pumps, 30 hp	7
Wells and pumps	5
Pump houses	10
Generators, 60 kVA	5
Drip kit systems*	17
Installation drip systems*	17

* Although 16 new nurseries were established, 17 drip kits were installed because one large nursery required two.

The support to these nurseries will help date producers increase their production in the long run, as date offshoots from the mother orchards that are cultivated in the nurseries will have a greater chance of being successfully transplanted to farmers' orchards. As noted above, the 170,000 trees moved from nurseries to farmers' fields each year, combined with the 70,000 offshoots moved directly from the mother orchards to farmers' fields will total 240,000 new trees per year, for a 6% replacement/increase of the national orchard each year.

RESTORING DATE PALM ORCHARDS IN BASRAH AND MUTHANNA GOVERNORATES

Most date producers in southern Iraq suffered from the destruction of their date orchards, either from abandonment during political conflict or from damage done by poor drainage management. Those producers who have maintain their lands still suffer from ever-decreasing production due to aging or damaged trees.

ARDI worked with 120 date producers in Muthanna and Basrah governorates (the Basrah project included the Hammar marshland area of Al-Midaina district) who had maintained the basic irrigation and drainage structures in them, but badly needed new planting material to replenish their orchards. The projects provided higher-value planting material and technical assistance to increase the amount of land dedicated to the cultivation of high-value date palms, and raise the income of participating farmers.

(above and below) Early dates in the market

(below) Ripe dates in the market

ARDI provided 800 offshoots to 20 farmers in Muthanna to replenish date palm orchards.

ACTIVITIES

The 120 selected date producers were low-income farmers who suffered from poor production due to damaged, dead, or aging trees. ARDI supplied each producer with 40 high-quality date palm offshoots from commercially desirable varieties: Barhi, Bream, Sayer, and Khadrawi (a fifth variety – Chebchab – was added in the marshlands project). Two local nongovernment organizations (NGOs) trained farmers on offshoot planting, including the use of rooting hormone, and helped them plant the offshoots. The NGOs also provided training in after-planting care, methods for protecting date palms from pests and diseases, the importance of fertilization, and other best practices for production.

RESULTS

TABLE 43 DATE PALM OFFSHOOTS PLANTED IN BASRAH AND MUTHANNA

Governorate	Beneficiaries	Trees Planted
Basrah	100*	4,000
Muthanna	20	800
Total	120	4,800

* (including 50 in the marshlands)

The participating farmers can expect that each of their newly planted offshoots will produce an average of 3.5 offshoots in the second year (or 140 per orchard). If these offshoots are replanted, each will begin to produce about 50 kg of dates per year. Thus, when the trees reach the full bearing stage in four years, each farmer could possibly produce 9,000 kg of dates annually, assuming that all offshoots are planted and also producing fruit. A farmer with growing numbers of productive trees, could produce a gross income of $5,000-$7,000

per year. In addition, the date palm trees will continue to produce offshoots after the four-year period, which farmers can sell for an average of $12 each. This will bring additional income to farmers and provide other date farmers with access to high-quality, commercially valuable date palm varieties.

Assuming that the farmers rely on mixed sales of offshoots and fruits, the expected annual increase in farmers' gross income in four years (when trees reach the bearing stage) is $2,713 from the production of fruit and $1,512 from the sales of offshoots (new tree seedlings produced by mature trees). Thus, the possible gross income from the project upon maturity is $4,225 per farmer, or $507,000 per year for the 120 farmers participating in the project. Extra income will be earned by farmers who plant such crops as pomegranate or other fruits between their rows of date palms.

Local consumers will also benefit from the project, as they will no longer have to depend on dates imported from other parts of Iraq or from abroad. These projects also contribute to the goal of combating desertification in these two governorates, which tends to occur as orchards go out of production.

SUCCESS STORY

ARDI's date palm restoration project has been enthusiastically received in such governorates as Basrah and Muthanna. A regional coordinator from Muthanna summed up the project thus:

> *"We receive each day visits from farmers and sheiks who ask us about the possibility of expanding this project to include more farmers in the future. All the farmers who received the offshoots informed us that this is the first time they have seen such very good quality offshoots distributed by an organization.*
>
> *"At last, I would on behalf of all the farmers who received the offshoots to thank you from the depth of our hearts for this great support that we feel will improve the agricultural situations in the south of Iraq."*

Date palm destruction in the South.

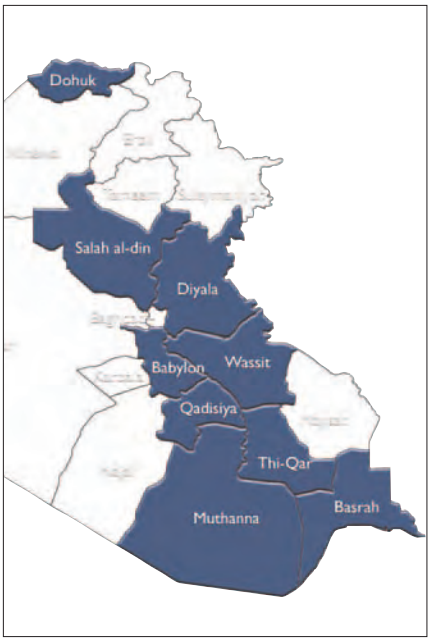
OLIVES

Olives are an essential ingredient in Iraqi diets and are eaten with most meals as fruit or oils.

Olives are a lucrative crop for Iraqi farmers. They can grow well throughout the country, and as an essential part of the Iraqi diet they are in constant demand. Olives are sold for around $2.50/kg in local markets. The production costs of olives are low relative to other fruit tree crops, and yields are high, making them a very economical crop to grow. In addition, planting olive trees can help farmers control soil erosion and be an element of good watershed management practices.

Despite these advantages of olive production, only about one million olive trees are now in production nationwide. This is due to farmers' limited financial ability to purchase trees and their lack of knowledge on how to cultivate olive orchards properly. As a result, most olives sold in Iraq are imported from neighboring countries, representing great potential losses to both Iraqi farmers and consumers.

In order to increase olive production in Iraq and increase farmers' income, ARDI worked with both the MOA and individual farmers to implement olive production programs. ARDI helped the MOA establish 16 demonstration orchards in eight governorates, to introduce farmers to proper production practices and technologies. ARDI also worked directly with 24 new olive producers in northern Iraq to establish orchards and provide technical assistance for olive cultivation.



Governorates where olive orchards have been established.

OLIVE ORCHARDS

Two projects helped increase Iraqi farmers' olive production. The first established nursery demonstration programs with the MOA, and the second planted orchards for farmers in Dahuk governorate. Those plantings also helped farmers gain an additional source of income, replace costly imports, and aid in soil erosion and watershed management practices.

ESTABLISHING HIGH-OIL OLIVE DEMONSTRATION ORCHARDS

Previously, the MOA had little capacity to work with farmers in testing and demonstrating olive orchard production practices and technologies. It also lacked a model to address these limitations and respond to farmers' needs. The MOA proposed in 2005 to build demonstration orchards, which would enable the MOA to:

- Raise farmers' awareness about the potential for olives as a cash crop;
- Increase the number of olive trees planted to raise production nationally.

ARDI provided assistance to the MOA to establish 16 model demonstration olive orchards in eight central and southern governorates.[1] Each orchard was built on 2.5 ha of land, and ARDI provided a storage room/pump house and a water reservoir for irrigation. Six hundred olive seedlings, procured from MOA olive nurseries, were planted in each olive orchard. High-oil and table fruit varieties were planted where they grow best: table olives in central Iraq and both table and oil varieties in the south.

TABLE 44 OLIVE ORCHARDS ESTABLISHED

Governorate	Number of Sites	Number of Seedlings to be Planted
Babylon	2	1,200
Basrah	2	1,200
Diyala	2	1,200
Muthanna	2	1,200
Qadissiya	2	1,200
Salah al-Din	2	1,200
Thi-Qar	2	1,200
Wassit	2	1,200
Total	16	9,600

RESULTS

This project met its goal of establishing extension demonstrations in olive oil producing regions of Iraq. It is now up to the MOA to utilize these orchards as they mature to raise farmer awareness about olive production and teach best methods for increased production. The MOA expects that extension projects based on these model orchards will encourage farmers to plant an additional 1 million trees, effectively doubling the number of olive trees in the country.

[1] The original work plan called for 30 orchards in 15 governorates. However, the MOA General Company for Horticulture and Forestry was not able to secure use rights in several governorates, so the scope of the project was revised to 16 orchards in eight governorates.

ESTABLISHING OLIVE ORCHARDS, DAHUK GOVERNORATE

ACTIVITIES

Northern Iraq has excellent conditions for producing olives, particularly varieties that are cultivated for fruit. In 2005, ARDI received a proposal from farmers through a local NGO to assist them in establishing olive orchards in upland areas. The governorate of Dahuk had announced plans to use the flatland plots of these poor farmers for housing, prompting the farmers to explore the possibility of reclaiming plots in these upland areas for farmland. Olive orchards are an excellent crop for this type of land.

ARDI worked with a partner NGO to help each farmer select a 0.75 ha plot for the cultivation of an olive orchard. The NGO provided assistance to the farmers to prepare their land, leveling rough areas and clearing land that contained rocks and shrubs. ARDI granted to each farmer 300 seedlings of two high-quality olive varieties (Dogel and Ajrasi) that are well suited to local conditions, and are cultivated for fruit rather than oil.

An important element of the ARDI grant was technical assistance and training to teach the farmers how to cultivate olives properly to maximize production. The NGO held a training course for the new olive producers prior to planting the orchard. The course focused on the importance of horticulture, and modern methods of orchard establishment and maintenance, using proper agricultural machinery, pest control, tree pruning, fertilizing, harvesting, and marketing. At the conclusion of the training, each farmer received a basic kit of farm tools necessary to maintain the orchard, including pruning scissors and saws, shovels and pick.

All activities were implemented at no cost to the farmers, but farm families contributed to project activities through planting, maintenance, and seedling protection.

A farmer prepares his land for planting olive trees in Dahuk

RESULTS

Once the trees begin bearing fruit, in 3 to 4 years, the 24 participating farm families will improve their production of olives and have a secure source of income. At an average yearly yield of 12.5 kg, each farmer could potentially harvest about 3,750 kg of fruit per year, which would have a market value of $2.50/kg. after processing. Using modern techniques introduced by the project, participating farmers also helped to restore plant cover in the areas above their village. The MOA hopes that the replanting of these mountain areas will encourage other farmers to reclaim their upland plots and plant them.

TABLE 45 OLIVE ORCHARDS ESTABLISHED IN DAHUK

Villages Served	Beneficiaries (Families)	Number of Plots	Trees Planted per Farm Family	Total Trees Planted
1	24	0.75 ha	300	7,200

Clearing the land of stones to permit cultivation of crops and planting of orchards.

GRAPES

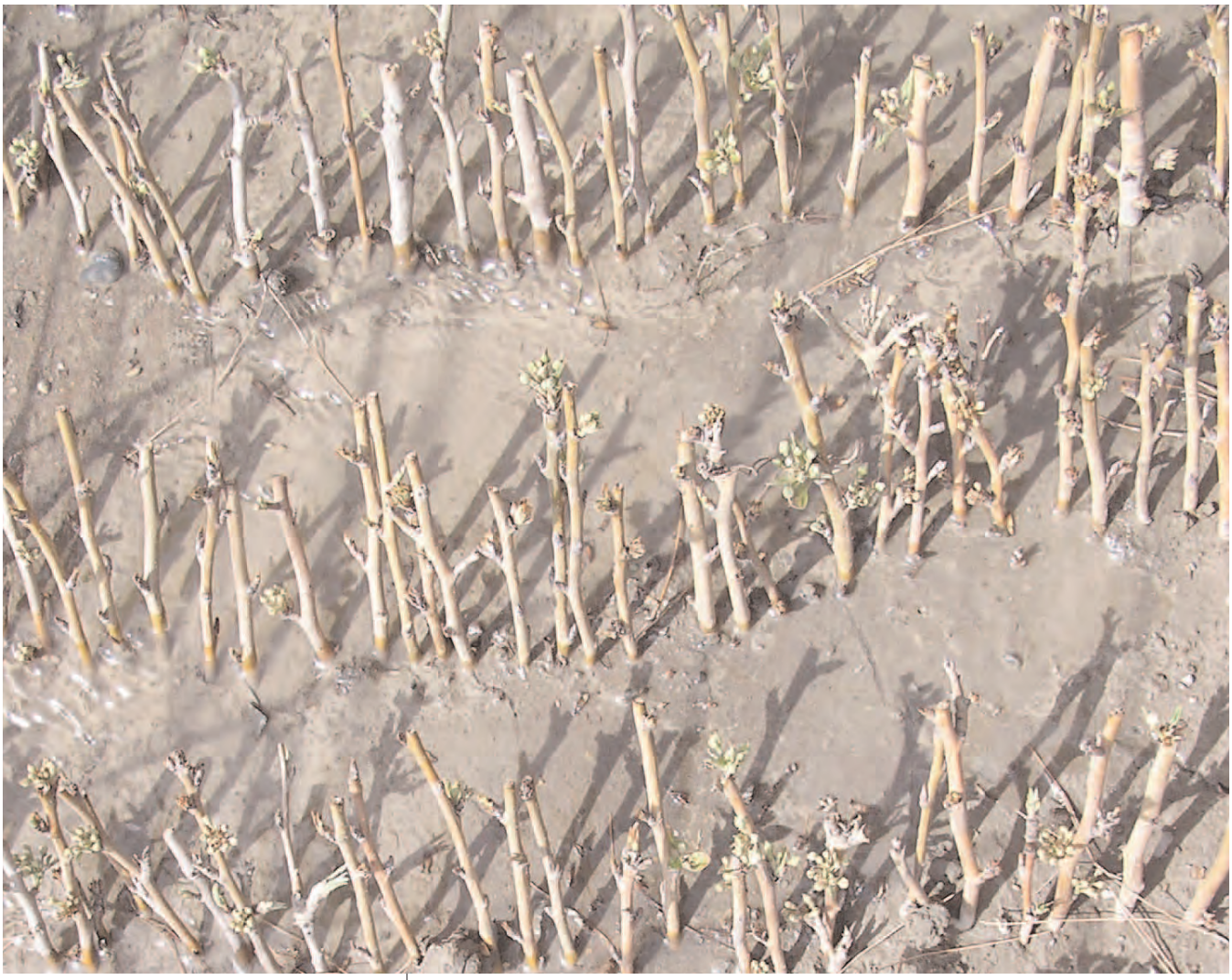
Grapes ripening on the vine.

Grape production is an important economic activity in Iraq that is a source of income for thousands of grape growers, most of whom are small to medium-size farmers. Grape producers sell table grapes, as well as grapes for the production of syrup, raisins, vinegar, and fresh grape juice. Although about 80% of the fruit produced in Iraq is sold in retail and wholesale markets, the quality and quantity of local production is inadequate to meet consumer demand, resulting in the importation of large volumes of grapes.

Most of Iraq's grapes are grown in the semiarid northern governorates (Dahuk, Erbil, and Sulaymaniyah). Roughly 30% of the area planted to grape orchards in the north (nearly 30,000 hectares) is planted on the steep hillsides common in the region, which are generally unsuitable for other crops. Grape production in those regions provides an effective barrier against hillside erosion and loss of valuable soils, and allows farmers to increase the amount of land under cultivation.

A major problem for Iraq's grape farmers is the lack of high-quality planting stock (desirable varieties) needed to replenish their vineyards, plant new land, and improve the quantity and quality of grape production. The MOA's nurseries have been the only significant source of planting stock for producers, but these nurseries have only been able to meet a small fraction of farmer demand. Despite the huge demand for new and improved grape planting material, the

Iraqs' grape growing regions.



Three private sector grape nurseries are now propagating "true-to-type" grape seedlings using modern drip irrigation technology.

network of private nurseries in Iraq is small and production capacity is limited. For this reason, farmers must rely on cuttings from their own vines, many of which are of doubtful provenance, to replace older plants or plant new land to grapes.

The FAO conducted many grape production surveys and began extension programs that included on-farm demonstrations, assistance to government nurseries, and direct technical assistance to growers. After its abrupt departure from Iraq in 2003, most of the work in producing parent stock was discontinued and field demonstrations were allowed to lapse. With relatively modest investments, ARDI built on that work to encourage investment in nurseries, rehabilitate demonstration projects, and provide technical assistance to farmers wishing to expand production or plant new vineyards.

ACTIVITIES

ARDI established three private sector nurseries in northern Iraq to provide high-quality planting material and improved varieties of grapes. ARDI first identified and "benchmarked" the best grape vines available in the northern governorates, and then took more than a million cuttings from them to establish three private nurseries, which propagate and increase availability of these varieties. The project also established demonstration plots, which are used to introduce farmers to improved grape cultivation techniques that increase production.

Farmers at a nursery in Erbil prepare their field to plant grapes

Benchmarking Varieties. ARDI contracted with Iraq's foremost grape expert (Ampelographer) to identify the best grape vines in the three northern governorates, based on cluster, color, commercial desirability, resistance to diseases, and leaf shape. This expert trained three teams from a local NGO in grape benchmarking, and under the expert's supervision they visited 71 of the best grape orchards in the area to benchmark 20 varieties and 38,972 vines. Global Positioning System devices were used to record the locations of the benchmarked vineyards. The benchmarked vines, which would serve as the genetic basis for improving vineyards throughout the region, were categorized as "true-to-type" varieties. This designation assured that cuttings taken from these vines would produce exact genetic copies of the identified varieties. This is important to grape producers looking to plant commercially valuable grape varieties, since they must invest in the cuttings, the land to cultivate them, and other inputs before fruiting occurs and they can verify the variety.

Collecting Cuttings. A total of 1.2 million cuttings were taken from the 71 farms identified during the benchmarking activity and supplied to the three private nurseries. Not all of the cuttings from Dahuk and Sulaymaniyah were utilized (some cuttings were not suitable due to dryness, infestation with powdery mildew disease, or being pruned too early, although more than anticipated were collected in Erbil). An additional 23,555 cuttings were brought from Baghdad to make up the

Modern grape trellising system

(below) Zarek and Javga grapes.

shortfall. The cuttings were then bunched and stored for distribution.

Establishing Three Private Sector Grape Nurseries. The 1.2 million cuttings were used to help establish private sector nurseries and demonstration plots. The nurseries will produce new high-quality true-to-type grape seedlings each year, providing farmers with a reliable source for purchasing plants to replenish their vineyards and plant new land.

Three nurseries were established; one each in the governorates of Dahuk, Erbil, and Sulaymaniyah. Each nursery was supplied with 400,000 cuttings (over 80% of the cuttings were successfully rooted). A modern drip irrigation system was installed at each nursery to improve water management, and owners were trained in rooting and maintaining cuttings (irrigation, weed control, fertilization, etc.). The private sector entrepreneurs who own the nurseries assumed a share of the cost to establish them. Together, the three nurseries will be able to propagate 800,000 to 900,000 "true-to-type" grape seedlings each year, as well as use some of the stock to plant "mother vineyards" from which cuttings will be taken in following years.

ARDI also held field days for farmers who live near the nurseries to demonstrate better production practices. This activity not only trains the farmers, but provides incentives for farmers to purchase improved vines from the nurseries.

Trellising and Irrigating to Improve Grape Production. After the nurseries were established, ARDI worked with a local NGO to provide extension in grape production to local producers. The training introduced improved technologies and practices for grape cultivation, primarily in the areas of trellis installation, vine training, and irrigation.

Sixteen demonstration vineyards were set up in the three governorates; each

Traditional bush planting with drip irrigation system.

served at least 20 neighboring farmers. The vineyards selected for demonstrations had already been planted with high-quality, true-to-type vines. The project installed drip irrigation systems on about half of the 3-hectare demonstration plots.

ARDI then introduced at least one type of the following technological improvements at each vineyard. Farmers could visit different vineyards in the area to observe the results of all four of the improvements:

- Pergola-type trellising systems with irrigation;
- T-shaped trellising systems with irrigation;
- T-shaped trellising systems without irrigation (rain-fed vineyard);
- Traditional cultivation ("umbrella" vine training with no trellising; however, this type of cultivation benefited from drip irrigation).

Extension agents from the NGO implementing the project held field days for farmers to demonstrate how the trellises and irrigation systems work, and explain their benefits.

This extension will help grape producers improve their yields, and will also encourage them to invest in improved varieties of grapes from the newly established nurseries to increase their production and income further.

(below) Besola and Taefee-Red grapes.

RESULTS

When they mature in three years, the 800,000-900,000 superior-quality vines from the benchmarked plants will strengthen the nurseries' supplies; they will be able to continue supplying stock to further increase the productive value of Iraq's

TABLE 46 GRAPE REHABILITATION ACTIVITIES

	Dohuk	Erbil	Sulaymaniyah
Benchmarking			
Benchmarked Vines	23,505	7,795	7,672
Grape Cutting			
Grape Cuttings	589,690	212,266	290,500
Varieties	10	16	12
% utilized	86	102	91
Nurseries Established			
Grape cuttings planted	400,000	400,000	400,000
Trellising and Irrigation Demonstrations			
Farmers Assisted	6	5	5

grapes. New vines will become commercially productive in three years, after which the productivity of Iraq's vineyards will grow and the area cultivated should increase. There is a very strong demand for high-quality grapes in Iraq, ensuring increases in farmers' income.

The current price for rain-fed Iraqi grapes is around $0.13 per kilogram. However, preferred grape varieties cultivated using improved methods can produce grapes with higher sugar content, better color, more uniform bunch sizes, and fewer diseases, and bring this price up to $0.50 per kilogram. Thousands of farmers throughout northern Iraq can benefit from the increased availability of improved grape varieties and knowledge of improved cultivation techniques.

The assistance farmers received in trellising and irrigation should increase their production significantly in the years to come. In the future, the demonstrations should yield data for recommending the most cost-effective packages for improvements on other farms.

Construction of trellis system.

FRUIT ORCHARDS

Newly emerged fruits beginning the ripening stage.

The moderate climate of northern Iraq is excellent for growing such fruits as apples, peaches, and plums, and local demand for this produce is strong. However, the quantity and quality of fruit production in Iraq is low, largely owing to Iraqi farmers' reliance on traditional cultivation methods. Currently, consumers who can afford it prefer to buy higher-quality and expensive imported fruits from as far away as Washington State and Chile. There is an opportunity for Iraqi farmers to improve the quality and quantity of their fruit production through improved cultivation practices, to meet consumer demand, displace these imports, and raise farmers' income.

ARDI worked with local NGOs to provide extension services to fruit producers throughout Iraq. In northern Iraq, ARDI conducted a census of apple orchards. Apples are a significant fruit widely grown in northern Iraq, and the census revealed important information about current cultivation practices and

New apple orchard.

challenges that informed ARDI's assistance projects.

In 2005, ARDI implemented extension projects to restore fruit orchards in northern and southern governorates through the provision of inputs, including seedlings and technical assistance from horticulture specialists from partner NGOs. In 2006, ARDI adopted a more participatory extension approach, in line with its efforts to revamp the MOA extension service. ARDI used local, village orchards as extension plots, and invited large numbers of farmers to extension field days on these plots to observe the improved practices and adopt them in their own orchards.

TABLE 47 MAIN APPLE VARIETIES GROWN IN DAHUK AND NINEWA AND WATERING METHOD

Apple Variety	Irrigated	Rainfed	Total	Productivity (kg/tree)
Golden Delicious	778,218	5,746	783,964	40.9
Baraway Bala	718,074	3,445	721,519	50.6
Red Delicious	438,483	45	438,528	39.9
Starking	150,579	25	150,604	45.4

APPLE ORCHARD CENSUS, DAHUK AND NINEWA

ACTIVITIES

In 2005/2006, ARDI conducted a census of 6,391 farmers in 631 villages in the governorates of Dahuk (3 districts) and Ninewa (2 districts). Teams of enumerators from a local NGO gathered data on over 2.2 million apple trees to determine the number of trees and varieties grown, the types of watering practices employed (irrigated vs. rain-fed), varieties of apples planted, and growing practices.

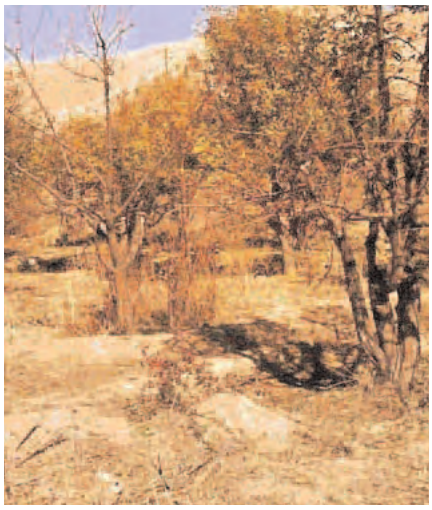
RESULTS

The census revealed that farmers leave about half their produce in the orchard because they cannot compete with the higher-quality imported apples. The imported apples sell for $7-15 per 22-25 kg box, while those of Iraqi producers sell for only $0.66 to $2 per box. In some cases, the income from apple sales does not even cover the cost of inputs, which discourages production.

Farmers were also asked about the main problems they face in apple production. The census found these to be:

- Lack of knowledge on proper horticultural practices (e.g., many farmers prune shortly before the blossoming period rather than during the winter, making the cut parts vulnerable to disease).
- Poor orchard establishment techniques (improper variety selection, high-density planting, poor availability of pollinator bees).
- Poor maintenance of existing orchards (e.g., practices like tree training, pruning, fruit thinning, irrigation, cultivation, fertilization and pest control are not performed regularly).
- Pest and disease incidences are high and integrated pest management is not used, while pesticides are misused.
- There are shortages of irrigation water, the existing canal system has deteriorated, and irrigation practices are declining, allowing water losses of up to 50%.
- Harvest and postharvest technology is primitive and improper, fruit processing plants and other facilities are absent, and marketing outlets are poor.

The data collected from this census will enhance the MOA's knowledge of the problems Iraq's apple farmers face and will enable it to create effective assistance programs to help improve apple production and farmers' income. Apple farmers, in turn, will greatly benefit from extension services to learn more about proper cultivation and postharvest techniques.



(above) Neglected orchard, (below) properly pruned orchard

ESTABLISHING AND REHABILITATING PEACH AND APPLE ORCHARDS IN NINEWA AND DAHUK

Apple production in northern Iraq is well below its potential. The main reason for this is the paucity of apple varieties, which are not well suited for the local climate, soil makeup, commercial desirability, and tastes. In addition, farmers often employ improper cultivation techniques and maintenance methods that do not create the best conditions for tree growth and development.

Peaches are not a principal commodity crop in Iraq, but there is great interest in the fruit and they have significant potential as an income generator for farmers. Production is low in Ninewa, even though peaches are widely grown in the governorate's mountainous areas. The three main reasons for low production are lack of proper cultural practices, the nonavailability of superior varieties/genotypes, and farmers' reliance on traditional orchard maintenance practices. Further, the varieties grown in Ninewa produce peaches that are generally small and have an undesirable taste. Most of them fall from the trees before they are ripe.

ACTIVITIES

Two projects conducted in 2005 (one for apple orchards in Dahuk and one for peach orchards in Ninewa) sought to enhance the quantity and quality of fruit

produced in those governorates. These projects directly established and rehabilitated orchard plots for all farmers and provided them with a complete package of inputs.

Two staff from the Dahuk MOA and project managers from a local NGO invited mayors and local leaders of the two governorates to go on field visits to encourage farmers to participate in the project and adopt new orchard cultural practices. They then selected two villages with a large number of apple and peach orchards that were not producing well. The two villages were located near several other villages with similar orchards. The orchards in both villages had been established using traditional methods, and farmers lacked the necessary knowledge and skills for modern agricultural practices (mainly pruning, grafting, and pest control). Twenty low-income farmers in each village elected to participate in the project; all of them wanted to improve their orchards' production and their income.

TABLE 48 PEACH AND APPLE ORCHARDS ESTABLISHED AND REHABILITATED IN DAHUK AND NINEWA

Governorate	Participating Farmers	Orchards Established	Orchards Rehabilitated	Indirect Beneficiaries
Dahuk	20	20	20	100
Ninewa	20	20	20	100
Total	40	40	40	200

TABLE 49 FRUIT ORCHARDS ESTABLISHED IN BASRAH

District	Participating Farmers	Grape Orchards Established	Fig Orchards Established	Jujube/Mango Orchards Established
Fao	70	30	20	20

Through small one-time grants, project staff selected two 0.25 hectare plots on each farmer's land. One was used to establish a new orchard according to modern methods, and on the other there was an existing orchard that was rehabilitated. The project hired private tractors to plow each demonstration plot and dig holes for planting. Each farmer then planted 2,000 grafted seedlings provided by the project:

- In Dahuk, 1,500 grafted seedlings of Golden Delicious variety and 500 Caville and Star King (most farms were planted with Star King apples) varieties.
- In Ninewa, 500 budded seedlings of the Dextred 6 peach variety (the same variety of trees planted in the existing orchard) and 1,500 seedlings of Cornet "Cubi" (a new variety).

This allowed farmers to see the differences between the old orchards established using traditional methods and the new orchards established with proper scientific methods and sound planning.

For the plots to be rehabilitated, each farmer was given a set of orchard tools (including a shovel, pick, ladder, pruning shears and saws, grafting knife, trowel, iron leveler, sprayer, harrow, brush, and agricultural calendar). Inputs such as fertilizers and pesticides were provided by the farmers. ARDI contracted a

A newly trained Dahuk farmer demonstrating how to properly prune fruit trees.

technical specialist to supervise the rehabilitation work, which was carried out by two laborers.

The technical specialists held several demonstrations (field work days) for farmers at these demonstration sites, to address the major horticultural practices related to orchard establishment and maintenance, integrated pest management, weed control, irrigation and other topics. Each participating farmer invited five other farmers from nearby villages to attend these field days in order to encourage them to adopt these practices. The technical specialists also visited the orchards regularly, where they inspected the plots and helped farmers implement appropriate measures like irrigation and weed control to ensure the seedlings' success. At harvest, they arranged for the 20 participating farmers to see the orchards their colleagues developed.

Farmers were given a bee colony, beehive, clothing and a set of beekeeping equipment.

Beekeeping plays an important role in enhancing fruit production by increasing the pollination of tree flowers, and the honey produced provides additional benefits to farmers. Each participating farmer was given a bee colony, beehive, clothing, and set of beekeeping equipment to encourage rearing of bees in orchards. ARDI contracted with an apiary specialist to provide training in hive management and inspection for pest infestation, and periodically inspected the colonies. Farmers were expected to invest in additional beehives after seeing the project's results.

Workers are using a jig to determine correct spacing and depth for planting grapevine cuttings.

RESULTS

Almost all of the seedlings planted at the demonstration orchards grew normally. Their stems and branches were strong and free of diseases and pests. The trees on the rehabilitation plots of all farmers were found to be improved and pest- and disease-free, owing to better practices. When the new trees mature and begin bearing, they should produce better-quality fruit, while the rehabilitated trees will bear more fruit and enjoy a longer productive life (the productivity of the new apple varieties, for example, should rise from 28,000 kg/hectare to 48,000 kg/hectare).

These projects will help increase income for 40 farmers and their families through improving their orchards and increasing technical skills in establishing and managing orchards. When each of the 40 farmers spread the knowledge and techniques they learned to five of their neighbors, an additional 200 farmers benefit indirectly from the project.

ESTABLISHING FRUIT TREE ORCHARDS IN BASRAH

This project, which was conducted in 2006, supplied seedlings and training to 70 small farmers in three villages in Basrah. The objectives of the project were to encourage farmers to return to their land, provide them income-generating opportunities, and encourage other farmers in the area to establish more fruit orchards.

Mature fruit trees which have been pruned correctly.

TABLE 50 TECHNIQUES TAUGHT AND PRACTICED

Establishing New Orchards		Rehabilitating Old Orchards	
Month	**Activity**	**Month**	**Activity**
March	Orchard design Pit digging, organic fertilization, planting seedlings	February-March	Pruning, orchard cleaning Spraying with winter oil
May	Irrigation	April	Pest and disease control at blossom
July	Urea fertilization Weed control Soil cultivation around stems	May	Irrigation Fruit thinning
August	Urea fertilization	June	Pest and disease control
		August	Summer pruning
		September-October	Harvesting Grading
		October-November	Spraying with copper sulfate after harvesting

ACTIVITIES

Seventy fruit tree orchards or vineyards, each approximately 0.25 hectares in size, were established in the three villages. Thirty orchards were planted with grape seedlings (100 seedlings per orchard), 20 with fig seedlings (100 per orchard), and 20 with jujube and mango seedlings (50 jujube and 6 mango seedlings per orchard). Technical specialists from the NGO that implemented the project trained participating farmers on new planting techniques and the care of seedlings after planting, and visited farms over the 20-day period after the seedlings were planted to monitor their progress and advise farmers.

RESULTS

This project helped increase the income of 70 farm families in Basrah through the provision of seedlings. It also helped improve their knowledge of modern planting and seedling management techniques.

ESTABLISHING AND REHABILITATING FRUIT ORCHARDS IN SULAYMANIYAH, DAHUK, NINEWA, AND ERBIL

In 2006, ARDI implemented four activities to improve orchard fruit production in the northern governorates. Rather than supplying all the participating farmers with seedlings for establishing new orchards or rehabilitating all of the orchard plots of each participating farmer, these projects employed a new approach. Farmers came together in groups of 12-15 in the orchards of a group member to learn and practice orchard management techniques under the supervision of an orchard specialist. They then returned to their own farms and put what they had learned into practice.

Flowering fruit trees and well maintained orchard.

Unlike earlier ARDI apple and peach orchard projects in Dahuk and Ninewa, which directly established and rehabilitated orchard plots for farmers and provided inputs, these projects relied on a participatory extension approach. Here, agricultural specialists used a small number of orchards as a tool for teaching farmers appropriate horticultural methods. Through a hands-on teaching approach, the specialists demonstrated modern cultivation techniques to farmers.

TABLE 51 FRUIT ORCHARDS ESTABLISHED AND REHABILITATED IN DAHUK, ERBIL, NINEWA, AND SULAYMANIYAH

Governorate / Fruit	Farmers Trained	Plots Established	Plots Rehabilitated
Dahuk (apples)	60	4	60
Erbil (apples, peaches, plums)	90	6	90
Ninewa (peaches)	60	4	60
Sulaymaniyah (pomegranates, apples, peaches, pears)	105	7	105
Total	315	21	315

ACTIVITIES

NGOs implemented learning-by-doing projects to help orchard farmers in Dahuk, Erbil, Ninewa and Sulaymaniyah improve the quality of their apples, peaches, pears, plums, and pomegranates. Private orchard specialists from local NGOs provided extension services to help farmers rehabilitate existing orchards and establish new ones.

The NGOs contacted farmers and asked them to participate in the projects. Because the projects did not supply free inputs such as fertilizers and pesticides, some farmers initially declined to participate. The extension agents were largely able to solve this problem by personally visiting the farmers to explain the project's objectives. Where the farmers still declined to participate, alternative villages were found.

The NGOs formed groups of 15 farmers each. The groups attended regular meetings with an extension agent during the year to learn about and practice orchard management techniques in the orchard of one of the group members. The extension specialists used a participatory approach in teaching farmers. They explained and then demonstrated appropriate orchard practices, their

advantages, and periods of application, and also compared them to traditional practices.

Farmers then divided into smaller groups of two or three each to practice what they had learned under the supervision of the horticultural specialist. Each full group of 15 worked on one new orchard and one rehabilitation orchard, supervised by horticultural and extension specialists.

These four projects were planned to improve the technical knowledge and skills of 315 farmers. Somewhat fewer orchards were rehabilitated than originally intended, because a few farmers dropped out of the project. Also, the average attendance at the group meetings was 10 to 12 by the end of each project.

This extension program transferred methods of proper cultivation to farmers, which will help form a basis for a long-term solution to the problem of low productivity due to the use of traditional cultivation methods. When their orchards mature, farmers will enjoy higher yields and produce better-quality fruit, and consequently increase their net income. Further, they will pass their knowledge on to other area farmers, resulting in a far larger pool of beneficiaries.

Last, improved fruit production will increase the high-quality fruit available on the local markets for longer periods. Instead of having to rely on imported fruit, local consumers will have a greater choice including better prices.

Hands on training at the farmer's orchard demonstrated the practical application of classroom lectures.

NATIONAL HORTICULTURE CONFERENCE

In 2006, ARDI sponsored a national horticulture conference with stakeholders throughout Iraq. The objective of the conference was to discuss the current horticultural situation in Iraq and find ways to develop a successful horticultural industry, and to:

- Build a common understanding of current production and market structures in Iraq;
- Recommend production and market development priorities for the coming four years;
- Exchange perspectives on the roles and contributions of stakeholders in addressing priorities;
- Identify ways stakeholders could begin working together to address priorities.

ACTIVITIES

The two-day national horticultural conference was attended by 81 representatives of the public and private sectors (MOA horticulture and agriculture specialists, senior MOA officials, and representatives from NGOs, universities, farmers, and the private sector). The 81 people who attended

TABLE 52 NATIONAL CONFERENCE TOPICS

Groups 1-4 MOA Agricultural Specialists	Groups 5-6 NGOs, Farmers, and Traders	Group 7 Senior MOA Officials
· High-quality plant material · Research and extension · Optimal agronomic practices	· Market structures · Postharvest technology · Horticulture associations	· Zoning · High-quality plant material · Research and extension · Optimal ag. practices

represented 15 of Iraq's 18 governorates.

Following the opening speeches, stakeholders were organized into seven working groups. Each group was given a questionnaire that listed three or four high-priority topics. Groups were asked to describe the current situation in reference to that topic and agree on three or four recommendations to enhance activities in each area.

RESULTS

The strategic priorities developed for 2007-2010 as a result of these recommendations included:

- Horticulture Research and Training: strengthen MOA horticulture and training activities, and horticulture zoning;
- NGOs and Private Nurseries: establish private nurseries in central and southern Iraq;
- Horticultural Marketing: improve the commercialization of horticulture products;
- Post harvest Technology: Assess post harvest needs for horticulture products;
- Horticulture Associations: form associations based on ARDI's approach to honey production.

Horticulture species and variety diversification was also given high priority. Thus, the conferees strongly recommended the introduction/importation of new germplasm. Their recommendations also included:

- Establishing and restoring date palm orchards and nurseries;
- Establishing olive orchards;
- Benchmarking grapes and establishing nurseries and vineyards;
- Developing and improving fruit orchards;
- National horticultural conference;
- Expanding tomato varieties and improving production;
- Improving beekeeping production and extension.

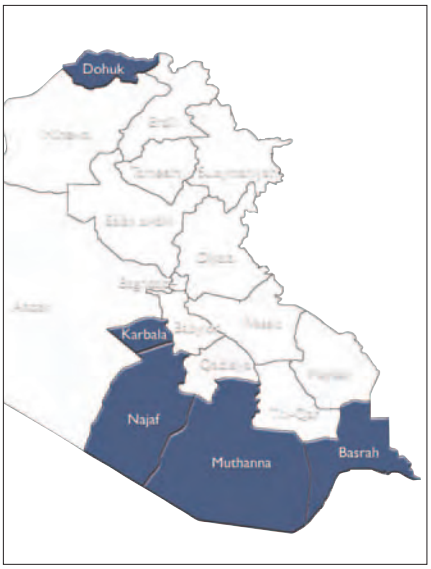
TOMATOES

Fresh tomatoes ready for market.

Tomato production is a lucrative economic activity for Iraq and has great potential for growth. There is strong domestic demand for tomatoes, but due to the poor quantity, quality, and marketing practices of tomato production, tomatoes imported from Syria, Jordan, and Iran have a strong presence in the Iraqi market and command higher prices than Iraqi tomatoes. In September 2006, the average price per kilogram for tomatoes from Iraq was 350 ID, while tomatoes from Jordan, Syria, and Iran ranged from 375 to 725 ID per kilogram.

There is a great potential to increase tomato production in Iraq to replace these imports and in time enter export markets. Iraq can produce large quantities of tomatoes because they are grown year round in most parts of the country. In the northern governorates, peak tomato production takes place during the hot summer months, while in the southern governorates tomatoes are grown in all but the hottest months.

The MOA took steps to improve tomato production under the previous regime. Beginning in 1996, it directly supported tomato production with a Tomato National Program (TNP). The program was intended to introduce transplanting techniques and provided subsidized peat moss, bioagents to control fungal diseases, fertilizers, and hybrid seeds. TNP monitored production farms, tested new tomato varieties, and provided advice to farmers. However,



Tomato production projects were implemented in these governorates.

budget cuts forced the MOA to drop the TNP as it did not yet generate adequate sales revenue from farmers. As a result, many farmers did not have an opportunity to participate directly in or observe the benefits of the (TNP) program.

ARDI's cooperation with the MOA focused on introducing new methods to improve tomato cultivation, including the use of hybrid seeds, transplant planting, proper fertilization, and covering tomato crops to protect from frost. Tomato production projects have been implemented in Najaf, Kerbala, Muthanna, Basrah and Dahuk governorates.

2004 - 2005
SUMMER CROP TECHNOLOGY DEMONSTRATIONS FOR TOMATOES

ACTIVITIES

ARDI began working with the MOA in the summer of 2004 to implement a tomato production program introducing farmers to improved methods of tomato cultivation. This project was implemented in August 2004 in Najaf, Kerbala, and Basrah governorates. A total of eight demonstration plots were established, two per governorate, on which new production technologies was introduced. These technologies included:

- Use of hybrid seeds;
- Transplant production;
- Soil and foliar application of fertilizers;
- Methods to control tomato disease and pests, including pesticide application;
- Methods to protect tomato crop from frost.

Using good planting material is an essential first step to improving tomato production. The demonstration plots were planted with two locally available tomato hybrids, Hatouf, and Dona, which are resistant to Tomato Yellow Leaf Curl Virus (TYLCV). A third, local variety of tomato seed, Super Marmande, was planted as a control. This variety is widely planted by Iraqi farmers, but is not as productive as the hybrid seeds.

Transplant production, which is the process of sowing tomato seeds in peat moss in a tray before transplanting them to fields to increase germination rates of tomato plants, is not widely used in Iraq. The usual practice of Iraqi farmers is to sow the seeds directly into the soil, which results in low initial germination rates, stunted plant growth, and wasted plants from thinning. The demonstration plots showed that the transplant method of cultivation resulted in a much higher germination rate than direct planting. Approximately 90% of the tray-cultivated seed germinated and grew vigorously.

It is important for Iraqi farmers to adopt methods to protect tomato crops from frost. These frosts can kill an entire crop; indeed, in demonstration plots in Najaf and Kerbala, the farmers did not use plastic as instructed covering during a frost and the entire crop was lost. An inexpensive method of frost protection can save the season's crop.

Individual tomato plants grown in seed trays for transplanting into fields.

Extension was an important element of the demonstrations for tomatoes. It introduced as many farmers as possible to these improved methods for tomato cultivation. In late December 2004, after the demonstration plots were completely planted, a workshop was held at an agricultural extension center in Najaf. Over 140 farmers attended the workshop, at which representatives from the College of Agriculture of the University of Kufa delivered a presentation on how to protect tomato crops from frost by covering them with plastic to reduce damage. The attendees participated in a question and answer session, followed by a discussion of the new crop protection methods. The day concluded with a tour of the demonstration field to show farmers the differences among the hybrids tested, and the practical application of frost protection for tomatoes, including branch removal and the use of suitable fungicide for restarting the growth and flowering process. The farmers were encouraged to apply these methods to their own tomato fields to increase their tomato production.

The crop from the demonstration sites began producing fruit in December 2005, and harvest continued for several months. One of the advantages of the hybrid tomatoes is that they continue to produce fruit well beyond the fruiting period of the local tomato varieties, and therefore give a greater overall yield and a more steady stream of income to the producer.

RESULTS

The results of the demonstrations show that the hybrid tomato plants Hatouf and Dona were much more productive than the local Super Marmand variety. The biggest improvement was in Najaf, where the Hatouf hybrid showed an average increase of 228% over the local variety, and the Dona hybrid exceeded the local variety by 578%. In Kerbala, increases were also over 100% for both hybrids, and in Basrah the increases were an average of 61% and 52% for Hatouf and Dona, respectively.

DONA F1 HYBRID

- Early producing, 60-65 days, planting to fruit.
- Indeterminate plant with large (170 grams) fruit.
- Heavy yields of slightly flattened fruit.
- Preferred for table fruit.

2005 – 2006 SUMMER TOMATO DEMONSTRATIONS

ACTIVITIES

In September 2005, ARDI and the MOA implemented a second tomato production program to speed the introduction of improved cultivation practices and increase the quality and quantity of tomato production in Iraq. A total of 80 tomato producers was selected, 20 each in Kerbala, Basrah, Najaf, and Muthanna, to cultivate Hatouf and Dona hybrids on a total of 40 hectares of land.

TABLE 53 PRODUCTION OF TOMATOES, SUMMER CROP TECHNOLOGY PROJECTS, 2004-2005

Site	Hybrid	Average Yield, kg/ton	Improvement over Local Variety (%)
Najaf 1	*Hatoof*	31	228%
	Douna	64	578%
	Super Marmand	9.4	--
Najaf 2	*Hatoof*	100% Frost Damage	
	Douna		
	Super Marmand		
Kerbala 1	*Hatoof*	14	117%
	Douna	16	137%
	Super Marmand	1.1	--
Kerbala 2	*Hatoof*	100% Frost Damage	
	Douna		
	Super Marmand		
Basrah 1	*Hatoof*	41	69%
	Douna	39	58%
	Super Marmand	24	--
Basrah 2	*Hatoof*	31	53%
	Douna	30	46%
	Super Marmand	21	--

The MOA, with assistance from ARDI, provided each farmer with Hatouf and Dona hybrid tomato seeds. ARDI provided other production inputs including plastic for tunnels. The farmers used the inputs to establish nurseries with the hybrid seeds, sowing them in trays approximately one month before transplant to the fields. ARDI also provided supplemental labor to each farmer to assist in maintaining the irrigation system, planting, fertilizing, spraying, weeding, harvesting, and grading. The laborers recorded daily activities, which were later used in the economic analysis of the project.

As with the 2004 – 2005 tomato production, extension was an important aspect of this project. Field days were held during the productive season at fields in each governorate. A total of 235 farmers who did not participate in the program were able to observe production and harvest activities, and discuss with technical staff from ARDI and the MOA the economic viability of using hybrids and other improved cultivation techniques to increase production. The field days were quite successful. Field staff reported that the hybrid Hatouf and Dona seeds sold out in many markets.

RESULTS

The 80 participating farmers observed large increases in production over the use of local varieties, which were estimated to yield an average of approximately 16 tons/ha. The biggest gains were in Muthanna and Basrah, where the use of Hatouf and Dona resulted in improvements of yield of over 200% (in Basrah, only six of 14 fields reported results). In Kerbala, there was a 94% improvement, and in Najaf a 50% improvement. The total yield from these demonstrations (not including 14 nonreporting fields in Basrah) was 4,831 kg, and the total revenue was $370,100.

*Production of local variety is estimated at 16 tons/ha

**Only 6 fields of 20 reported from Basrah

IMPROVING TOMATO PRODUCTION IN DAHUK GOVERNORATE

To increase the production of tomato plants in northern Iraq, in 2006 ARDI partnered with a local NGO to introduce farmers in Dahuk to improved production practices.

TABLE 54 TOMATO PRODUCTION, SUMMER CROP TECHNOLOGY DEMO TOMATOES, 2005-2006

Governorate	Number of fields	Average Yield (kg/ton)	Improvement over local variety*	Total Revenue ($)	Total Yield (kg)
Kerbala	20	31	94%	92,500	1,193
Najaf	20	24	50%	71,100	949
Muthanna	20	53	231%	158,500	2,113
Basrah**	20	48	200%	48,000	576
Total	80	--	--	370,100	4,831

A farmer in a tomato nursery in Muthanna

ACTIVITIES

The NGO selected a 500-square-meter plot of fertile land to serve as the nursery for this project. Laborers leveled the soil, plowed it, and prepared 18 individual plots, each 1 x 7 meters. In March 2006, the NGO planted 300 grams of tomato seeds of the Dona variety, which is famous for its high productivity, taste (its acid-to-sugar ratio is near perfect), color, and good portability and storage characteristics. Two or three seeds were planted per cell in germination trays that contained garden soil, sand, and organic fertilizer, and the nursery was covered with nylon tarps. The project also supplied tools to the nursery, including the tarps, hand watering cans, pickaxes, BRC fencing, curved iron wires, storage tent, organic fertilizer, and sand.

In May, ARDI selected 80 farmers from 20 villages in Dahuk and distributed 1,125 plantlets to each farmer (a total of 100,000 seedlings) at no cost. After the seedlings were planted, the NGO visited the farmers' fields to instruct them in agricultural operations and observe the plants' progress.

RESULTS

This project was initiated toward the end of the ARDI program, so its final results were not directly observed. However, the initial results were extremely promising, and suggested a positive conclusion of the project.

All of the participating farmers expressed strong desire to maintain the plantlets provided to them. The plantlets were of very good quality and had grown by over 90% at the time of the NGO's last visit (about 90 days after the project began). Further, the market price of this variety was about 50% more than the price for local varieties.

Thus, this tomato project gave farmers a new source of income from the cultivation of a superior variety of tomatoes, and the income they realize will be almost 50% higher than if they had planted local tomato varieties.

HONEY PRODUCTION AND BEEKEEPING

Honey production has been an important economic activity for Iraq's farmers for over 5,000 years. Beekeeping is also essential for improved agricultural production, because bees are excellent pollinators, especially of legumes, cucurbits, and fruit trees.

The domestic demand for honey is strong; Iraqis much prefer honey that is locally-produced and sold in the comb. Iraq does not produce enough honey to meet his demand, so consumers depend instead on costly imports from Germany, Australia, Egypt and the Gulf states. There is an opportunity for Iraqi honey producers to increase the quantity and quality of their output to meet this consumer demand.

In the past 20 years, Iraq's beekeeping industry was severely damaged through a combination of widespread violence and population movement, particularly in the northern region. After 1991, the industry recovered somewhat through assistance from humanitarian organizations that distributed beehives and tools.

A newly established bee colony on fresh wax molds and frames.

Recycled traditional woven hive.

This recovery, however, was hampered by the inappropriate use of insecticides, the introduction of the parasitic varroa mite from outside the country, and the lack of information on modern beekeeping methods, equipment, and medication. In addition, a 2003 fire at the Mishra State Sulfur Plant destroyed nearly all of the beehives in Ninewa governorate.

To improve the quality and quantity of honey produced in Iraq, ARDI coordinated with local NGOs to work directly with new and existing beekeepers to improve honey production. ARDI also trained local carpenters to produce such beekeeping equipment as modern beehive boxes, which had always been imported a high prices from Italy, Turkey, or Iran. Finally, ARDI established or strengthened beekeeping associations and worked with the MOA to bette extension services, in order to improve training opportunities for beekeepers.

COMMUNITY HONEY PRODUCTION PROJECTS

From 2004 through 2006, ARDI worked directly with 368 new or existing beekeepers to improve honey production. ARDI provided technical assistance, modern beekeeping inputs, and training to beekeepers to help them set up apiaries and sell honey.

Many of the hives in the project-assisted villages were destroyed under the

previous regime. For example, two of the villages themselves were destroyed more than once during the previous decades of conflict, and all of their beehives were burned. In the late 1990s, the farmers did their best to start producing honey again, using traditional basket hives made from plaited willow. However, the beekeepers suffered from low productivity, as these traditional hives are much less productive than modern beehives, and because they are closed systems they cannot be checked during the season for disease or other problems. They also must be destroyed to harvest the honey at the end of the season. By the time the ARDI project began, honey production was very low in these areas as a result of disease, lack of information on modern beekeeping techniques, and lack of access to modern beekeeping equipment.

Distribution of materials to new beekeepers.

ACTIVITIES

The 2004-2006 projects created new opportunities for villagers – widows and handicapped individuals who were interested in and capable of working with bees, current beekeepers, and poor men and women who owned no land or livestock – to learn about beekeeping, improve the quantity and quality of honey produced, and increase their income.

TABLE 55 HONEY PRODUCTION BENEFICIARIES

Governorate	Villages	Widows	Handicapped	Current Beekeepers	Poor Farmers	Internally Displaced Persons and Returnees
Diyala, Tameem, Sulaymaniyah	5	44	41	19	79	--
Erbil	10	2	2	--	--	48
Ninewa	1	20	11	20	--	--
Sulaymaniyah	1	8	11	5	8	--
Sulaymaniyah	2	15	13	18	4	
Total	**19**	**89**	**78**	**62**	**91**	**48**

Working groups – comprising a village leader, an MOA bee specialist, representatives from local beekeeping associations, and a local NGO – selected farmers to receive assistance for the project. Bee experts from the MOA and local universities gave lectures and hands-on training to farmers for six days on a wide range of topics, including how to set up and maintain an apiary; how to produce honey and other commercial bee products such as royal jelly, venom, wax, pollens, and propolis; the differences between traditional and modern beehives; how to select appropriate sites for apiaries; how to identify queens; and how to protect hives over the winter. Other area beekeepers also benefited by attending the training.

Each farmer then worked with a technical team to choose an apiary location. The project supplied all necessary inputs, including colonies, beehives, smoker, feeder, food, stand, tools, and medication. A week later, the technical team checked up on all beehives in the village to ensure they were in good condition and visited again every month to monitor and supervise beekeeping activities. Every other month, the technical teams held field days at a village training center, where farmers observed and discussed the practices and technologies they had learned with their own hives in the field.

Apiary located in pomegranate orchard.

ARDI trained 368 beekeepers on modern beekeeping technology in five governorates.

Fabrication of hives in local carpentry shop.

RESULTS

These projects provided direct technical assistance and about $300 in inputs per person to 368 beekeepers in five governorates. In the first year of production, each beekeeper could produce a minimum of 40 kg of honey, which is sold on the local market at $10 per kg, giving each participant $400 additional income. In the second year, with the exception of investments for medicine, the beekeepers will have all the inputs they need to produce more honey. Furthermore, the successful colonies will swarm and produce new bee colonies, which the farmers can capture to increase the number of their own hives in succeeding years, or sell to other beekeepers in the area.

The new beekeepers should realize income increases from the sale of their honey production -- those assisted by the project together realized nearly $155,000 in additional income in their first year of honey production. Their improved livelihoods should serve as a model for other area beekeepers, and the sector will continue to expand as more beekeepers gain access to modern beehives and beekeeping technology.

TRAINING FOR AGRIBUSINESS ON BEEHIVE MANUFACTURING

Modern beehives are an essential input to improve the quality and quantity of honey production. These beehives produce about three times as much honey as traditional beehives (about 15-20 kg/box compared to 5-8 kg/traditional hive). Unlike the traditional hives, which are not opened until the honey is harvested, the modern beehives can be opened for feeding, to administer medicine, and to check on the general health of the hive to prevent or treat problems before the end of the season.

Despite the advantages of these modern beehives, they are not widely available to Iraqi beekeepers. They must be imported, and the high cost prohibits many beekeepers from investing in them.

ACTIVITIES

In 2005, 12 carpenters from five governorates participated in a four-day training workshop in Dahuk, which focused on how to manufacture beehives to international standards. In addition to the training course, ARDI provided these carpenters with enough raw materials to produce 25 beehives, the sale of which would enable them to invest in additional materials to continue producing and selling beehives. The workshop's topics included:

- The technical skills needed to construct modern beehives
- The types of materials needed in beehive manufacturing (queen breeding hive, wasp traps, queen cell holder frame, etc.)
- Manufacturing beehives with standard dimensions.

TABLE 56 CARPENTERS TRAINED ON BEEHIVE MANUFACTURING

	Dahuk	Erbil	Tameen	Ninewa	Sulaymaniyah
Beekeepers Trained	3	3	2	2	3

RESULTS

These 12 carpenters will benefit from the additional business opportunities they gained as a result of their training. They can now also meet local demand for modern beehives and beekeeping equipment, and at lower cost than for imported equipment (an imported beehive costs US $45 on the market, while a locally manufactured one costs $28).

SUPPORTING MOA EXTENSION

In May 2005, the MOA and ARDI hosted a beekeeping conference that drew representatives from dozens of organizations around the country. This day-long event was an important step toward redeveloping Iraq's once thriving beekeeping sector.

Representatives gave presentations on their work in Baghdad, Basrah, Dahuk, Diyala, Erbil, Mosul, Najaf, Ninewa, and Sulaymaniyah. Participants then discussed the common problems and solutions devised in different parts of the country. Some of the issues highlighted were the impacts of pesticides, how best to make wax foundation (the starting point for the bees to begin making a comb), and finding better access to markets.

REHABILITATING THE BEEKEEPING LIBRARY AND RESEARCH AND EXTENSION FACILITIES, BAGHDAD.

ARDI helped increase the depth and breadth of training and education available to beekeepers by rehabilitating the Ministry of Agriculture's Beekeeping Library and Research Extension Center in Baghdad. The MOA Bee Department is responsible for reviewing and updating current MOA recommendations for beekeeping, and develops educational materials such as an activities calendar that describes proper beekeeping methods throughout the year. However, the MOA Beekeeping Library and Research Extension Center was damaged and lost virtually all of its educational materials when it was looted in 2003.

An ARDI grant helped refurbish the Center's lecture hall, procured basic equipment for its teaching and research laboratories, and supplied the Center with audio and visual equipment (including Internet capability) for educational purposes. As part of this project, ARDI procured 150 basic books for the library on all aspects of beekeeping, product processing, marketing, and creation of ancillary economic activities. Finally, ARDI purchased two sets of 120 back issues of *The American Bee Journal*. One set was donated to the State Board for Plant Protection Research and Extension Center Library in Baghdad, and the other set was given to the Kurdistan Beekeepers Association.

The improvements will restore the Center's ability to train extension workers and private beekeepers. It trained over 330 people during the first year after renovations. The improvement of beekeeping educational facilities will enhance the quality of extension services nationwide.

REHABILITATING THE QUEEN BEE APIARY AND RESEARCH FACILITY, KERBALA.

Years of constant inbreeding of bee colonies in Iraq has produced bee populations that demonstrate poor productivity and other undesirable characteristics. In recent years, Iraq has imported some *Carniollan* bees from Italy,

SUCCESS STORIES

BEEKEEPERS IN SULAYMANIYAH

In this northern governorate, many beekeepers assisted by the project in 2005 have decided to invest in additional beehives. Initially, the MOA/ARDI gave 62 new beekeepers 182 hives and accompanying inputs. In 2006, these same beekeepers own 567 beehives. These hives can produce 12,750 kg of honey, representing $127,500 in additional annual income for their owners.

BEEKEEPERS IN ERBIL

I have been in the business for 11 years, but it was only after the training I received that I managed to increase my beehives to 250.

An apiary owner assisted by the project, who was able to produce two tons of honey and 250 grams of royal jelly within a year.

This is the first time I am taking part in such an activity and hope more women will follow suit to improve their income. This is a good opportunity for me to increase my income to support my children. I hope I can produce scores of beehives from the two provided me by [the NGO].

Honey stored in inappropriate containers.

Bees assist in proper pollination for many plants, flowers, and vegetables.

which yielded hybrid bees that can produce 80 kg of honey per hive under proper management conditions. However, these bees were introduced haphazardly, and while honey production increased overall, there was no research to determine which crosses were preferable.

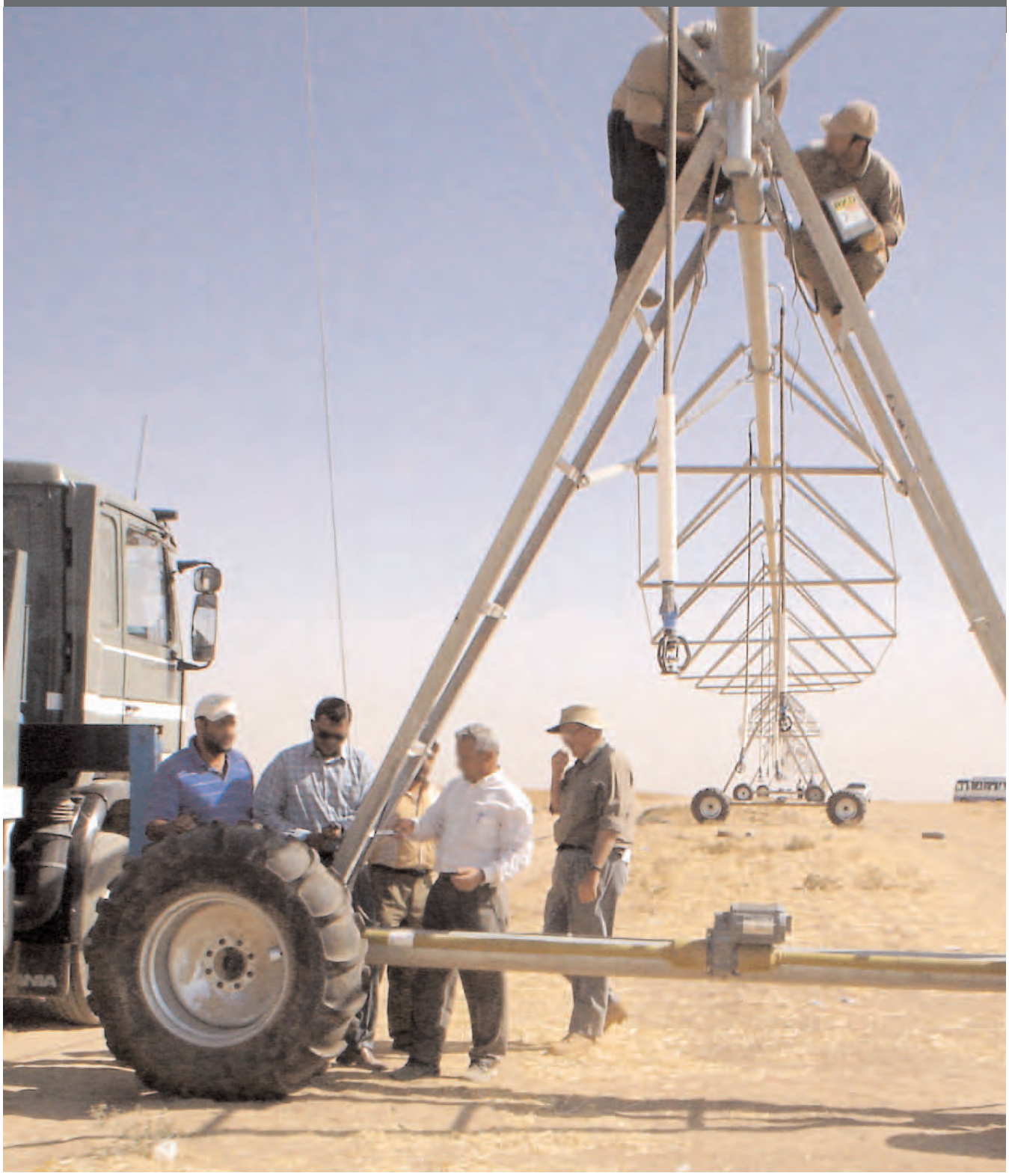
Demonstration and training apiary.

ARDI provided the MOA with a model apiary to produce virgin queen bees from imported queens of standard recommended strains. An apiary site was established in Kerbala by providing electrical hookups to local power sources, a small backup generator, a small water pump, and queen-rearing laboratory equipment. The apiary was then supplied with three strains of bees (Back-fast hybrid, Italian, and Caucasian races), whose queens were mated with local bees.

The queens were distributed to approximately 300 beekeepers in Baghdad, Babylon, Erbil, Sulaymaniyah, and Wassit governorates to mate with local male drones to produce hybrid races of increased productivity, tamer bees, and higher resistance to diseases and pests. The MOA will continue to track the hybrid races to compare their performance and determine the best hybrids for future planning. It will also work closely with the Iraqi Beekeepers Association to ensure the proper distribution of queens and adequate training in hybrid management. In the coming years, this facility will produce enough queens to satisfy the demands of up to 6,000 beekeepers each year.

Traditional woven beehive from the North.

2.4 INFRASTRUCTURE FOR IMPROVING WATER USE EFFICIENCY



INTRODUCTION AND BACKGROUND

Saline soils are exacerbated by improper irrigation and inadequate drainage.

Agricultural production in Iraq depends heavily on irrigation. According to the results of the ARDI AEZ program (see Section 3.1), the total irrigated area in Iraq during the 2004 – 2005 period was approximately 3,543,000 hectares, accounting for 51% of the total cultivated agricultural land. Of the irrigated areas, approximately 63% receive water through gravity fed irrigation systems, 36% from rivers and major channels via pumps, and the remaining 1% from ground water aquifers and springs. The main irrigated crops are wheat, barley, rice, maize, vegetables, and date palms. In the arid southern regions of Iraq, irrigation is necessary year-round. In the northern region, irrigation is necessary during the dry, hot summers, and there is some supplemental irrigation during the winter season.

Iraq has an existing, although poorly maintained, irrigation and drainage infrastructure. Prior to 1980, the previous regime maintained and made improvements to water-related infrastructure. Irrigation canal systems were upgraded with new infrastructure, including regulators and pumps to distribute water to agricultural areas, and many canals were lined with concrete to reduce water loss and drainage problems. The government maintained this infrastructure through a network of district-level Water Resource Directorates until onset of the Iran-Iraq war (1980 – 1988), when the government diverted its resources into the war efforts and seriously neglected the nonmilitary infrastructure. This neglect continued through the period of UN sanctions (1990 – 2003).

ARDI conducted irrigation projects in these governorates.

Failure in distribution pipe from junction box.

Culvert blocked by years of accumulated debris.

The poor condition of Iraq's water sector has resulted in numerous problems for agricultural production. Overirrigation in the upper reaches of the canal systems, underirrigation in the lower reaches, and other forms of poor agricultural management have caused water logging and salinization, significantly reducing the productivity of agricultural lands. A high water table associated with salinity problems affects more than half the irrigated area in Iraq. In addition, there has been a decrease in the supply of water available in Iraq and the quality of the available water has deteriorated over the past two decades, largely due to development activities in Turkey and Syria. The salinity of the Tigris and Euphrates rivers during the summer months is deteriorating downstream to an alarming level. These problems are affecting the central and southern regions of Iraq most profoundly, including the governorates of Wassit, Missan, Kerbala, Babylon, Baghdad, Diyala, Najaf, and Thi-Qar. These are arid regions in which farmers depend on year-round irrigation for agricultural production.

When ARDI initiated reconstruction and development activities in 2003, the water sector was suffering from over 20 years of neglect, resulting in poor agricultural production to such an extent that many farmers left their lands altogether. While the government's existing policy was to invest in new infrastructure, ARDI programs stressed improving the performance of existing infrastructure, working directly with the farmers themselves, and strengthening the intuitions serving the farmers.

All of ARDI's activities undertaken for the water resources sector were participatory and based on principles dictated by the water demand management approach (supplying water based on the crop needs, both in quantity and time). ARDI worked on increasing institutional capacity of the Ministries of Agriculture and Water Resources in Baghdad and the Ministries of Agriculture and Irrigation in Erbil and Sulaymaniyah. ARDI also considered it important to work directly with agricultural producers and related NGOs to improve water management and crop production.

ARDI's projects in the water sector included:

- Physical improvements to existing irrigation infrastructure – canals, structures, and laser land leveling;
- Expanding access to highly efficient irrigation equipment;
- Introducing small-scale irrigation systems;
- Addressing issues of drainage and salinity; and
- Improving data collection for water resource planning.

PHYSICAL IMPROVEMENTS TO WATER MANAGEMENT INFRASTRUCTURE

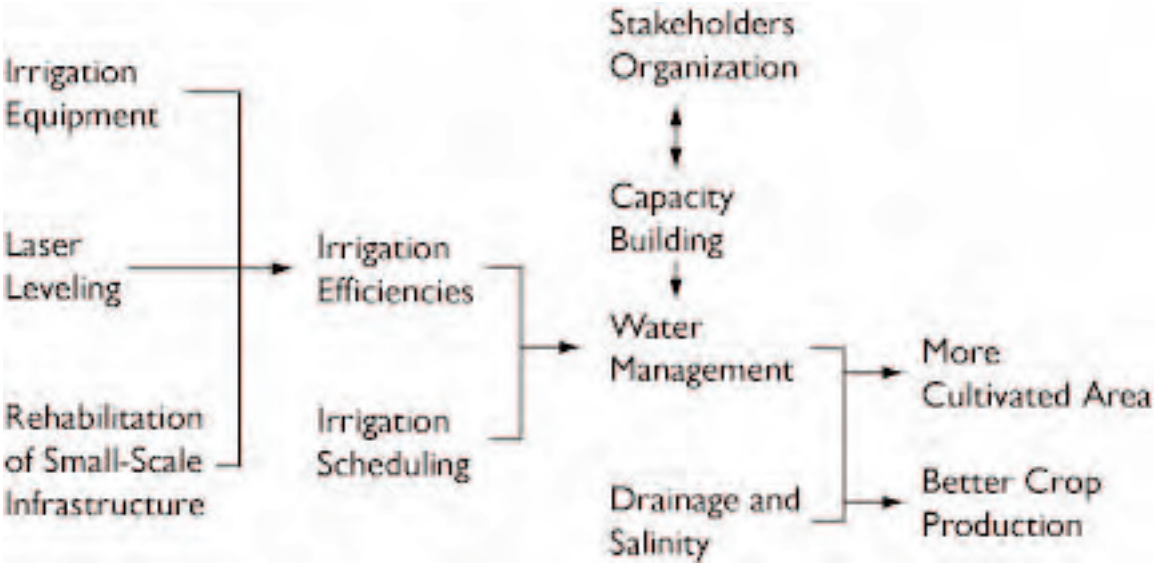


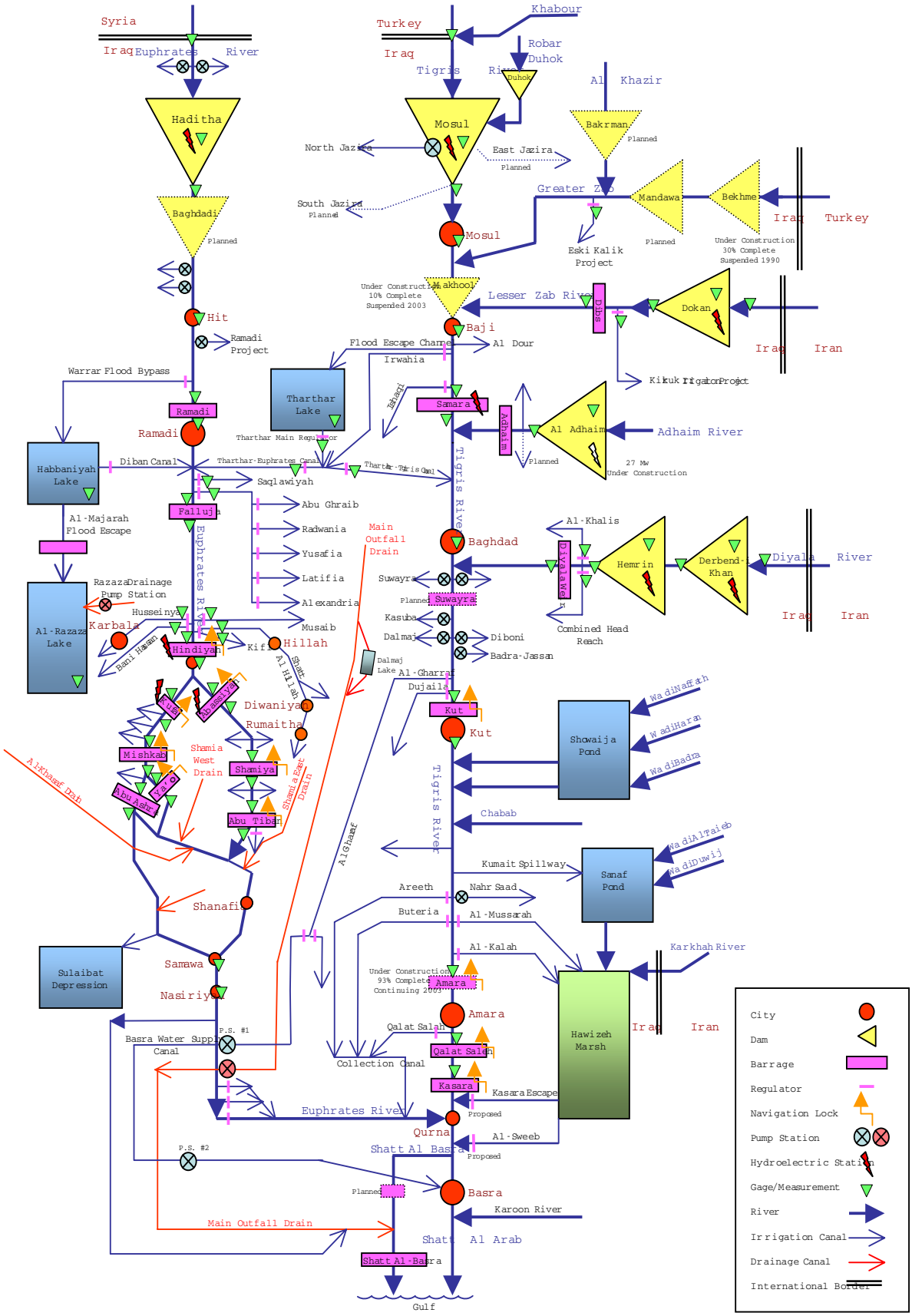
Figure 1 ARDI's approach to reconstruction and development of the water sector, which illustrates the emphasis on improving water management conditions.

The majority of irrigation in Iraq uses the gravity surface method, which involves creating earth channels for water conveyance and water applications by furrows or in basins. The water use efficiency of these irrigation systems is often low in Iraq, either because existing infrastructure has not been maintained, or because appropriate structures to improve efficiency were never built.

ARDI canal infrastructure rehabilitation activities included canal cleaning and rehabilitation of structures such as regulators and drainage pumping stations, with the goal of improving the distribution and conveyance efficiencies in the irrigation water network. These activities were quick-impact, with uncomplicated designs requiring relatively low capital investment, and an opportunity for participatory development, as the benefited farmers were involved in many of the projects. Many of the projects were identified through requests from the Departments of Agriculture, Water Resources Directorates at the governorate and district levels, and farmers themselves.

MINISTRY OF WATER RESOURCES

SCHEMATIC DIAGRAM FOR STORAGE AND CONTROL OF WATER IN IRAQ



CANAL CLEANING

Canal cleaning in Muthanna governorate.

Thousands of kilometers of irrigation canals in Iraq are not able to deliver adequate irrigation water to agricultural land because they are blocked with weeds, mud. and other debris, due to the lack of routine maintenance over many years. In addition, many of the underground pipe drains and drainage ditches that are designed to prevent waterlogging and salinization of the soil are blocked and require cleaning.

According to Iraqi law, farmers are required to maintain their own (tertiary) irrigation canals, while the government authority in charge of water resources in an area is charged with maintaining primary and secondary canals. Many farmers who depend on tertiary irrigation canals for agricultural production have not maintained them because they do not have the resources to pay for cleaning. This has resulted in reduced agricultural productivity and lower income, leading farmers further into poverty.

Cleaning canals is an extremely labor-intensive process that creates an opportunity for farmers to participate directly in the rehabilitation of the irrigation canals that serve their land. For canal cleaning activities, ARDI worked with local NGOs or the district Water Resources Directorate to organize local farmers into labor teams. ARDI supplied labor teams with tools such as shovels and rakes, and the NGO or Water Resources Directorate provided supervision. The farmers received modest

THE THREE CATEGORIES OF IRRIGATION CANALS:

- **Primary:** the major canal coming from a water source such as a river or reservoir;
- **Secondary:** canals extending from primary sources, and directed toward villages and their fields; and
- **Tertiary:** canals directed from secondary sources into individual farmers' plots.

Manual cleaning of canals provides need income for local farmers and villagers.

cash wages for their labor, which supplied an immediate injection of cash to the local economy. They also kept the tools used to clean the canals, which they will use in future years to maintain them.

The principal idea behind canal cleaning is to improve the flow conditions in the canal by diminishing the roughness coefficient, (*n*) (sometimes called the resistance coefficient), which is a measure of the roughness of the sides and bottom of the canal. The higher the roughness coefficient (*n*), the lower will be the discharge capacity of the canal will be.

Due to the lack of maintenance over the last 15 or 20 years, the condition of the canals in southern Iraq was very poor. As a result, parts of irrigated land received no water, and other parts did not receive enough to meet crop water requirements. The problem was compounded by increasing salinization resulting from poor drainage and a general lack of proper water management practices, causing many farmers to abandon their lands. The remaining farmers are struggling to cope with the further deterioration of canals due to silting and blockage, resulting from a lack of maintenance. This blockage impedes the flow of water to irrigate crops, causing high losses through seepage, and also obstructs systems of drainage that protect land from salt buildup.

In addition water use fees are not collected by the GOI. This results in increased water use and reduced funds for system maintenance.

Table 57 Values of the Coefficient *n*

Canal lined with finished concrete:	0.012 – 0.014
Canal lined with formed, rough concrete:	0.013 – 0.017
Earth canal, uniform, cleaning completed:	0.016 – 0.018
Earth canal, uniform, short grass, few weeds:	0.022 – 0.027
Earth, fairly uniform, no vegetation:	0.022 – 0.025
Earth, fairly uniform, some weeds:	0.025 – 0.030
Vegetated canal:	0.040 – 0.050

The ARDI canal cleaning projects changed *n* from the existing condition of over 0.050 to about 0.018. This enabled restoration of the original flow conditions.

ARDI cleaned a total of 1,167 km of 311 canals, providing 6,380 farmers with temporary jobs and benefiting over 85,000 farmers (see Table 58). The direct impact of cleaning these canals was dramatic, increasing water flow to farmers' land by an average of 150%. The improved irrigation enabled many farmers to begin summer cropping in areas where none had been possible for many years, increasing the productivity of the land and increasing farmers income through the sale of summer crops for the first time in 15 or 20 years. Farmers in northern Iraq benefited from improved supplemental irrigation during the winter season, while farmers in southern Iraq gained much more efficient year-round irrigation.

TABLE 58 DIRECT IMPACT OF IRRIGATION CANAL CLEANING AND STRUCTURE REHABILITATION

Canal Length Cleaned (km)	Number of Structures Rehabilitated	Agricultural Land Benefited (ha)	Families Benefited	Workers Employed
1,167	48	283,000	85,165	6,380

IRRIGATION STRUCTURE REHABILITATION

(1) Construction of a head regulator, before rehabilitation, and (2) after, (3) culvert beneath road, (4) pipe flume in northern Iraq, (5) karezes tap into a mountainside, (6) canal lining.

The effectiveness of a canal irrigation system often depends on hydraulic structures and other infrastructure that make the efficient distribution of water possible. Like the canals themselves, this hydraulic infrastructure had been badly neglected by the Iraqi government over 20 years of wars and sanctions. To improve the efficiency of the canals in delivering irrigation water to agricultural land, ARDI rehabilitated a wide range of canal structures, including:

- **Regulators,** which are gates of various sizes that divert water from one canal into another and control the flows throughout the irrigation systems. In some circumstances, pumps may be used near a regulator, or elsewhere along the canal, to maintain flow capacity in the drainage system or to deliver water for irrigation.
- **Culverts,** which are structures that carry water underneath roadways to reach agricultural lands.
- **Pipe flumes,** which are structures that carry water across drains to reach agricultural lands.
- **Karezes,** which are traditional irrigation structures that tap ground water through gravity flow. These are used in mountainous areas of northern Iraq.

ARDI also carried out **canal lining,** which is the process of lining a canal with

concrete to reduce seepage and increase capacity, delivering significantly more water directly to agricultural lands.

In addition, ARDI worked in northern Iraq to construct **water storage facilities** at the village level. Vegetables and fruit trees are widely grown in many areas of northern Iraq, and farmers depend on irrigation from mountain springs. Water basins enable the storage of water from these springs during nonirrigated times, when it would otherwise run off and be wasted. This water can be saved for use during the dry season or other times when rainfall and water from the springs is scarce. ARDI constructed 20 of these basins, in close coordination with village councils. Those councils are administering the basins to ensure fair and equitable use of the stored water by village farmers.

In order to build capacity within the GOI to carry out rehabilitation and maintenance activities for Iraq's irrigation canal system, ARDI trained 14 engineers from the Ministries of Agriculture and Water Resources in design of hydraulic structures. The training course was delivered in coordination with the Department of Water Resources of the College of Engineering at the University of Baghdad.

CASE:
REGULATOR INCREASES EQUITABLE WATER DISTRIBUTION AND IMPROVES RICE YIELDS

In Muthanna governorate there is a subdistrict known for production of high-value Anbar rice, which sells for around $1.20 per kg. This region produces yields of up to 4.0 mt/ha, much higher than average yields in other parts of Muthanna. Due to the poor management of irrigation, water did not reach many farms so farmers could plant their lands. Other farmers receive some water,

but not enough to meet the rice crop water requirements. The result was reduced productivity: some farms were producing only 2.8 mt/ha. ARDI installed a regulator on the irrigation canal that serves the farms in this subdistrict, which permitted equitable distribution of irrigation water year-round. This more efficient use of water will enable farmers to increase their yields by 1.2 mt/ha, back to 4.0 mt/ha, adding value to production of up to $1,440 per ha.

CASE: REPAIR OF A DETERIORATING CANAL SYSTEM

At a village in northern Iraq, located 80 km away from an urban area, a system using natural springs irrigates approximately 40 ha farmed by 80 families. The main crops grown are tomatoes, apricots, sesame, cucumbers and other high-value vegetables. The irrigation system was composed of an earth canal and a deteriorating intake and turnouts. Most of the water diverted was being lost to seepage, limiting the chances for some farmers to produce good yields, especially those farmers located at the tail of the canal.

ARDI rehabilitated the intake, including a small weir, lined 1,300 m of canal with concrete, and constructed complementary infrastructure like drops, and foot and car passages. Farmers are now able equitably to irrigate these 40 ha during the summer and to supplement the area with additional water during the rainy season. The completion of this project also encouraged the return of farmers who had previously left their lands due to poor agricultural production.

LASER LAND LEVELING

(above) A tractor pulls the laser guided scraper to level the land.

(below) Laser beam receptor on the scraper feeds a signal to the scraper control unit.

While the use of the gravity surface method of irrigation via open canals is the most popular method, it is estimated that it currently wastes over 60% of water. The main factor causing this loss is the uneven fields, which results in uneven water distribution. Areas of high elevation do not receive sufficient water, while areas of low elevation become waterlogged and prone to salt buildup. Fields must be as level as possible for gravity surface irrigation, so that moisture content is constant throughout the field, enabling uniform crop growth and reduction of weeds.

ARDI implemented a project to introduce laser land leveling that is much more accurate, less costly, and more efficient than traditional leveling methods. The system consists of a laser transmitter placed in the field, and a laser receiver, electrical control computer, and hydraulic control valve connected to a four-wheel drive tractor.

The use of laser land leveling requires a relatively high initial capital investment in equipment, and a high level of skill to correctly level land. ARDI worked with an NGO that was formed to provide laser land leveling services to farmers. ARDI provided a training course in laser leveling for the eight members of the NGO staff, including a surveyor, two engineers, two tractor mechanics, and three experienced tractor drivers. The course included training in laser system operation and maintenance; principles, methods, advantages and problems

Laser emitters like this one, send signals to the scraper mounted receiver to lower or raise the scraper blade.

associated with laser leveling; and how to carry out the laser leveling operation. The course also included some business management training, including how to calculate the operating, administrative, and overhead costs of the system. ARDI granted the NGO the equipment necessary to capitalize it and begin operations. The NGO is now providing laser land leveling services to farmers for a fee, in order to help it expand its services, and help farmers create even fields and ultimately optimize water-use efficiency for improved crop production.

EXPANDING ACCESS TO HIGHLY EFFICIENT IRRIGATION EQUIPMENT

Rotating center pivot sprinkler with drop spray heads.

As noted previously, traditional gravity surface irrigation methods using earth channels for water conveyance and on-farm distribution can be highly inefficient, resulting in water losses of over 60 percent.. The use of highly efficient, pressurized irrigation systems such as sprinklers, minisprinklers, center pivots, hose move, and drip irrigation is an excellent way to increase water use efficiency on agricultural lands and eliminate most conveyance losses.

Under the Oil-for-Food program, the previous regime purchased more then 2,000 of these pressurized irrigation systems. However, government staff were never trained in the installation and operation of the systems, and most of the systems were never distributed to farmers.

In order to get these systems out of warehouses and into farmers' fields, ARDI conducted a training program for Ministry of Agriculture engineers for the

(top to bottom)
1) Laying the water source pipe, 2) preparing the lateral lines, 3) pressurized line to the system, and 4) installing a control valve.

installation and operation of the systems. ARDI set up 14 demonstration areas: five center pivot systems, three drip systems, three hose move systems, and three minisprinkler systems. A total of 117 MOA officials were trained in installation and operation of these systems, as well as in water management theory including how to calculate peak crop water use, determine a simple irrigation schedule, and calculate pumping times required for each type of irrigation system. The MOA officials are now prepared to provide technical assistance to farmers in installing highly efficient equipment, and to provide advice to help farmers use water more efficiently for agricultural production.

At the same time, the MOA started an awareness campaign to inform farmers about the availability of the pressurized irrigation equipment in the warehouses and began a credit system to help them purchase it. The result of this combined MOA/ARDI effort is that 50 center pivot, 50 drip systems, and 50 solid set irrigation systems have been purchased and installed by farmers.

ARDI also implemented a separate program to install center pivot irrigation systems on farmers' fields in Tameem governorate. At least 380 farmers in the area received center pivot systems during the Oil-for-Food program, but due to a lack of technical assistance never installed them. ARDI worked with a local NGO to provide this technical assistance in system installation and operation. The NGO provided training to farmers while installing a total of 24 systems in the area. The farmers trained are now expected to install their own systems in their own fields.

EXPANDING ACCESS TO SMALL-SCALE IRRIGATION EQUIPMENT

While the pressurized irrigation equipment described in the prior section enables the efficient use of water for crop production, millions of small-scale farmers do not have access to these types of systems, due to the high initial capital costs of system installation, its complex operation and maintenance requirements, and because the systems are too large for their farms. However, small-scale farmers can still benefit greatly from irrigation, particularly for the production of high cash-value-crops that can provide an important source of food and income. Low-cost, highly efficient drip irrigation systems called Family Drip Irrigation Systems (FDIS) are ideal for small-scale agricultural production on small plots of land of 100 to 200 square meters. These systems are complete drip irrigation units that work at very low pressure through gravity from a small elevated tank. System operation and maintenance are very simple, requiring no special skill.

In order to increase access to these types of systems, ARDI implemented a project to distribute FDIS to small-scale rural producers and to train MOA officials to provide technical assistance to farmers on the installation and operation of them. The objective of the project was to enable rural farmers, many of whom were previously subsistence-level producers, to generate income through production of high cash-value-crops using the FDIS. The project was also intended to stimulate demand for FDIS in the local market, in order to encourage local production of these inexpensive and simple systems.

Emitters for the small scale drip systems come in many types and water flows. They require minimal pressure to operate.

(top to bottom)
1) The basic FDIS installed on a farmers field, 2) lateral lines carry water to individual plants, and 3) efficient water use increase plant health and yields.

ARDI initiated the project in Qadissiya with the distribution of 15 FDIS to rural farmers who were previously not generating any income from crop production due to the lack of irrigation. The farmers each received a system, and training on its installation and operation, plus advice on crop production. The success of this program led ARDI to expand the project to eight governorates and 240 farmers.

The expanded project was implemented in close coordination with the MOA in order to build capacity for providing technical assistance to small-scale farmers on FDIS installation, operation, and maintenance. The project trained 58 staff from the MOA on FDIS and on improved water management techniques relevant to small-scale agricultural. ARDI created a *Family Drip Irrigation System Technical Handbook* for use during the training program, which the MOA can continue to use to train staff on FDIS.

When the training was complete, the 58 MOA staff members worked in teams of two to distribute FDIS to the 240 recipient farmers. After all the systems were installed, 58 of the farmers were chosen at random to receive continued technical assistance from MOA staff throughout the growing season. The MOA teams distributed vegetable seeds to the farmers, and visited them to provide advice on irrigated crop production, water management techniques, and to provide assistance with FDIS. These visits were conducted as field days, and other area farmers also attended to learn about using the FDIS to increase their production of high-value cash vegetable crops.

ARDI staff recorded production data to determine the economic benefit of using

TABLE 59 INCREASE IN YIELD FROM FDIS

Governorate	Number of Systems	Crop	Yield (kg/ha)	Average yield under traditional cultivation (kg/ha)	Difference (%)
Babylon	15	Cucumber	12,630	7,000	80
		Okra	8,000	4,000	100
Basrah	30	Okra	6,300	2,700	133
Kerbala	15	Squash	13,500	7,200	88
Missan	50	Cucumber	11,390	6,400	78
		Okra	8,000	3,800	110
Muthanna	50	Cucumber	12,320	7,400	66
		Okra	8,000	3,500	128
Najaf	15	Melon	11,200	7,000	60
		Okra	8,750	3,800	130
Thi-Qar	50	Cucumber	11,300	6,500	74
		Water Melon	12,000	7,500	60
Wassit	15	Melon	12,080	7,200	68
		Squash	13,000	7,400	76
Qadissiya	15	Tomato	14,000	4,000	250
Total	**255**				

FDIS to increase agricultural production. The crops cultivated with FDIS were cucumber, okra, squash, melon, and watermelon. On the average, production of these crops doubled using FDIS (See Table 59). With continued extension efforts by the MOA to improve farmers' use of the equipment and application of proper cropping and water management techniques, productivity can be improved even more. These production increases provide additional food security for the farmer and income from the sale of excess crops.

ADDRESSING THE PROBLEMS OF DRAINAGE AND SALINITY

Recently cleaned canal in central Iraq.

While irrigation is important and even essential to agricultural production in some parts of Iraq, poor drainage creates significant problems on irrigated agricultural land. In addition to delivering water for agriculture, irrigation systems must provide a mechanism for removing excess rain or irrigation water or for leaching salts from the soil. Inadequate drainage leads to rising levels of salinity in the soil, with the eventual result that the soil becomes too salty for crop production.

Over the past two decades, the neglect of Iraq's irrigation infrastructure has also resulted in a deterioration of drainage components. As a result, thousands of hectares of agricultural land, mostly in the central and south-central region of the country, are becoming too saline for crops. It is estimated that more than 50% of the agricultural land in this region is affected by high salinity and much of the land has been abandoned by the farmers who previously relied on agricultural production as a source of food and income.

Input pipes carry water to pumps at secondary level.

One way to increase production in highly saline soils is through the development and use of salt-tolerant crop varieties. Iraqi researchers have been successful in developing a variety of salt-tolerant wheat that grows well on saline soils. (See Section 2.1 for a discussion of ARDI programs to expand the use of these varieties). However, this technique limits the range of crops that can be grown. The other option is to actually reduce the soil salinity by installing drainage systems that enable proper drainage and to provide a means of leaching salt from the soil in those areas where soil conditions are conducive to leaching. This is more costly and time-intensive, but brings agricultural land fully back into production.

At the beginning of the project, ARDI sponsored training for 19 MOWR and MOA staff, in order to prepare them for implementing the Pilot Drainage Catchment Areas project. The training course, which was held in Holland, addressed many issues related to the problems of waterlogging and salinity, including:

- Agricultural drainage criteria (design criteria and drainage design parameters);
- Water and salt balances (water and salt balance in a pilot area, in drained plots, and the role of the aquifer);
- The effects of drainage (how drainage influences the water table, soil salinity, crop yields, and the socioeconomic conditions in the pilot area);
- Principles of drainage research (interrelationship of drainage and irrigation water management, and how to set up a research program);
- Field research in Pilot Areas (how to plan data collection and how to design, construct, operate, and maintain pilot areas);
- Data management (data handling, analysis, and presentation); and

- Case studies (how to create logical frameworks and computer software to diagnose drainage and irrigation problems and formulate a research program to investigate and solve these problems).

When the training was complete, ARDI and the Task Force selected four pilot drainage catchment areas ranging from 100 ha to 500 ha. Routine soil and water sampling, and groundwater depth measurements, were taken to establish the water and salt balances of each pilot drainage catchment area, including:

- Groundwater depth measurements (monthly, one fixed point per 20 – 30 ha);
- Groundwater salinity measurements (monthly, one fixed point her 20 – 30 ha with a portable conductivity meter) and water sampling to determine Na, Ca, Mg, K, Cl, SO_4, HCO_3 and CO_3 (quarterly, one fixed point per 20 – 30 ha);
- Soil salinity sampling (seasonally per layer of 0.25 m till 2.00 m deep around the fixed point per 20-30 ha for Saturated Soil Paste (SSP) and $EC2_e$ analyses); and
- Crop yield assessments (in-situ where a farmer is cutting fodder crops, and seasonally where a farmer harvests his grain crops, or picks seed cotton). When crop yield assessments are made always a composite soil sample is taken from the top soil (00-25 and 25-50 cm) at the site for SSP and $EC2_e$ analyses.
- Irrigation water inflow: total monthly supply from continuous recordings of the head in calibrated flow measurement devices and salt import on the basis of weekly pen-type electrical conductivity (EC) probe measurements; and
- Drainage water outflow: total monthly discharge from continuous drainage water level recordings at calibrated sections or from the operation hours of a calibrated pump and salt export on the basis of weekly pen-type EC probe measurements.

In addition, in each pilot area a test plot of 10 – 30 ha was established to monitor the impact of drainage systems on reducing soil salinity and improving crop production using traditional (not otherwise improved) farmer practices. Piped drainage systems were installed in these test plots, with pipes located at different depths and spacing to determine the main parameters important in designing future drainage-based soil salinity control investments and practices under the conditions in Iraq.

The routine soil and water sampling, groundwater depth, pipe drain discharge, and piezometric pressure level measurements program in each drainage test plot included:

- Groundwater depth measurements midway between two successive drains with the same depths and spacing (daily in permanent groundwater observation wells with a depth of 2 m). In a few observation wells, measurements have been carried out by water pressure data loggers;

- Groundwater salinity measurements by means of a pen-type EC probe midway between 2 successive drains with the same depth and spacing (monthly in the permanent groundwater observation wells). Quarterly, groundwater samples are being collected to determine Na, Ca, Mg, K, Cl, SO_4, HCO_3 and CO_3 concentrations;
- Measurement of the discharge of selected pipe drains daily by means of bucket and watch, but preferably continuously by an automatic recorder;
- Measurement of the EC of the discharge of the selected pipe drains (daily by means of a pen-type EC probe). Quarterly, drain discharge samples are collected to determine Na, Ca, Mg, K, Cl, SO_4, HCO_3 and CO_3 concentrations;
- Measurement of water levels in a set of 3 piezometers installed preferably within the fenced meteorological station at a depth of respectively 2, 3.5 and 5 m, to detect upward or downward flows in the subsoil (monthly level readings); and
- Soil salinity sampling (quarterly per layer of 0.25 m till 2.00 m deep around the permanent groundwater observation wells for SSP and $EC2_e$ analysis, and to determine Na, Ca, Mg, K, Cl, SO_4, HCO_3 and CO_3 concentrations).

Irrigation water and related salt intake of the different (cropped) drainage trials were calculated on the basis of irrigation water discharge and irrigation time measurements, and measurement of the irrigation water salinity by means of a pen-type EC probe. The automatic recordings of the meteorological station were checked and registered monthly.

In August 2006, ARDI held additional training for 17 MOA and MOWR staff involved in activities in the pilot areas. This training course, which was delivered by the Department of Water Resources of the College of Engineering from Baghdad's University and an ARDI drainage consultant, addressed the following topics about salinity and drainage in semiarid zones:

- Surface water distribution and drainage (international examples; aspects of the Iraqi situation);
- Assessment of salinity drainage projects (agricultural aspects; economic aspects; social and rural health impacts; and, environmental risks and opportunities); and
- Sustainability of salinity drainage projects (institutional requirements; farmers' participation; and financial and O&M aspects).

The Pilot Areas are still in use, and the active involvement of the Drainage and Salinity Committee and the Task Force throughout project implementation should ensure the continuation of the monitoring activities, presentation of analytical interim reports with consolidated field data, and the completion of investigative reports with recommendations for the implementation of drainage-based soil salinity control projects and practices elsewhere in Iraq.

CASE: VALUABLE ORCHARD AND CROP LAND ABANDONED DUE TO HIGH SALINITY

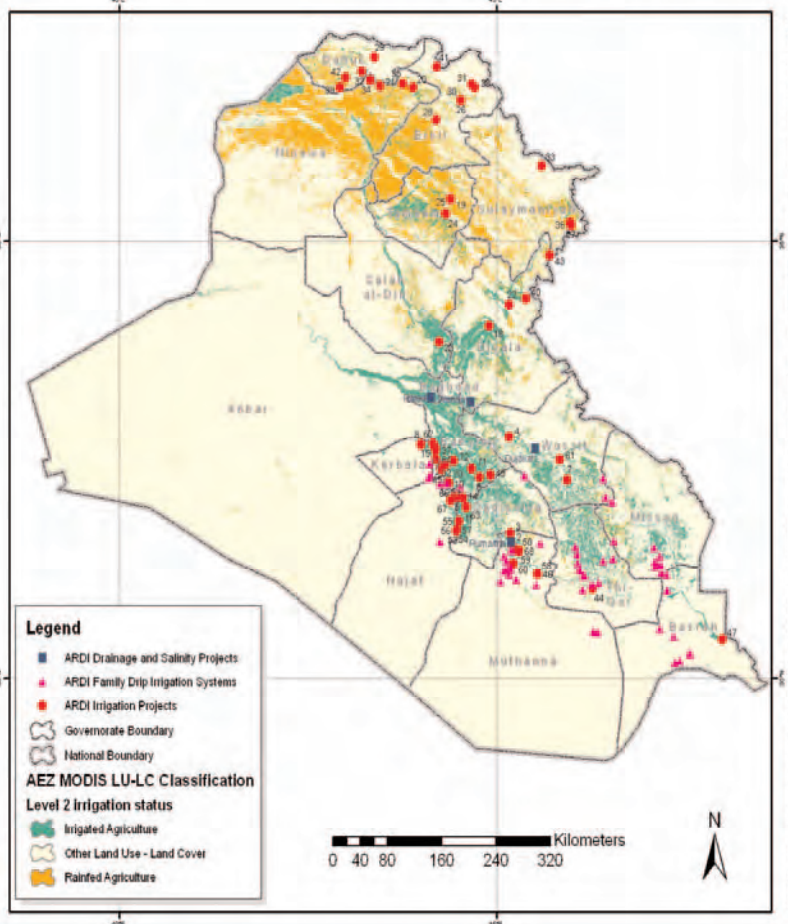
Neglect of drainage systems has led to damage of many thousands of hectares of formerly arable land. In many cases, the land has become so waterlogged and saline (salty) that cropping became impossible, and farmers abandoned their farms. One case of this occurred in Kerbala governorate, in an extremely important agricultural area where date palms, wheat, maize, sesame, tomatoes, and other fruits and vegetables were produced. In 1990, a project was implemented to construct a drainage system, including a nearly 6 km-long drain, and to line irrigation canals to control seepage. However, when the project was not completed and there was no maintenance of the system after 1991, the following problems arose:

1. Blockage in parts of the canal which had mixed with sewage;
2. An increase in the salinity of the soils;
3. The death of 20% of the fruit and date palm trees;
4. The death of 80% of the citrus trees;
5. The abandonment of land by many farmers; and
6. A decrease in the area of cultivated land.

ARDI funded cleaning of the drainage system by providing hand tools and using farmer labor to restore its ability to drain excess water from agricultural fields. The rehabilitated drain will be able to drain 400 ha and reduce salinity, resulting in improved crop productivity and increased income. The farmers kept the tools used to clean the drains and will be able to maintain the drains in the future.

Direct Impact of this Project: Cleaning the drain in this particular area increased the area of agricultural land cultivated by decreasing the area affected by waterlogging and salinity problems. In addition, the entire 400 ha cultivated area benefited from the decrease of the water table levels and of the levels of salinity in the soil. Therefore, farmers are now able to irrigate the entire area during both summer and winter seasons, to increase their productivity and income further. Finally, this project also created temporary employment for cash wages, and encouraged the return of farmers who had left their land due to low agricultural productivity.

ARDI Crop-Soil-Water Relationships Projects



Key to Irrigation Projects

No.	Project	Governorate	Dunum
1	Construction of Al-Khdrawy Canal regulator in Al-Warka'a Sub-District-Al-Muthanna	Muthanna	1,500
2	Construction of Abo-Hohuf regulator in Ar-Rymaitha District -Al-Muthanna Governorate	Muthanna	5,000
3	Irrigation canals cleaning project in Al-Hilal Sub-District	Muthanna	22,850
4	Reconstruction of Al-Jadwal Cross Regulator, Wassit Governorate	Wassit	40,000
5	Reconstruction of Om Al Ward Head Regulator	Babylon	60,000
6	Rehabilitation of the Om Hayaya Head Regulator	Najaf	35,000
7	Reconstruction of Hannoon Cross Regulator	Wassit	180,000
8	Reconstruction of Shleet regulator	Karbala	9,400
9	Improving the Drainage Conditions of a Waterlogged Affected Area	Muthanna	2,080
10	Reconstruction of the Monaither Pumping Station between Hilla-Kifil Canal and the Euphrates River	Babylon	13,804
11	Reconstruction of Al Mokhtrab Cross Regulator	Najaf	50,000
12	Construction of head regulator and retaining walls for Eathan Graad Canal	Babylon	5,430
13	Rehabilitation of retaining wall and pipe flume in Al-Ajdy's River	Babylon	4,600
14	Irrigation Canals Cleaning in Al-Mhannawiyah	Qadessiyah	6,000
15	Cleaning and Rehabilitation of drainage canal in Al-Hindia	Karbala	1,660
16	Cleaning of Irrigation and Drainage Canals in Al-Buhwaichma and surrounded villages	Muthanna	21,320
17	Irrigation Canals Cleaning in Al-Warka'a District	Muthanna	16,010
18	Main Baquba Drain Cleaning Project	Diyala	39,844
19	Installation of Center Pivot Irrigation Systems in Tameem Governorate, Phase II	Tameem	1,800
20	Irrigation Canal Cleaning in 85 villages in Dinarta Sub-District	Ninewah	16,364
21	Cleaning Shekhan Irrigation Canal	Ninewah	9,100
22	Cleaning Jaleela Irrigation Canal	Diyala	5,530
23	Cleaning Al-Duzeil Irrigation Canals	Salahaddin	7,350
24	Gordara Irrigation Canal Cleaning in Taza District	Tameem	10,000
25	Installation of Center Pivot Irrigation Systems in Tameem Governorate	Tameem	1,800
26	Water Storage Facilities at 5 Villages (Bardgirka, Gochar, Dargala, Kawlokan and Jundean) in Rawandoz	Erbil	450
27	Cleaning Khormal Irrigation Canal	Sulaymaniyah	24,700
28	Cleaning Irrigation Canals in 4 Villages in Salah el-Din Sub-District (Kore, Almawani Sanu, Almawani Kwary and Zayaat)	Erbil	4,000
29	Water Storage Facilities in Gadirah Village	Dohuk	150
30	Cleaning of Irrigation Canals in 6 Villages of Rawandoz Subdistrict	Erbil	6,700
31	Cleaning Irrigation Canals in (Mesar, Shwan, Mawatawa, Kazhak, Galetan, Kawna Sidakan)	Erbil	2,960
32	Rehabilitation of the Baskadere Irrigation Project	Dohuk	160
33	Cleaning Irrigation Canals in Bawre	Sulaymaniyah	800
34	Village Water Storage Facilities in Shekhan District	Ninewah	189
35	Village Water Storage Facilities in Akre District	Ninewah	156
36	Rehabilitation of Zamqoy Sane Karezie, Halabja District	Sulaymaniyah	148
37	Constructing Al Bishrah pipe culvert on Al Salamiyah main drain	Karbala	3,000
38	Cleaning Irrigation Canals in Dasnee, Bekajooshie, Zheen and Zhozhel villages	Erbil	2,500
39	Cleaning Irrigation Canals in Faida	Ninewah	2,575
40	Cleaning Bekara Irrigation Canal	Diyala	11,000
41	Rehabilitation of the Moka (Sharwan Main) Irrigation Project	Erbil	110
42	Village Water Storage Facilities in Dahuk	Dohuk	221
43	Cleaning Bekda Irrigation Canal	Diyala	5,000
44	Irrigation canals cleaning in Sayed Dakheel-Nasiriya	Thiqar	6,750
45	Shomaly Pumping Station Emergency Regulator	Babylon	240,000
46	Civil and Engineering Works for Canal at Al-Bidairy Irrigation System	Muthanna	6,000
47	Irrigation Canals Cleaning in Abu alkhaseeb	Basrah	7,800
48	Irrigation Canal Cleaning, Small Irrigation Canals Project	Muthanna	7,800
49	Irrigation Canal Cleaning, Al Dokhan Village Project	Muthanna	4,875
50	Irrigation Canal Cleaning, Eastern Drainage Canals Project	Muthanna	6,825
51	Rehabilitation of Al Tayash Culvert	Babylon	2,500
52	Rehabilitation of Al Hammiyah Culvert	Babylon	2,500
53	Abu Jaqi Head Regulator Reconstruction	Najaf	1,000
54	Al Al Maid and Al Awad Irrigation Head Regulators Reconstruction.	Najaf	1,100
55	Al Gowah and Al Ghalal Irrigation Head Regulators Reconstruction	Najaf	1,300
56	Al Ghazali and Al Al Habib Irrigation Head Regulators Reconstruction	Najaf	1,100
57	Irrigation Regulators Reconstruction for Jannatiyat Al Mokhtrab Canal	Najaf	2,000
58	Install Pumping Station for Al Bidairy Irrigation System	Muthanna	6,000
59	Reconstruction of the Al Thal Regulator for the Al Thal Drain	Muthanna	3,000
60	Rehabilitation of the Um Al-Agal Pump Station	Muthanna	30,000
61	Reconstruction of Al-Bawmiliyah Cross Regulator	Wassit	20,000
62	Raising the Canal Banks for Transporting Drainage Water	Karbala	70,000
63	Reconstruct Al Khashamiyah Head Regulator	Qadessiyah	2,000
64	Re Construction of Al Eyewy Canal Pipe Flume	Karbala	3,000
65	Re Construction of Al Bakta Canal Pipe Flume	Karbala	300
66	Rehabilitation of the Om Hayaya Regulator	Najaf	26,000
67	Al-Kufa Drain Rehabilitation Project	Najaf	30,000
68	Construction of Irrigation Regulator at Al Mhaddad Pumping Station	Muthanna	60,000
69	Rehabilitation of Tertiary Canal System at Al Hilla-Kifil Reclamation Project, Phase II	Babylon	4,000
70	Rehabilitation of Tertiary Canal System at Al Hilla-Kifil Reclamation Project, Phase I	Babylon	5,000
71	Reconstruction of Al-Khamsiyah Canal Bridge	Babylon	75,000
72	Rehabilitation of Tertiary Canal System in Al Nasiryah Reclamation Project	Babylon	10,000

INSTITUTIONAL CAPACITY BUILDING IN THE WATER SECTOR

ARDI provided international observation tours in specialized irrigation disciplines (ie. London flood control district)

Training was an important component of ARDI's work in the rehabilitation of Iraq's water sector. In every activity carried out, ARDI sought to develop the capability of Iraqi people to continue reconstruction and development. This training included:

- 19 MOA engineers were trained in designing and implementing pilot areas for drainage systems to reduce soil salinity;
- 58 engineers were trained in Family Drip Irrigation System operation and maintenance to assist farmers in utilizing these systems to increase production of high-cash-value crops;
- Over 5,000 farmers were trained through employment in cleaning canals to improve irrigation and received tools for ongoing maintenance;

Irrigation engineers received training in Excel and in CROPWAT, a specialized planning tool for irrigation.

- 117 MOA staff received training in operation and maintenance of highly efficient irrigation equipment, especially those systems held by the government through the Oil-for-Food program and currently being sold to farmers;
- 2 MOA senior staff members attended the *8th International Seminar on Participatory Irrigation Management* in Tarbes, France. The seminar addressed developing cooperation between government and the private sector to improve water management;
- 14 MOA technicians were trained in the design of hydraulic structures to improve gravity surface irrigation systems;
- ARDI sponsored training for 19 MOWR and MOA staff in Holland, in order to prepare them for implementing the Pilot Drainage Catchment Areas project.
- 56 people from twelve governorates and the national Agriculture, Extension and Irrigation offices of the MOA were trained in irrigation scheduling. They learned to assess soil by feel, calculate irrigation needs, find and use weather data in planning, and use Excel and CROPWAT computer software in planning. Most importantly, they received training in teaching farmers some of these skills and water management techniques; and
- 10 professionals were trained in Amman, Jordan in water management techniques. They observed sophisticated water management systems employed in Jordan's Central Valley.

2.5 RECONSTRUCTING THE ANIMAL HEALTH INFRASTRUCTURE AND LIVESTOCK PRODUCTION

Private veterinary center at a northern animal auction.

RECONSTRUCTING THE ANIMAL HEALTH INFRASTRUCTURE AND LIVESTOCK PRODUCTION

Sheep awaiting Brucellosis vaccination in southern Iraq.

Livestock production is an important economic activity in Iraq, contributing about 50% of agricultural GDP annually. Livestock production takes place throughout the country, and popular animals for breeding include sheep, goats, buffalo, cattle, and chickens. Some of this production is large-scale, representing the main source of an income for a breeder. There is also a great deal of small-scale, "backyard" livestock production in Iraq, wherein families keep small numbers of livestock and poultry for household consumption and supplemental income from their sale.

ARDI focused its efforts on improving the infrastructure that supports livestock production, including improving animal health services and increased production of forage crops and improving rangelands. ARDI also implemented projects to improve production of sheep and buffalo, animals that represent a large proportion of livestock breeding activity in Iraq.

TABLE 60 SUMMARY OF ANIMAL HEALTH PROJECTS

Program Target	Number of Projects	Projects Primary Beneficiaries
Improving Infrastructure for Animal Health	3	1 project to rehabilitate veterinary clinics (68 clinics) 1 project to establish private sector veterinary clinics (40 clinics) 1 project to raise awareness of zoonotic diseases
Improving Sheep Production	6	1 project to improve nutrition in pregnant ewes 1 project to improve nutrition in lambed ewes 1 project to improve nutrition in suckling lambs 1 project to improve nutrition in pre-mating lambs 1 project to provide brucellosis vaccination 1 project to provide access to sheep dip tanks
Improving Forage Crop Production and Rangelands	3	1 project to improve barley/vetch production 1 project to improve forage crop production 1 project to assess rangelands and recommend improvements
Improving Buffalo production	2	1 project to improve reproduction in the hot season through hormone treatment 1 project to improve reproduction through improved nutrition

IMPROVING INFRASTRUCTURE FOR ANIMAL HEALTH

Vet Clinic - Before and After

VETERINARY CLINIC REHABILITATION

Veterinary services are essential to maintaining the health of livestock and reducing production losses caused by diseases or general poor health. The Ministry of Agriculture maintains a network in excess of 200 veterinary clinics throughout Iraq that provide essential services to livestock breeders to maintain the health of their animals. For many breeders who cannot afford the costs of private clinics, these clinics are the only source of basic services to maintain animal health and prevent or reduce production losses. The clinics also implement vaccination campaigns against major diseases (foot and mouth disease, enterotoxemia, brucellosis, and newcastle), and coordinate preventive vaccination campaigns and treatment during disease outbreaks.

During the previous regime, many of these veterinary clinics were not maintained. Although there is a large cadre of well-educated veterinarians in Iraq, the staff of these clinics were often poorly paid and undertrained. As a result,

many clinics are inoperable or ineffectual in providing services to livestock breeders. Many veterinarians employed at the clinics are not able to go to work, due to the poor condition of the clinic facilities.

ACTIVITIES

In 2003, as part of its reconstruction strategy, the Ministry of Agriculture in Baghdad developed a comprehensive strategy for rehabilitation to return the clinics to a functional condition. ARDI agreed to fund a number of these, while construction of new clinics and other rehabilitation was to be funded through the MOA budget, as well as through the Food and Agriculture Organization, the United States military, some NGOs, and other donors. The MOA preferred that ARDI renovate clinics in disputed areas on the border with the northern Kurdish region, including the governorates of Ninewa, Diyala, and Tameem.

The clinics in the governorates of Erbil and Dahuk were under the jurisdiction of the MOAI/Erbil, and the MOAI/Sulaymaniyah controlled those in that governorate. The clinics are now under the jurisdiction of the Ministry of Agriculture of the Kurdish Regional Government. The MOAs in the northern region did not create a specific rehabilitation plan nor commit funding to clinic repairs as did the MOA/Baghdad. ARDI worked with the General Director of Veterinary Services from each MOA to assess the requirements. From 2003 – 2006, ARDI was the only funding source to rehabilitate veterinary clinics in the northern region, and the major program to improve veterinary services to farmers in the KRG.

In all locations ARDI worked through local subcontractors, who were awarded the jobs based on competitive bidding. The rehabilitation grants provided each clinic with the necessary repairs to walls, roof, floors, doors, and windows, and repaired or replaced the electrical and plumbing systems and necessary hardware.

ARDI rehabilitated a total of 68 clinics in 17 governorates, serving 135,068

TABLE 61 VETERINARY CLINIC REHABILITATION PROJECTS BY GOVERNORATE

Governorate	Number of Clinics	Livestock Breeders Served	Animals Served	Veterinarians Employed	Temporary Workers Employed
Anbar	6	3,200	372,000	46	285
Babylon	2	4,100	160,000	29	90
Baghdad	6	42,050	677,500	69	275
Basrah	2	1,250	121,000	14	95
Dohuk	5	5,300	205,000	46	375
Diyala	2	2,250	138,000	27	115
Erbil	11	18,648	667,060	312	935
Kerbala	1	500	80,000	10	35
Muthanna	1	780	110,200	8	75
Najaf	2	11,970	347,000	27	105
Ninewa	5	8,800	372,000	45	305
Qadissiya	3	4,100	194,900	51	210
Salah al-Din	3	2,840	137,000	30	170
Sulaymaniyah	4	5,860	594,000	54	300
Tameem	10	14,670	568,000	97	490
Thi-Qar	2	5,550	740,000	54	110
Wassit	3	3,200	220,000	48	125
Total	**68**	**135,068**	**5,703,660**	**967**	**4,095**

A veterinarian in his PSP clinic in Dahuk

livestock breeders owning 5,703,600 animals. Thanks to these efforts, a total of 967 veterinarians were able to return to work in fully functioning clinics. Besides reducing production losses and increasing the income of the owners, the improved veterinary services will help prevent zoonotic diseases that may spread to humans, thus benefiting every member of the community in the target area. The veterinary clinic rehabilitation projects also provided temporary employment for a total of 4,905 workers who carried out the repairs (see Table 61 on prior page).

VETERINARY PSPS

While MOA clinics provide important animal health services to many Iraqi livestock holders, there are also large numbers of private clinics in Iraq that provide veterinary services on a fee-for-service basis. These clinics often operate in areas where the MOA clinics do not, and sometimes provide more expanded services for livestock breeders.

ACTIVITIES

In addition to rehabilitating MOA clinics, ARDI has worked with veterinarians to help them set up their own private sector clinics. There are many well-educated but unemployed veterinarians in Iraq who have the skills to do this. To help set up Private Service Provider (PSP) clinics, ARDI worked with the Veterinary Syndicates of Tameem, Dahuk, Ninewa, and Salah al-Din to select appropriate veterinarians, and trained them in business management skills (see Section 3.6 for more information on ARDI Business Management training workshops). ARDI also granted the veterinarians equipment to make the clinics operational.

RESULTS

In each governorate, 10 PSP clinics were opened, each employing two to three veterinarians. A total of 40 clinics owned by veterinarians have been set up, employing a total of 130 veterinarians. These clinics are expected to serve over 900 livestock holder clients.

VET-IN-A-BOX GRANTS

ARDI discovered during the process of rehabilitating veterinary clinics that often they would be slow to become operational due to a lack of instruments and supplies. To address this problem, ARDI designed a complementary program to provide clinics with equipment to enable them to become operational soon after repairs were completed. The Vet-in-a-Box is a clinic startup kit containing 48 basic instruments and supplies often hard to find in Iraq. Forty of the rehabilitated veterinary clinics received the Vet-in-a-Box package.

ANIMAL HEALTH AND ZOONOTIC DISEASE AWARENESS PROGRAMS

Small-scale ("backyard") breeding is a popular economic activity in Iraq. Families raise animals at their homes, which provides an essential source of food and income. However, traditional methods of breeding animals in or near the home often result in the spread of zoonotic diseases, which are diseases such as brucellosis, mange, echinococcus, tuberculosis, and avian influenza that can be transmitted from animals to humans. These diseases are spread to humans through contact with infected animals and consumption of products such as meat and milk from infected animals. The spread of zoonotic diseases is a threat to human health, and also increases livestock mortality, lowers production, and reduces breeders' income and source of food.

TABLE 62 PSP PROVIDERS BY GOVERNORATE

Governorate	Number PSP Clinics Established	Number Veterinarians Employed	Number Breeders Served
Dohuk	10	20	140
Ninewa	10	30	210
Salah al-Din	10	20	140
Tameem	10	20	140
Total	**40**	**90**	**630**

In order to raise awareness of zoonotic diseases among populations that rely on backyard livestock breeding, and teach prevention and treatment techniques, ARDI implemented a program of zoonotic disease awareness workshops in villages of four governorates. ARDI hired teams of agronomists and animal production specialists to work in pairs through local NGOs to deliver the workshops. ARDI trained the teams in participatory extension methods, including the use of extension materials such as posters and brochures, to maximize the impact of the training workshops.

Women in Ninewa are trained in identifying ectoparasites (ticks) on a goat

Women attend a zoonotic disease awareness workshop in Dahuk

The training workshops were delivered in a total of 1,845 villages in four governorates (see Table 63). They targeted mostly women, who are particularly susceptible to contracting and spreading zoonotic diseases because they feed the animals, handle newborn animals, and process milk. Workshop topics included proper feeding and milking methods, sanitary food processing, common health risks when working with animals, and handling of newborns. The women learned the symptoms and treatment of common zoonotic diseases, as well as how to prevent these diseases in animals and humans.

The participatory nature of the training rendered it very effective. As one of the trainers reported, "The workshop attendees were very responsive to the training materials and contributed greatly to the discussions and the question and answer period." Following the training, 2-3 women were selected from each village to be "pioneers" for extension to the rest of the women in their village. Further extension was achieved by distributing posters and leaflets containing information on animal breeding and zoonotic diseases. Each village posted the information in public places such as schools and mosques.

Interviews conducted after the program yielded praise for many aspects of the training, as well as requests for further information and continued outreach. As one respondent noted, "The training sessions have been very effective since they were supported with simple, clear, and easy to understand illustrational materials such as posters and folders . . . every person in the villages could easily comprehend the idea of the distributed folders and posters."

After the appearance of avian influenza in Iraq, the workshops began offering information on how to recognize signs of infection in poultry, how to report suspected cases, and safe handling of poultry to prevent infection. The workshop participants were grateful for the information. Said one participant, "Before we were scared to even look at a chicken. Now we know how to handle them safely."

Classes were often held in impromptu venues.

Materials uses in zoonotic disease awareness training workshops

TABLE 63 ZOONOTIC DISEASE AWARENESS WORKSHOPS

Governorate	# villages visited	# Trainees		
		Women	Men	Total
Ninewa	405	6,260	1,667	7,927
Dohuk	240	2,695	1,733	4,428
Sulaymaniyah	720	7,948	7,535	15,483
Tameem	240	1,817	1,443	3,260
Diyala	240	2,520	1,667	4,187
Total	**1,845**	**21,240**	**14,045**	**35,285**

IMPROVING SHEEP PRODUCTION

Sheep marked for sale at a sheep market in Iraq

Sheep production is a very popular activity in Iraq. The type of sheep most commonly raised in Iraq is prized for its meat. Although exports are currently banned by the government, sheep breeders enjoy a good market for meat domestically, and also in the region via smuggling channels through Iran. Sheep holders gain income from the sale of both meat and wool.

It is estimated that there are currently 200,000 – 250,000 head of sheep in Iraq. The size of flocks varies from small (30-150 head) to large (more than 1,000 head). Production is lower than international standards, due to low reproductive efficiency caused by poor nutrition, and to disease, the most serious being brucellosis. Those who raise sheep for wool also suffer reduced income due to a lack of facilities to clean wool, so that it sells at lower market.

ARDI has implemented several programs to improve production of Iraq's sheep population through:

- Increasing the reproductive efficiency through improved nutrition, including improved forage crop production and rangelands management;
- Implementing a brucellosis vaccination campaign; and
- Increasing access to sheep dip tanks to improve wool production.

Breeders collect barley feed for their sheep

INCREASING REPRODUCTIVE EFFICIENCY OF SHEEP THROUGH IMPROVED NUTRITION

Proper nutrition for ewes and lambs is important to the reproductive efficiency of a flock. Proper nutrition stimulates ovulation in premating ewes and increases the chances of conception. During pregnancy, nutrition is essential to the health of the lamb. Poor nutrition in pregnant ewes results in low lambing rates and higher lamb mortality rates. After lambing and during the nursing period, ewes require proper nutrition to maintain their own body condition, so that they will be ready to mate again the next season. It is also essential that lambs receive proper nutrition during this nursing period, either from well-fed mothers or in supplemental feed, to survive until weaning at higher rates.

In Iraq, many sheep holders depend heavily on stubble grazing and poor pastures as the sole source of feed for their sheep. Many farmers cannot afford, or do not have access to, better nutrition such as green roughage and concentrates, which are especially important during the limited rainfall seasons or dry years. As a result of recent droughts that have reduced food availability, many holders feed their ewes only on grazing stubble, without any supplemental feed such as barley, which provides excellent nutrition for sheep. The result has been an overall reduction in reproductive efficiency in Iraq's national sheep flock.

In order to reverse this trend, ARDI implemented a comprehensive program to improve nutrition in premating, pregnant, and lambed ewes, as well as suckling lambs. The program included the distribution of barley feed to sheep holders in south-central and southern Iraq to demonstrate the economic benefits of feeding sheep an improved diet. In addition to improving sheep reproduction in the target flocks, these projects encouraged area breeders to adopt regimes of improved nutrition for their own sheep, and stimulated local agribusiness to begin selling the concentrate diet.

In addition, ARDI implemented a program to increase production of nutritious forage for livestock. It demonstrated integrated barley-vetch production as part of the 2004 – 2005 Winter Crop Technology Demonstration project, and in 2006 demonstrated crop rotation for clover, Sudan grass, and Egyptian sorghum. We also conducted an assessment of rangelands in Iraq and sponsored a national workshop with government and other stakeholders to determine next steps for preserving and improving grazing lands in Iraq.

IMPROVING NUTRITION OF PREGNANT EWES

The ARDI sheep nutrition project began in August 2005 with an effort to improve nutrition for pregnant ewes in Wassit. Good nutrition is particularly important for pregnant ewes because healthy, well-fed ewes are more likely to give birth to heavy, healthy, and viable lambs more likely to survive to weaning.

ACTIVITIES

To demonstrate the importance of good nutrition for pregnant ewes, ARDI provided barley fodder to 28 sheep holders in Wassit governorate, who owned a total of 2,000 pregnant ewes. These breeders faced an especially dry year and the resulting lack of pasture put ewes at risk of an even higher rate of unsuccessful pregnancies than usual. With improved nutrition, the breeders saw an increase in lambing rates, as well as an increase in milk production from

Breeders at a field day to observe the results of the ARDI project Improving Nutrition in Pregnant Ewes.

lambed ewes, which contributed to improved health of the lambs and increased the percentage of lambs that survived to weaning.

ARDI provided barley feed to participating holders for their pregnant ewes, at a rate of 0.25 kg per head for the last three months of gestation. ARDI staff monitored the pregnant ewes throughout the project, and took measurements including the rate of successful pregnancies (lambing rate), the weight of the lambs at birth, and the milk production during the first week post-lambing. ARDI staff also visited area sheep holders to measure their flocks for comparison purposes (see Table 64).

RESULTS

The project was successful in increasing the lambing rate to 84%, higher than the average lambing rate of 65% recorded from area flocks that were fed average nutrition. The average weight of the lambs born to ewes that received the improved nutrition was 59% higher than area lambs (4.6 kg as compared to 2.9 kg). These heavier lambs were more likely to survive to weaning. In addition, milk production from the project ewes in the week after lambing was 67% higher than area ewes (0.25 kg as compared to 0.15 kg). Higher milk production means

TABLE 64 INCREASED PRODUCTION FROM IMPROVED NUTRITION IN PREGNANT EWES

Number Owners	Number Ewes	Lambing Rate (%)		Lamb Birth Weight (kg)		Ewe Milk Production (kg)	
		Program	Area	Program	Area	Program	Area
28	2,000	84	65	4.6	2.9	0.25	0.15
% Improvement		31%		59%		67%	

better nutrition for the lambs, contributing to higher weight gain and higher rates of survival to weaning.

The sheep holders who fed their pregnant ewes improved nutrition saw real economic benefits from the project. The increased birth rate of the lambs means that more lambs survive to weaning, resulting in a greater number of male lambs that the holder can sell for meat, and a greater number of female lambs who will survive to adulthood and reproduce, replenishing the flock more quickly.

After the lambing season was complete, ARDI staff held a field day with breeders, both those involved in the project and those from the area, to explain the results of the project and encourage other breeders to adopt the practice of feeding pregnant ewes improved nutrition to increase lambing rates. A total of 130 breeders attended. Those who had received improved feed for their ewes were extremely grateful for the project, and explained to the other breeders the economic benefits that they had gained from increased lambing rates, and from having heavier and healthier lambs. The other breeders were impressed with the results, and indicated interest in improving nutrition for their own flocks.

A lambed ewe nursing her lamb

IMPROVING NUTRITION IN LAMBED EWES

In December 2005, after the lambing season was complete, ARDI initiated a program to improve nutrition in lambed ewes (ewes that have given birth and are nursing). ARDI worked with 274 sheep breeders who owned 6,000 lambed ewes in Wassit, Qadissiya, and Muthanna governorates in the arid south-central region of Iraq, where many sheep holders feed their flocks on inadequate grazing stubble. High lamb mortality is one consequence of this poor nutrition. This year, 9% of lambs nursing on mothers fed with the average diet did not live to weaning. Those lambs that did survive to weaning had relatively low weight, which means a lower price for the owner at market.

The project illustrated the advantages of feeding lambed ewes with improved nutrition during the period of nursing (three consecutive months after birth). Improving the nutritional level of lambed ewes through better feeding regimes is a logical initial step to improving the overall health of sheep in Iraq, and increasing flock sizes and breeders' income. Improving nutritional levels of

lambed ewes helps the ewes maintain their body weight and increase milk production. Consequently, lambs are healthier and survive to weaning at higher rates and with a higher body weight. This results in higher income for the breeder from the sale of male lambs for meat, and higher replacement rates of the flock from healthy, weaned female lambs.

ACTIVITIES

ARDI staff distributed barley concentrate diet to the breeders to feed their lambed ewes at a rate of 0.50 kg per head per day during the three-month nursing period after birth. ARDI staff visited the flocks to measure milk production, lamb mortality rates, and the weight of lambs at time of sale to market (three months after birth). For purposes of comparison, ARDI also took these measurements from lambed ewes and their lambs in the same areas, which were fed a diet normal for the area (see Table 65).

TABLE 65 INCREASED PRODUCTION FROM IMPROVED NUTRITION IN LAMBED EWES

Governorate	Number Owners	Number Ewes	Lamb Market Weight (kg)		Mortality rate (%)		Increase in milk production (%, v. area)
			Program	Area	Program	Area	
Wassit	93	2,000	21	18	2.5	9	66
Qadissiya	81	2,160	20	16.5	4	7	46
Muthanna	100	1,900	20.5	19	5	9	29
Average			**20.5**	**17.8**	**3.8**	**8.3**	
Average Improvement			**18.80%**		**53%**		**47%**

RESULTS

The project succeeded in increasing lamb market weight by 18.8% compared to area lambs that were fed by ewes that did not receive improved nutrition. Since lambs are sold by weight, this increase in market weight represents a significant increase in income for breeders. The project was also successful in reducing the mortality rate of lambs by 53%, thus increasing the number of lambs who survived to weaning to be sold for meat (male lambs), or to replenish the flock and increase flock sizes (females). This also represents a real increase in income for breeders.

Sheep holders saw an immediate economic benefit this season from the sale of their male lambs for meat. For those male lambs which nursed on ewes that received improved nutrition, the average weight at time of sale was 20.5 kg, while the average weight of other weaned male lambs in the area was 17.8 kg. At an average price of $3.6/kg, breeders who fed their lambed ewes improved nutrition will receive a price of approximately $75 per lamb, while other breeders will get only $64.

Breeders who fed improved nutrition also had more lambs to sell, due to reduced mortality rates. Out of 100 lambs, these breeders saw 96 survive to weaning (3.8% average mortality), and approximately half were male, suitable for

sale after weaning. This represents an income from the sale of meat of $3,600 per 100 lambs born (98 survive to weaning, 48 are male). However, those breeders who did not feed an improved diet this year saw only 91 survive past weaning (8.3% mortality rate), for a total income from sale of meat of $2,880 per 100 lambs born (91 survive to weaning, 45 are male).

In addition, breeders who fed improved nutrition to lambed ewes saw an increase in the number of female lambs that survive to weaning. This will result in a faster increase in their flock sizes, which means greater milk and wool production, as well as higher rates of reproduction when these female lambs reach puberty.

In June 2006, ARDI held a field day for area and participating sheep holders to demonstrate the results of the program, and to encourage breeders to adopt the practice of feeding improved nutrition to lambed ewes, to increase lamb market weights and reduce mortality rates. A total of 150 breeders attended the field day.

A lamb that received supplemental feed is weighed at weaning.

IMPROVING NUTRITION IN SUCKLING LAMBS

While improving nutrition in lambed ewes can be an extremely effective way to increase the weight and weaning rates of lambs, it is also important to supplement the diet of the lambs themselves to improve their health. This is especially important in areas where lambs have limited opportunity to suckle. In many parts of Iraq, during the dry season, sheep holders will graze their ewes in pastures far from the farm and away from their lambs, which remain on the farm. These lambs are able to suckle only twice per day, and as a result they have lower body weights and higher mortality rates. Improving nutrition in these lambs through supplemental feeding increases weaning rates and helps lambs gain weight more quickly, which brings a higher price for them at market.

ACTIVITIES

To demonstrate improvements in lamb health and weight when fed an adequate supplemental diet, ARDI worked with 116 sheep holders in Wassit governorate and 125 holders in Najaf governorate. These holders owned a total of 2,000 lambs whose mothers graze far from the farm, which would normally result in inadequate suckling. ARDI provided a supplemental diet of barley feed, which the holders fed to the lambs at a rate of 0.50 kg/head for three months after birth, until weaning. ARDI staff monitored the flocks and took measurements, including a monthly weighing of the lambs and an estimation of mortality rates. ARDI staff also visited area flocks in order to collect the same data about lambs which did not receive a supplemental diet, for comparison purposes.

RESULTS

The project was successful in decreasing mortality by 65%, from an average of 6.5% in area lambs that did not receive supplemental diet, to an average of only 2.25% for project lambs. The weight of the lambs that did survive to weaning was 27% higher in lambs that received supplemental feed, as compared to those which did not (see Table 66). Male lambs are sold to market at weaning, and the higher weight represents an increase in income for breeders. Female lambs that are heavier at weaning are likely to be healthier and survive to reproductive age at higher rates, and will enable the holder to replenish the flock more quickly.

In April 2006, ARDI held a field day to demonstrate the positive results of this project to area breeders, both those who participated in the project and those who did not. Approximately 40 breeders attended the field day. All were impressed with the increase in lamb weight at weaning and reduced mortality, and they expressed interest in adopting improved feeding regimes to improve their own flocks.

TABLE 66 INCREASED PRODUCTION FROM IMPROVED NUTRITION FOR SUCKLING LAMBS

Governorate	Number Owners	Number Ewes	Lamb Market Weight (kg)		Mortality rate (%)	
			Program	Area	Program	Area
Wassit	116	2,000	29	24	**2.5**	**6.5**
Najaf	125	2,000	25.5	19	2	6.5
Total	**241**	**4,000**				
Average Improvement			**27%**		**65%**	

IMPROVING NUTRITION IN PREMATING EWES

For the most efficient reproduction in a flock, it is important to ensure that ewes receive proper nutrition even before mating begins. Ewes must enter estrus (ovulate) in order to mate, but many ewes in Iraq that feed on grazing stubble without any supplementary diet suffer from poor body condition and therefore do not ovulate in some seasons, which leads to lower mating and pregnancy rates, and impedes replenishment of a flock. A ewe that does not lamb costs the holder in terms of lost income from meat and wool.

Prior to the 2006 lambing season, ARDI introduced a program to improve nutrition in premating lambs in Kerbala, Wassit, and Muthanna governorates. The improved diet helps to increase the rates of ovulation and mating, and also

improves the body condition of the ewes to ensure successful pregnancies and greater birth weights of the lambs.

ARDI distributed concentrate diet to 274 breeders in Wassit, Babylon, and Kerbala governorates who own 6,060 ewes that were premating in May 2006. Each ewe was fed 0.50kg per day of barley grains, for three months premating.

The results of this project, including ovulation and lambing rates, will not be known until after the publication of this report.

TABLE 67 IMPROVING NUTRITION IN PREMATING EWES, 2006

Governorate	Number Owners	Number Ewes
Wassit	93	2,000
Babylon	81	2,160
Kerbala	100	1,900
Total	**274**	**6,060**

BRUCELLOSIS VACCINATION CAMPAIGN

Brucellosis is a significant disease in sheep in Iraq, and is prevalent in many regions of the central and southern parts of the country. Brucellosis causes heavy economic losses for sheep holders from decreased production due to abortions, sterility, decreased milk production, and the cost of replacing diseased animals in the flock. Brucellosis is a zoonotic disease, meaning that it can be spread from animals to humans, and therefore poses a threat to human health as well.

The incidence of brucellosis can be greatly reduced through vaccination. In order for brucellosis vaccination to be effective, it must cover all animals in a given area. In order to reduce the incidence of brucellosis in southern Iraq, ARDI implemented a vaccination campaign in 2005 covering the southern governorates of Muthanna, Qadissiya, Thi-Qar, Missan, and Basrah.

ACTIVITIES

In the summer of 2005, ARDI began planning for the vaccination campaign for nearly 572,000 sheep. The best time to vaccinate sheep against brucellosis is before the onset of puberty, since the vaccine itself can cause abortions in pregnant ewes. ARDI procured the brucellosis vaccine from a manufacturer in Spain, and worked with the Directorate of Veterinary Services in each governorate to obtain lists of unemployed veterinarians to implement the campaign. A total of 291 veterinarians were employed to carry out the campaign, working in 97 mobile teams of three veterinarians each. Before the beginning of the campaign, ARDI provided the teams with a refresher training on methods of vaccination, vigilance of the cold chain, the method of filling out registration forms, and security awareness. During the campaign, the mobile teams were responsible for the vaccinating the animals, keeping field-based record, maintaining equipment, and securing cold chain during travel.

The vaccination procedures were implemented according to the standards of the The State Company for Veterinary Services of the Ministry of Agriculture.

A veterinarian vaccinates a sheep in Basrah

The team leaders were responsible for announcing vaccination locations daily to local sheep holders. Registration forms were filled and filed for each sheep holder, regarding the number of animals owned and which animals were vaccinated. This paperwork will be used as both a record and a reference for other vaccination campaigns. It also enables the MOA to collect the latest statistical information on sheep holdings in Iraq. Vaccinated animals were marked with a tattoo on the ear to indicate successful vaccination.

RESULTS

The vaccination campaign was carried out between December 3, 2005 and February 17, 2006. The great majority of animals were vaccinated by the end of January, with the final few animals in outlying regions vaccinated last. In several areas, work was interrupted by extended religious holidays as well as periods of violence in some areas, which prevented teams from traveling safely. Table 68 shows the period of vaccination for each governorate, and the total number of animals vaccinated.

TABLE 68 BRUCELLOSIS VACCINATION CAMPAIGN IN SOUTHERN GOVERNORATES, 2005

Governorate	Dates of Vaccination	Number of sheep vaccinated
Muthanna	Dec 24 to Feb. 17	253,388
Qadissiya	Dec. 18 to Mar. 3	110,709
Thi Qar	Dec. 3 to Mar. 3	74,552
Missan	Dec. 4 to Feb. 28	98,477
Basrah	Dec. 3 to Jan. 27	34,824
Total		**571,950**

Sheep dip tank in the North. ARDI also developed a treatment for the used effluent to neutralize the chemicals used in the dipping solution, making them more environmentally friendly.

SHEEP DIP TANKS

Most sheep holders make the majority of their income from the sale of meat, but the sale of wool can add to the value of a flock. In parts of Dahuk and Sulaymaniyah governorates, sheep holders generate the majority of their income from the sale of shorn wool. Unfortunately, in these areas the holders have concerns about the deteriorating quality of the wool. Wool quality is dependent on a number of factors, including grade (diameter), uniformity, strength, crimp, handle, color, character, purity, and contaminants.

A process called "sheep dipping" can improve these characteristics by keeping the sheep clean of scabs, blowfly, ticks, ked, and lice. Cleaning the sheep may increase wool value by over 50%. Dirty wool sells for about $1.30/kg, and clean wool sells for about $2.00/kg.

ACTIVITIES

In order to improve the quality of wool in wool-producing areas, as well as to improve the overall health of the sheep, ARDI worked with MOA veterinary clinics in Dahuk and Sulaymaniyah to install sheep dipping tanks. The dip tank is a concrete basin that is filled with chemicals, into which sheep are dipped to kill pests and improve the condition of their wool. ARDI worked the MOA veterinary clinics in each target area to select sites, and then selected a local subcontractor through a competitive bidding process to construct the basins.

The veterinary clinic staff manage the tanks and oversee the sheep dipping process. They provide the chemicals for dipping at a nominal charge, and supervise the process each season.

ARDI funded the construction of 10 tanks, six in Dahuk and four in Sulaymaniyah. The tanks have the capacity to treat a total of over 102,000 sheep owned by 750 holders in the target areas each season. The construction of the tanks benefited 95 temporary employees, who earned wages for their labor, providing an immediate injection of cash into the local economy.

TABLE 69 SHEEP DIP TANK CONSTRUCTION

Governorate	Number of Tanks	Villages Served	Breeders Served	Sheep treated	Temporary Jobs Created
Dahuk	6	21	258	71,700	20
Sulaymaniyah	4	13	492	30,900	75
Total	**10**	**34**	**750**	**102,600**	**95**

IMPROVING FORAGE CROP PRODUCTION AND RANGELANDS

Sheep migrating to the mountains in the North.

Grazing pasture is an important source of food for many sheep and other livestock in Iraq. Breeders who own land can make good use of it by rotational planting of green forage crops that provide nutrition for their animals in most months of the year. These crops include barley, vetch, clover, Egyptian sorghum, and Sudan grass.

ACTIVITIES

In 2004, ARDI and the MOA implemented an integrated barley-vetch forage production project as part of the 2004 – 2005 Winter Crop Technology Demonstration program. Barley and vetch are both important food sources for sheep. Vetch seed is an especially good source of protein in the sheep diet.

Locations were chosen in areas of moderate rainfall in Ninewa. At two sites, vetch was planted alone for seed production (one 10 ha plot and one 1 ha plot).

Sheep graze on demonstration fields planted with barley and clover mixture in Wassit

In five other sites, a vetch-barley mixture (75% vetch, 25% barley) was planted.

The following improved technologies were used to cultivate the fields:

- Triple super phosphate fertilizer added at 50 kg/ha during seed bed preparation;
- Date of sowing was early January; and
- Seeding rates of 100 kg/ha for the two vetch seed production plots, and of 120 kg/ha for the mixture of barley (100 kg/ha for vetch and 20kg/ha for barley).

RESULTS

At harvest, the dry forage yield was estimated at 50% flowering by frame (1 m2) repeated ten times for each plot. The two vetch fields were harvested by combine or mower, and the crop was dried. The farmers used the vetch-barley mixture field for grazing or haymaking. Results of this project are noted in Tables 70 and 71.

TABLE 70 VETCH PRODUCTION, NINEWA, 2005

Location	Area (ha)	Dry forage yield (mt/ha)	Seed Production (mt/ha)	Utilization
1	10	4	1.2	Sheep fodder
2		33.6	--	Sheep grazing

TABLE 71 VETCH-BARLEY MIXTURES, NINEWA, 2005

Location	Area (ha)	Dry forage yield (mt/ha)		Utilization
		Vetch	Barley	
1	1	2.9	0.8	Sheep grazing
2	1	2.4	0.61	Sheep grazing
3	1	2.4	0.78	Sheep grazing
4	1	2.7	0.82	Hay making
5	1	2.8	0.86	Sheep grazing

It must be noted that there was a shortage of rainfall in April 2005, which is a critical month for the crop to have moisture for a good yield. This lack of rain resulted in a lower yield for both forage and seed production.

The farmers were enthusiastic about the production of barley and vetch for sheep grazing and fodder. There is a general lack of agricultural equipment for hay making, such a rakes, mowers, balers, and special harvesters needed to harvest low crops such as vetch. This issue must be addressed before more wide-scale production of barley-vetch mixtures can be achieved in Iraq.

In 2005, ARDI focused on the introduction of rotational cropping for clover, barley, Sudan grass, and Egyptian sorghum in arid regions of central and southern Iraq, where poor nutrition reduces production of flocks, particularly during the dry season.

The demonstrations were implemented in Wassit, Najaf, and Babylon to

introduce this type of rotational cropping to livestock holders and farmers. ARDI staff selected eight villages in which to establish demonstration fields (four in Wassit, two each in Najaf and Babylon). ARDI staff planted the fields, and also provided appropriate crop management techniques including irrigation, fertilization, and weeding.

In November 2005, four demonstration fields of 10 ha total were planted in Wassit. The fields were planted in two plots. Two ha were planted with a clover and barley mixture of varieties, that produced three harvests of green roughage that was used for fodder and grazing purposes. These harvests occurred in January, February, and April. A one-half ha plot was also planted with barley that produced a single crop, for comparison purposes. The clover-barley mixture produced a total of 500 kg of clover seed, in addition to the barley crop.

A field day was held to which area sheep holders and farmers were invited to observe the use cropping of barley and clover to produce several cuts of nutritional forage for livestock, which provides livestock with feed over a longer period than single-harvest crops.

ARDI expanded the program in July 2006 to include two demonstration fields each in Najaf and Babylon. These fields were planted with Egyptian sorghum, a very nutritious feed for livestock. The results of this project will not be known until after the publication of this report.

IMPROVING RANGELANDS MANAGEMENT

Many livestock holders in Iraq depend heavily on rangeland grazing to feed their animals. However, poor management has led to significant degradation of Iraq's rangelands, causing doubts as to the long-term sustainability of livestock grazing in these areas under current management practices.

In order to improve rangeland management in Iraq, ARDI conducted an assessment of the current condition of the rangelands, and brought together stakeholders including government officials, livestock holders, and NGOs for a national workshop to discuss a strategy for preserving and managing Iraq's rangelands.

A girl grazes sheep on rangelands in northern Iraq

The assessment of rangelands in Iraq found that these areas are becoming overgrazed. This is largely due to the conversion of much of the rangeland to cropland and residential property in recent years, which has reduced the amount of native rangeland available for livestock grazing, and is severely straining the capacity of the remaining rangelands to support the livestock being grazed. This deterioration of rangelands is most severe in areas immediately adjacent to villages. Soil compaction and erosion, deforestation, and deterioration of watersheds is evident in these areas, and perennial grasses and forbs are disappearing and being replaced by annual species with less nutritional forage value for animals.

Sheep grazing on rangeland in southern Iraq

The MOA is ostensibly responsible for the administration and management of rangelands in Iraq, and has made attempts to halt their deterioration and that of watersheds in some areas by installing livestock water facilities, rock check dams in eroded drainage channels, and contour furrowing with plantings of grass and trees. However, the ARDI assessment found that, even on projects that were less than two years old, there was evidence of heavy grazing use, giving the new seedlings little opportunity to get established and reproduce. These efforts have had only limited success as the underlying issue of unmanaged, intensive, year-round livestock grazing has not been addressed.

Although the MOA has responsibility for rangelands, in practice there is very little government involvement in administration and management them. No grazing use areas have been established, the government does not collect fees or issue permits, nor does it supervise use or establish carrying capacity for lands. There is not presently much capacity within the MOA for rangeland management. Very few managers have formal rangeland management training or education, nor do those skills exist at the local level. Presently there is not an effective extension or outreach service to bring rangeland management training or assistance to the local population or livestock breeders. In practice, management and use of rangelands tends to be controlled at the village level by the village council, which determines grazing use primarily based on local customs, and with no coordination on local, regional, or national levels.

In order to catalyze cooperation between stakeholders on a national level, ARDI sponsored a national rangelands management workshop in May 2006. This

workshop was attended by 64 participants from all over Iraq, representing the MOA, NGOs, community leaders, and livestock breeders. The participants expressed concern over the current state of rangelands in Iraq and a desire to work together to develop a strategy for better rangelands management. After much discussion, and with guidance from an ARDI management specialist, the following recommendations were developed by consensus:

1. Develop legislation, policy, and regulations specifically for rangelands in Iraq.

   While at least two laws currently exist to address usage of pasture and forest lands, it does not appear that they are applied. There was strong consensus from participants in the Rangelands Workshop that a separate law, along with a decisive policy statement and comprehensive grazing regulations, are needed for the MOA to administer rangelands effectively. The law needs to clearly define the role of government in protecting and administering the government lands and to set a direction for modern land use practices. Land tenure for existing users and direction for permitting use must be addressed in the new regulations.

2. Elevate grazing administration to the Director General level in the MOA.

   The status of rangeland management should be elevated to a Director General level within the MOA, as well in the governorate and district organizations, in order to provide better focus and budget advocacy for the rangeland program. Joint efforts for rangeland management, training/extension, and animal health could more easily be coordinated and implemented if rangeland management was on a par with other agriculture Directors General.

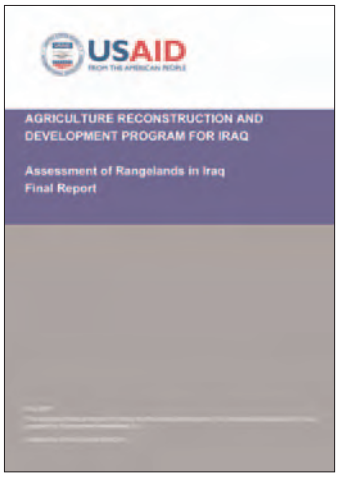
3. Expand training and outreach.

   There is a noticeable absence of professionally trained and educated Rangeland Managers in the MOA. A serious effort must be undertaken to recruit, develop, and retain staff with university training and field experience in range science, natural resource management, watershed management, land use planning, and animal science, to enable the MOA to function as a modern, effective rangeland management agency. Currently, these curricula are not available at any of the universities in Iraq.

4. Rebuild veterinary services.

   There is a pressing need to rebuild a robust, cost-effective veterinary services program in Iraq. Poor animal health prevents breeders from having productive livestock herds that provide adequate income. Little attention is presently given to preventive medicine, parasite control, and clinical care for diseased animals.

   In the past, most of Iraq enjoyed the benefits of an effective veterinary services program administered by the MOA. In recent years, due to war and other interventions, this service has been severely curtailed and the health and productivity of the livestock in the country has declined significantly as a result. This issue was clearly articulated by participants at



Rangelands in the foothills of the mountains in the North.

the Rangelands Workshop. A collaborative effort between the rangeland program, animal science, veterinary services, the private sector, and extension services to rebuild an effective animal health strategy would benefit all parties wishing to improve rangelands and animal production. An emerging private veterinary industry and its entailed associations could play a very important role in meeting some of Iraq's animal health needs. See Section 2.5 for more on ARDI efforts to rehabilitate Iraq's animal health infrastructure.

5. Convert excess wheat and barley acreage to green livestock feed, tame pastures, and native rangelands.

   The conversion of some surplus and abandoned cropland near villages into green feed (alfalfa, clover, grass), tame pastures (native grass, alfalfa, and other legumes), and native rangeland (native grass and vetch) would increased forage production. The best opportunities to implement this conversion exist in the northern governorates, where adequate rainfall and productive soils occur. See Section 2.5 for a discussion of ARDI projects to increase forage crop production for livestock feed.

6. Reconsider the existing prohibition against the export of sheep from Iraq.

   The present prohibition against the export of sheep from Iraq may be denying breeders the opportunity to increase their income substantially without increasing their herd size. The prices paid for Iraqi lambs in neighboring countries are reportedly three to four times higher than the prices being paid in Iraq. If breeders and farmers could benefit from higher prices for their products, they would be more receptive to changing their operations in ways that would improve the rangeland and watershed conditions.

7. Establish pilot/demonstration projects to teach, demonstrate, and integrate land use planning, grazing management, livestock production, and farming practices into a profitable agricultural enterprise.

   The MOA should select one or more village areas in both the north and south of Iraq to test and demonstrate the ecological, economic, and social benefits of integrating land use planning, farming, grazing management, and livestock management into land use decisions that are developed and implemented at the village level. The villages selected should already practice farming, grazing, and livestock production. Village leaders, farmers, and breeders should be engaged, possibly through a steering committee/advisory group, in a structured land use planning effort that would include an assessment of existing practices, an inventory of available resources including both natural and human resources, and the identification of desired future conditions that could realistically be achieved with improved management and commitment. The use of a Graphic Information System (GIS) would aid this effort a great deal.

IMPROVING BUFFALO PRODUCTION BY INCREASING REPRODUCTIVE EFFICIENCY

Buffalo departing the village for grazing during the day.

Buffalo production represents a large proportion of overall livestock breeding and production activities in Iraq. It is estimated that there are 500,000 head of buffalo in Iraq, with most in the central and southern regions. Buffalo holders gain income from the sale of buffalo meat and milk. Buffalo milk is used to make a yogurt that is preferred by Iraqi consumers.

A major problem faced by buffalo holders in Iraq is low reproductive efficiency, caused by failure of female buffalo to ovulate. There are two causes for this problem. The first is poor nutrition: when female buffalo have poor body condition due to poor nutrition, they are not able to enter estrus and mate. The other cause is the anestrus cyclicity that occurs during the hot season in Iraq, and prevents estrus and mating. This low reproductive efficiency reduces production, as calves are not produced to sell for meat (males) or to replenish the herd (females). In addition, buffalo that have given birth produce more milk, which is also a source of income for holders.

In order to improve the reproductive efficiency of buffalo, and increase production and income, ARDI implemented projects in central and south-central Iraq to increase successful pregnancies through improved nutrition and hormone treatments. A total of nearly 1,750 buffalo owned by 634 holders were treated by the projects.

A buffalo holder injects her buffalo with hormone treatment to induce estrus

IMPROVING REPRODUCTIVE EFFICIENCY IN BUFFALO THROUGH HORMONE TREATMENT

Buffalo production in Iraq is characterized by seasonal breeding. During the hot season in central and south-central Iraq there are almost no incidents of estrus (ovulation) in female buffalo, resulting in an average intercalving period that can reach eight months or more. In this case it is impossible for buffalo to calve during the peak months of two successive years and calving may be missed altogether in some years. This reduces the income that buffalo holders gain from the sale of calves and milk from calved buffalo. It also results in reduced herd sizes, as herd replacement rates are lower.

ACTIVITIES

Hormone treatments can enable female buffalo to enter estrus during the hot season, reducing anestrus cyclicity and improving reproductive efficiency. ARDI introduced a program of hormone treatment and improved nutrition in central and south-central Iraq. The hormone – Human Chorionic Gonadotropin (HCG) – is an inexpensive treatment that induces estrus in buffalo, even during the hottest months of the year. This treatment is practical, easy, and low-cost, and owners can easily perform it. ARDI paired the hormone treatment with improved nutrition to increase rates of successful conception and pregnancies.

ARDI implemented the program in the summers of 2005 and 2006. In 2005, we treated a total of 346 buffalo owned by 125 holders in Baghdad, Muthanna, and Thi-Qar governorates. In 2006, ARDI treated a total of 400 buffalo owned by 119 holders in Baghdad and Qadissiya governorates. Our staff met with local leaders to select the buffalo holders to participate in the program, and visited each holder to administer the hormone treatment to the buffalo. ARDI also gave the holders a supply of barley feed for the buffalo during mating and early pregnancy.

RESULTS

ARDI staff visited the buffalo throughout the duration of the project in order to measure rates of successful estrus and mating, as well as rates of pregnancy. In 2005, the treatment was successful in increasing average rates of estrus and mating to 84% and rates of pregnancy to 77% in a population of buffalo that would normally have a near zero mating rate during the hot season (see Table 72). In 2006, rates of estrus and mating were improved to 87% (see Table 73). Rates of pregnancies in this 2006 project will not be known until after the publication of this report.

The economic benefits of using hormone treatments in the hot season are significant. The investment in the hormone is $3, and the cost of improved diet for one buffalo during mating and early pregnancy is $42. With this $45 investment, breeders have a more than 80% chance of a pregnancy and calving, which will bring approximately $70 from the sale of the buffalo calf at weaning, and $620 from the sale of milk from the calved buffalo in the first month after birth. This $645 profit per calved buffalo is a significant increase in income, particularly since without the hormone treatment the breeders would have no pregnancies or calf production during the hot season.

At the conclusion of the project, ARDI held a field day with area breeders in all

TABLE 72 BUFFALO HORMONE TREATMENT, SUMMER 2005

Governorate	Number buffalo	Number owners	Estrus and Mating Rate (%)	Pregnancy Rate (% of Mated)
Baghdad	132	48	91	85
Muthanna	107	23	80	82
Thi-Qar	107	54	81	67
Total	**346**	**125**	**--**	**--**

three governorates in order to demonstrate the results of the program. The field days were attended by buffalo holders who participated in the program, as well as area breeders. There was considerable interest among the breeders in the hormone treatment.

TABLE 73 BUFFALO HORMONE TREATMENT, SUMMER 2006

Governorate	Number buffalo	Number owners	Estrus and Mating Rate (%)
Qadissiya	250	60	84
Muthanna	150	59	90
Total	**400**	**119**	--

Buffalo in the marshes are often fed reeds and other aquatic plants as part of their diet.

IMPROVING REPRODUCTIVE EFFICIENCY THROUGH IMPROVED NUTRITION

Inadequate nutrition has a negative effect on buffalo reproductive efficiency and the overall health of buffalo herds in Iraq. Most buffalo holders nourish their animals on wheat bran and cotton seeds, and in most cases on only small amounts of nutrition or green roughage. This poor nutrition is one of the main causes of low milk production, long intercalving periods and delays in the onset of puberty, all of which contribute to low reproductive efficiency and production losses leading to reduced income. Improving nutrition during the premating period stimulates ovulation and conception, and improving nutrition during the late gestation period increases the birth weights of calves and increases milk production from the calved buffalo. These improvements increase breeders' income from the sale of this increased meat and milk production, and also increase herd sizes.

ACTIVITIES

Beginning in September 2005, ARDI began working with buffalo holders in south and south-central Iraq to introduce the use of an improved diet of barley grains to premating and pregnant buffalo to improve reproduction. ARDI distributed this improved feed to 390 holders in Baghdad, Muthanna, Thi-Qar, and Basrah (see Table 74). Buffalo received feed for three months premating, and pregnant buffalo received the feed during the last three months of gestation. ARDI monitored the buffalo through the duration of the project and took measurements including birth weight of calves, average milk production of calved buffalo, and average rates of estrus and pregnancy in premating buffalo. ARDI

A buffalo feeding in southern Iraq

staff also took measurements from area buffalo that received average nutrition, for purposes of comparison.

RESULTS

The improved nutrition in pregnant buffalo was successful in increasing average calf birth weight to 42.75 kg, a 30.5% increase over the area average of 32.75 kg. This increase in birth weight means that the calf is more likely to be healthy, and if weight is maintained to weaning the calf will bring a higher price in the market. The pregnant buffalo that received improved nutrition also produced more milk after birth, an average of 11 kg per day, an increase of 76% compared to average area milk productive of calved buffalo of approximately 6.25 kg per day. This increased production is good for the health of the calf, and also represents an increase in income for the holder, as buffalo milk is a valuable commodity that brings a high price at market. (see Table 75)

In the premating buffalo, the improved nutrition was successful in achieving an estrus rate of nearly 63% in treated buffalo. The average pregnancy rate was 78% across all governorates, an increase of 30% over the normal pregnancy rate of 60% of mated buffalo (see Table 76).

TABLE 74 BUFFALO NUTRITION PROJECT IMPLEMENTATION BY LOCATION

Governorate	Number of Holders	Number of Buffalo		
		Total	Pregnant	Pre-mated
Baghdad	21	100	50	50
Muthanna	119	350	165	185
Thi-Qar	145	350	165	185
Basrah	105	200	100	100
Total	**390**	**1,000**	**480**	**520**

TABLE 75 BUFFALO NUTRITION RESULTS FOR PREGNANT BUFFALO, 2005 AND 2006

Governorate	Number of Pregnant Buffalo	Average Calf Weight at Birth (kg)		Average Milk Production (kg)	
		Program	Area	Program	Area
Baghdad	50	45	30	13	5
Muthanna	165	43	33	9	5
Thi-Qar	165	40	33	13	9
Basrah	100	43	35	9	6
Average % Improvement	**--**	**30.50%**		**76%**	

TABLE 76 BUFFALO NUTRITION RESULTS FOR PREMATED BUFFALO, 2005 AND 2006

Governorate	Number of Pre-mated Buffalo	Average Rate of Estrus (%)	Average Pregnancy Rate (%)	
			Program	Area
Baghdad	50	94	88	60
Muthanna	185	92	82	60
Thi-Qar	185	91	73	60
Basrah	100	62.8	69	60
Average % Improvement	**--**	**--**	**30%**	

AVIAN INFLUENZA

H5N1, Avian Influenza struck Iraq in early 2006. Human to human (H2H) cases were documented. Hundreds of thousands of chickens were immediately culled.

During the fall of 2005, there was increasing evidence of an outbreak of avian influenza (AI) in the region. Along with cases detected in southeast Asia, infected birds had been found in eastern Europe, and it appeared that the outbreak was spreading eastward across Europe and into central Asia. This was alarming news, because avian influenza, H5N1 is a zoonotic disease, which has been known to be transmitted from birds to humans. The most virulent strain of the disease is deadly to humans, and since domestic poultry (especially geese, ducks, and chickens) are common carriers, populations who keep uncaged chickens (backyard poultry) are especially at risk. Indeed, after reports of human infection with bird flu in eastern Turkey, the first cases were confirmed in Iraq, in the northern regions.

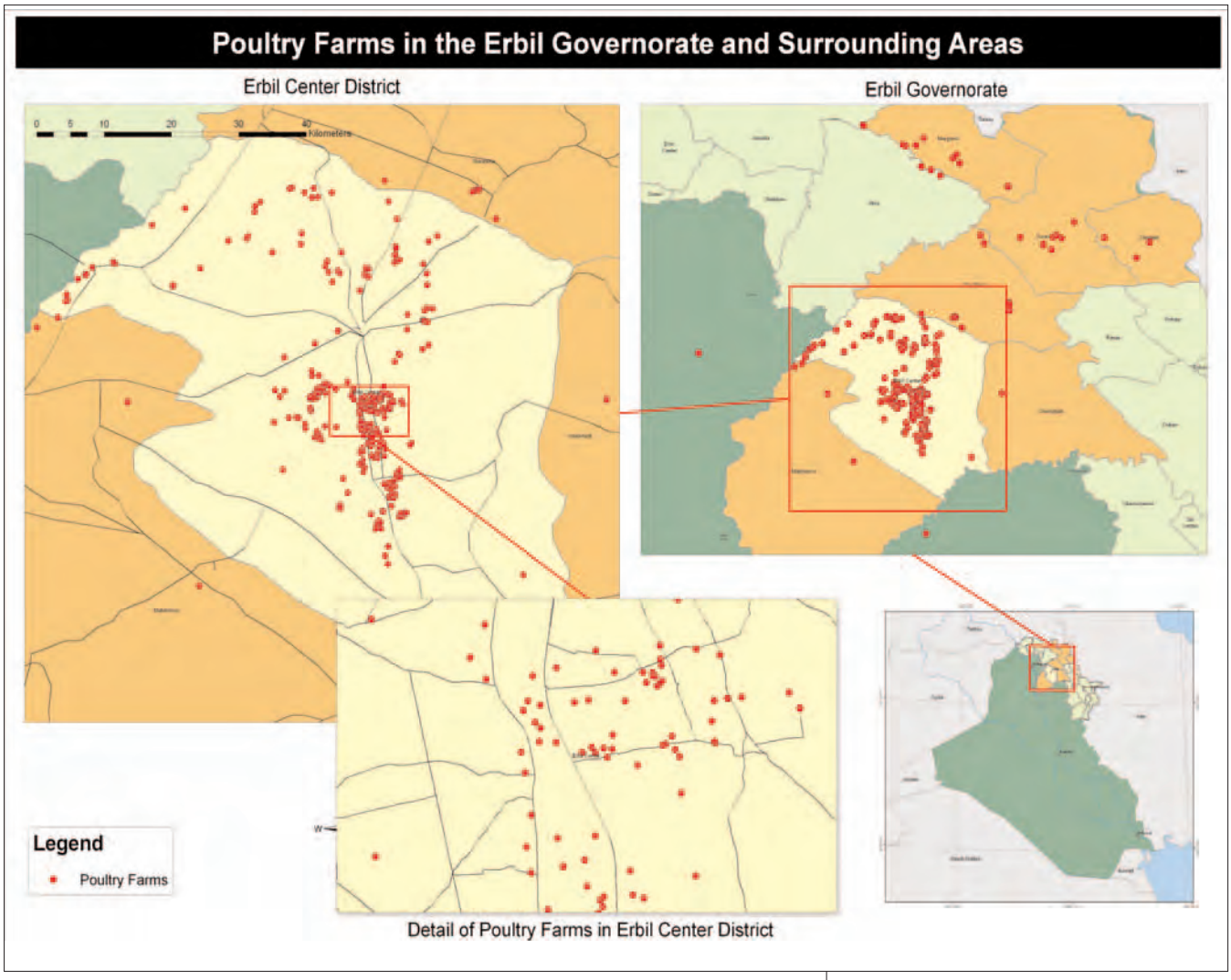
In October, an Interagency Avian Influenza Working Group was formed by the USG to assist the Government of Iraq to mobilize technical and program

Avian Influenza experts responding to the outbreak of a poultry farm outbreak in Iraq.

Autopsy photo from the world's first confirmed case of feline H5N1 occurred in Iraq. This established that sick cats might be a sentinel for AI.

resources in response to the outbreak. ARDI was particularly active in this effort as the prime representative of USAID in the group. ARDI mobilized rapidly to meet the challenge. The first efforts focused on improving monitoring and surveillance activities and enhancing the Ministry of Agriculture's preparedness for possible avian influenza outbreaks. These efforts were followed by other measures, which included specialized assistance for Iraqi professionals, grass-roots campaigns to educate the farming population, and the formation of a broad coalition of stakeholders from different ministries, agencies, NGOs, and international partners to form a coordinated response to avian influenza on a national level.

ARDI worked in close partnership with the Ministry of Agriculture on the avian influenza project. The MOA had primary responsibilities for these efforts since the most likely sources of the disease were on family farms in rural areas. The poultry industry is of great economic importance in the country, and formed a substantial part of the income of millions of rural Iraqis throughout the country. In fact, with the first rumors of the presence of the disease in the countries, authorities were forced to close bird markets and prevent the transport of live birds. These restrictions, combined with general concern throughout Iraq over the local cases, caused immediate declines in the poultry market, and threatened to have severe economic consequences for Iraqi farmers.



One of ARDI's recommended responses to the Avian Influenza crisis was to survey all poultry farms in the vicinity of the current outbreak permitting targeted education and swift response to future outbreaks.

One of ARDI's first activities was to assist the MOA/Erbil in the formation of veterinary-agriculture surveillance teams. These teams were trained to collect samples from farms where dead poultry had been reported, and test those samples for the avian influenza type A virus, which could be indicative that birds carried the deadly H5N1 strain of the disease. An essential part of the training was to prepare team members in the proper use of global positioning systems (GPS) equipment in order to pinpoint the exact locations of inspections and cases identified and map the spread of the disease. Team members were also furnished with personal protective equipment kits and disinfectants, to prevent the transmission of the disease to team members and prevent the spread of the disease between farms during inspection visits. At the same time, ARDI worked with MOA authorities to devise a plan for reimbursing farmers in the case that flocks needed to be culled.

Since the sophisticated laboratory facilities needed to identify the specific strain of virus did not exist in Iraq, ARDI helped to establish linkages between the Government of Iraq and the US Naval Medical Research Unit No. 3 (NAMRU-3) based in Cairo. ARDI sponsored travel for a group of Iraqi veterinary scientists to the NAMRU-3 laboratories in Cairo for training in diagnostic procedures for AI in Iraq. Soon afterward, ARDI identified an international expert in the epidemiology and prevention of AI, and sponsored his visit to Iraq

Attendees at the National Avian Influenza Conference, April 2006.

to consult with MOA and Veterinary Services personnel about initial needs, surveillance methods, and prevention strategies.

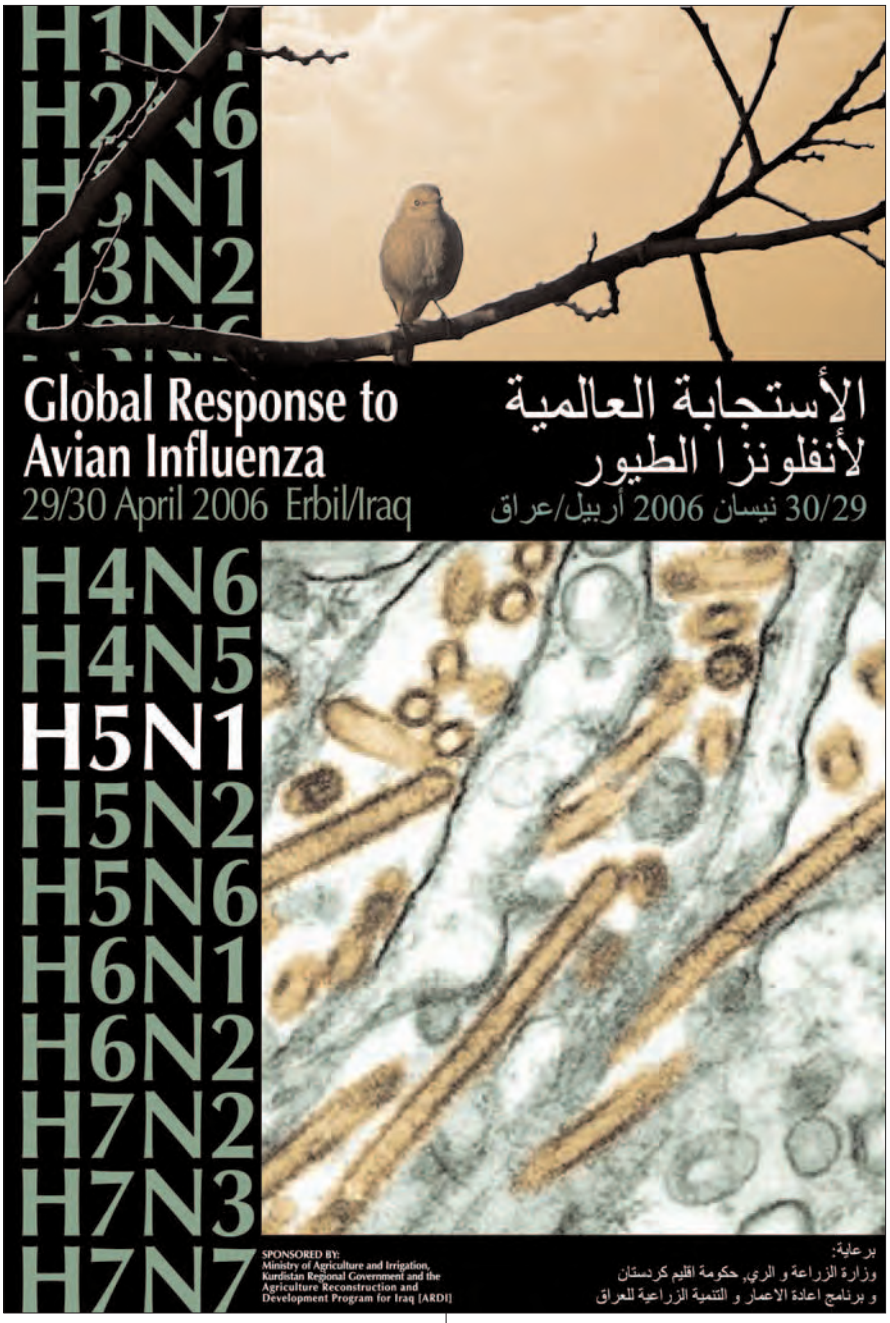
At the same time, ARDI took steps to inform farm families about risks, identification and prevention through a community education project aimed, in particular, at women, who bear most of the responsibility for managing small animal production activities on the farm, and who also care for the health of their families. At present there is no vaccination available for H5N1. One essential measure to prevent its spread is to educate poultry owners on how to care for their animals and avoid infection, since poultry owners often lack adequate information of poultry health and management.

ARDI already had in place a very successful project aimed at educating farmers on the recognition and prevention of zoonotic diseases in general (see Section 2.5), and it was appropriate to adapt this educational campaign to target avian influenza in particular. Working through a local NGO, ARDI mobilized teams of veterinarians, animal production specialists and public health officials to work together to deliver workshops in each village. ARDI trained these teams in participatory extension methods, including the use of extension materials such as posters and brochures, to maximize the impact of the training workshops.

The initial education project for zoonotic diseases had already reached a total of

1,125 villages, offering workshops for nearly 20,000 people, each of whom represented a farm family. However, these workshops covered AI along with all other principal zoonotic diseases such as brucellosis, mange, echinococcus and tuberculosis. The revised workshops were focused specifically on bird flu, and the teams reached an addition 720 villages in the governorate of Sulaymaniyah, the geographical center of the Iraqi outbreak. These workshops provided training for a total of 7,535 men and 7,948 women.

In May of 2006, ARDI, in conjunction with the MOA/ Erbil, sponsored a *National Avian Influenza Conference* in order to bring the various stakeholder groups together to build commitment to work towards a coordinated and strong national response to avian influenza. The conference was attended by over 120 people from 17 governorates, including senior government officials from Baghdad, Erbil and Sulaymaniyah; poultry producers; over 40 representatives of 23 NGOs working in agriculture across Iraq; and international organizations closely involved with the effort.



H5N1 Conference Poster

The conference began with a presentation of the Government of Iraq's current National Plan for Avian Flu response. The GOI of Iraq developed this plan based on information available from other countries, much of which is geared towards large-scale commercial poultry production sectors. In Iraq, however, there are large numbers of "backyard" poultry producers who raise chicken and other birds on a small-scale, and pose unique challenges in the event of an avian influenza outbreak. For the remainder of the conference, the stakeholders worked in a series of mixed working groups to develop recommendations to address Iraq's unique circumstances and improve the national response to avian influenza.

The working groups formed during the conference determined that the national response must give major attention to backyard poultry production, including the finalization of a compensation plan for poultry culling, to assure that poor producers would notify authorities when they suspect they have infected poultry. In addition, these backyard producers need technical assistance to

Infected backyard chickens from Iraq's 2006 outbreak of H5N1.

implement the use of chicken coops to encourage a transition away from free range production (and concomitant contact with wild birds) toward enclosed or fenced structures, which can help reduce transmission and prevent widespread outbreaks. These measures also reduce contact between the birds and family members, especially small children.

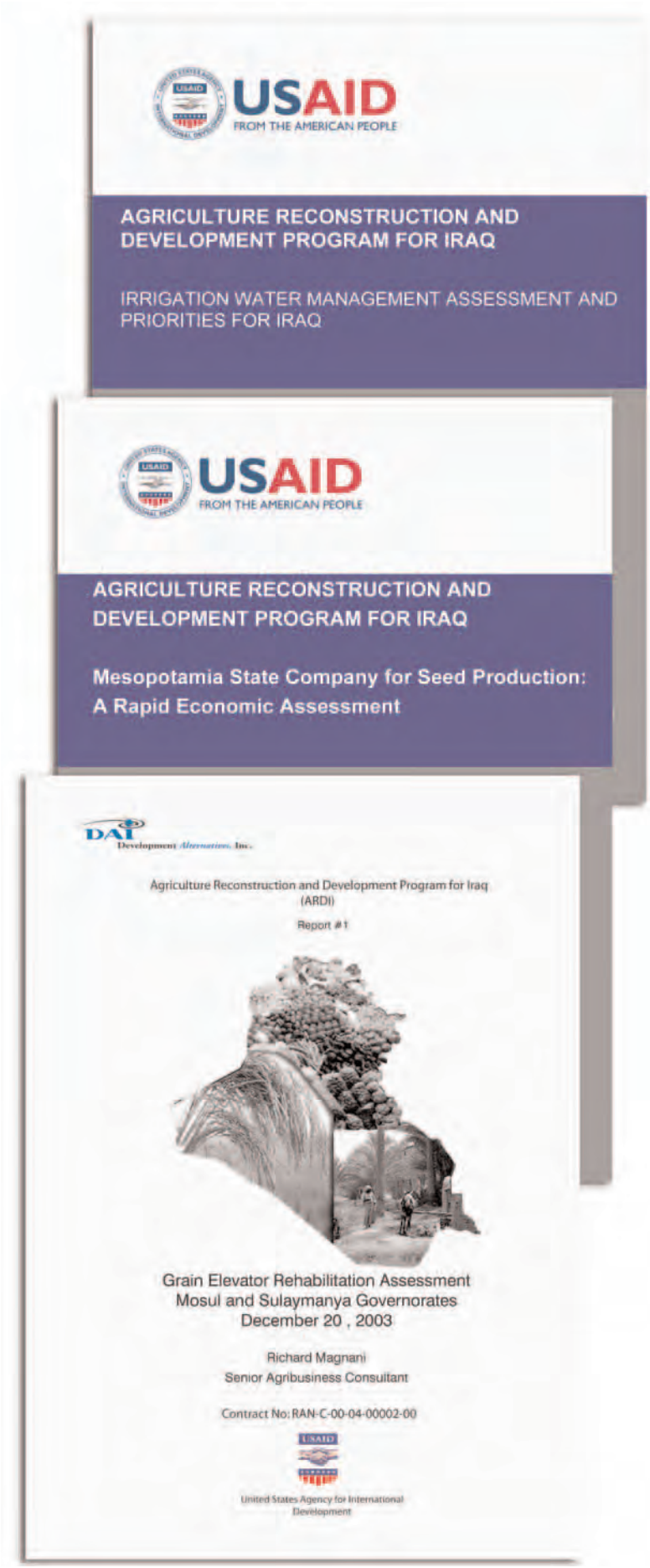
In addition, all stakeholder groups agreed that it is necessary to reassess and revamp the public awareness programs for avian influenza, in order to increase awareness and maintain consistency in the information that is disseminated. Awareness campaigns must be coordinated with messages that target specific audiences with relevant information. For example, consumers need to receive accurate information about how to safely consume poultry products, while backyard poultry producers need information about how to protect their poultry and recognize the signs of infection. This coordinated awareness campaign can be implemented throughout Iraq through government extension services, NGOs, civil society groups, associations, cooperatives, unions, and religious leaders. It was determined that the media needs to play a more active role in the dissemination of information, particularly in the announcement of confirmed outbreaks and human cases. This will help promote government transparency and build trust in the national response to the problem.

The final major recommendation of the *National Avian Influenza Conference* was to strengthen the technical capability of the Government of Iraq to respond to an avian influenza outbreak. The specific recommendations from the conference working groups on improving this technical capacity were as follows:

- The GOI must establish procedures for factually based, rapid response messages to increase the public's confidence in the government's handling of avian influenza. The awareness campaigns will play a large role in this effort.
- The GOI should also establish a laboratory that meets international standards that can be used for avian influenza diagnostic work and to train veterinary laboratory staff. In addition, the GOI must improve its surveillance program to enable rapid identification and containment of avian influenza cases. The number and reach of the teams should be increased, and training on collection and bio-security for veterinary staff and other government field workers should be improved. Clear guidelines must be developed for collection of field samples, bio-security of samples, and shipment to laboratories.
- The GOI should also send veterinarians to monitor poultry markets at least monthly, and develop monitoring guidelines for slaughter houses and commercial poultry farms.

The conference concluded with a consensus that there must be additional coordination between the GOI, civil society and NGOs in the response to avian influenza in Iraq.

3.0 INSTITUTIONAL AND ORGANIZATIONAL IMPROVEMENTS



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AGRICULTURE RECONSTRUCTION AND DEVELOPMENT PROGRAM FOR IRAQ

IRRIGATION WATER MANAGEMENT ASSESSMENT AND PRIORITIES FOR IRAQ

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AGRICULTURE RECONSTRUCTION AND DEVELOPMENT PROGRAM FOR IRAQ

Mesopotamia State Company for Seed Production: A Rapid Economic Assessment

DAI
Development Alternatives, Inc.

Agriculture Reconstruction and Development Program for Iraq (ARDI)

Report #1

Grain Elevator Rehabilitation Assessment
Mosul and Sulaymanya Governorates
December 20 , 2003

Richard Magnani
Senior Agribusiness Consultant

Contract No: RAN-C-00-04-00002-00

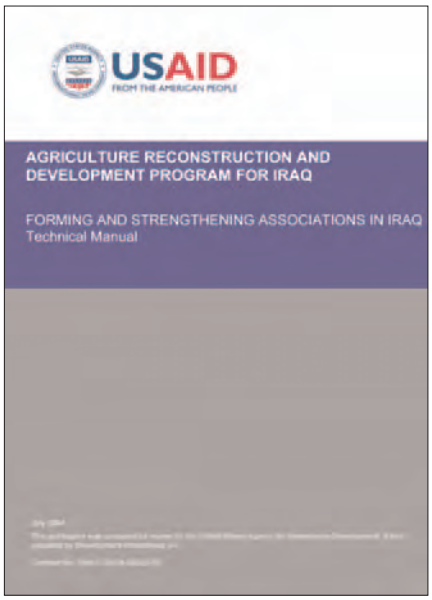
United States Agency for International Development

3.1 CAPACITY DEVELOPMENT IN THE AGRICULTURE SECTOR

Seasonal fruits and vegetables in a typical market stall.

Iraq's transition from a centrally-planned to a market-based economy has changed the Government's role in the economy. The Government is reducing its direct intervention in commercial activity, and instead is working to promote private enterprise through the creation of an environment that will permit the growth of stable and transparent markets. The role of individual economic agents (producers, buyers, and sellers) is also changing. Instead of following directions sent from the Government to conform to a central economic plan, producers, buyers, and sellers must make business decisions based on economic factors that most directly affect their activities.

Although the Government has reduced significantly its direct intervention in commercial activity, it nonetheless has an important role to play to ensure the general health of the various economic sectors, including agriculture. In order to promote the agriculture sector, the Government must support an efficient



market in which private business, including farming, can flourish; provide assistance to economic agents, including producers and consumers of agricultural products, to help them make good business decisions based on economic factors; and provide assistance to the agricultural sector to promote and support agricultural production when necessary.

As the Government is shedding its direct production and marketing activities, a vibrant and enthusiastic private agribusiness sector is developing to take over leadership in these areas. This emerging private sector, though still weak, has great potential to provide the foundation for growth and development of agriculture.

ARDI implemented a variety of programs to assist both the Government of Iraq and the private sector to make the transition to a market-based economy, in order to strengthen the agricultural sector. We provided assistance to build capacity within the Government to support efficient market mechanisms, with an emphasis on collection and dissemination of production and marketing information. We also worked with private sector groups, including NGOs, cooperatives, and associations to strengthen their capacity to contribute to reconstruction and development of the agriculture sector.

ARDI implemented private sector development activities in coordination with projects to improve agricultural production of agronomic crops, high-value agriculture, and livestock production. This section contains references to other parts of this report, where those activities are discussed.

AGRICULTURAL INFORMATION

Crop cutting to estimate wheat yields in Sulaymaniyah governorate

The wide dissemination of market data to all economic agents is an essential element of a stable, efficient market. Asymmetrical possession of market information by those who have the means to collect it through private networks leads to market distortions and failures. A public system of collection and dissemination promotes broad participation in market activities, and also reduces the cost of multiple private networks for data collection.

In the agricultural sector, information on market prices and production levels is useful to farmers, consumers, and traders making business decisions. A public system of data collection and dissemination ensures that all economic agents have access to these data, so that the market works efficiently.

A public system of information dissemination also provides the Government with the data necessary to assess the health of economic subsectors and plan assistance programs. In the agricultural sector, the collection of data about prices,

production, land use, crop suitability, and other factors that affect agricultural production are useful in planning efficient and effective assistance programs, whether through extension activities or targeted support projects.

To increase the ability of the GOI to improve the efficiency of the market though agricultural information and dissemination, ARDI provided technical support, tools, and capacity-building programs in surveys and statistics, agro-ecological zone mapping data collection, agro-meteorological networks, cadastral land mapping, and a strategy for water and land management. In addition, ARDI implemented a separate program, through the private sector, for wholesale market price data collection and dissemination.

Precise cuttings and measurements are essential for accurate crop forecasts.

ESTABLISHING STATISTICS UNITS IN THE MINISTRY OF AGRICULTURE

When ARDI began working with the Ministry of Agriculture in late 2003, the responsibility for collecting, analyzing, and disseminating data for all of Iraq's economic sectors rested with the Ministry of Planning. This ministry conducted agricultural surveys for winter and summer crops each year. Accompanied by a staff member from the MOA, surveyors traveled to nearly every village in the country, where they gathered data from on-farm interviews. Because of the labor intensity of this collection method, survey results were often issued two or three years late and thus had little direct benefit for planners or farmers.

The Ministry of Agriculture's own statistical capabilities were constrained by a lack of staff, facilities, and expertise. Its head statistical office in Baghdad did not have enough staff for field visits, so it would request estimates from MOA subdistrict offices, the staffs of which would go to the field and talk directly with farmers. This method of collecting data was piecemeal, and did not produce reliable or comprehensive results.

Within the GOI, ARDI assisted the MOA to establish a main Statistics Unit office in Baghdad, to assume the main responsibility for collecting, analyzing, and disseminating data for the agricultural sector which is now staffed by approximately 25 trained employees. The Statistics Unit also maintains branch staffs, with approximately 5 employees in each governorate. We supplied these governorate offices, which had been looted or destroyed in 2003, with computing equipment, internet connectivity, telephones, software, and reference materials.

The transfer of methodologies and training were two other important components of establishing these units. The MOA's traditional method of collecting data consisted of village-level surveys, which often yielded scattered data, and complicated the process of drawing meaningful results or conclusions. Beginning with the 2004 crop surveys in Babylon and Diyala, ARDI introduced new sampling methodologies to the Statistics Units. We also provided assistance in the design of survey tools and questionnaires, the provision of equipment, and logistical support for data collection. Most frequently this took the form of vehicles to carry enumerators to the fields. Some MOA offices had no vehicles at all, while in areas, cars recognized as belonging to the Government would be targeted for violence.

In 2005/2006 ARDI presented the MOA with a more sophisticated sampling technique: Area Frame Sampling. This sampling method, which was developed by the US Department of Agriculture, uses both high-resolution satellite imagery and field surveys. It is currently a standard method for collecting agricultural statistics in the US

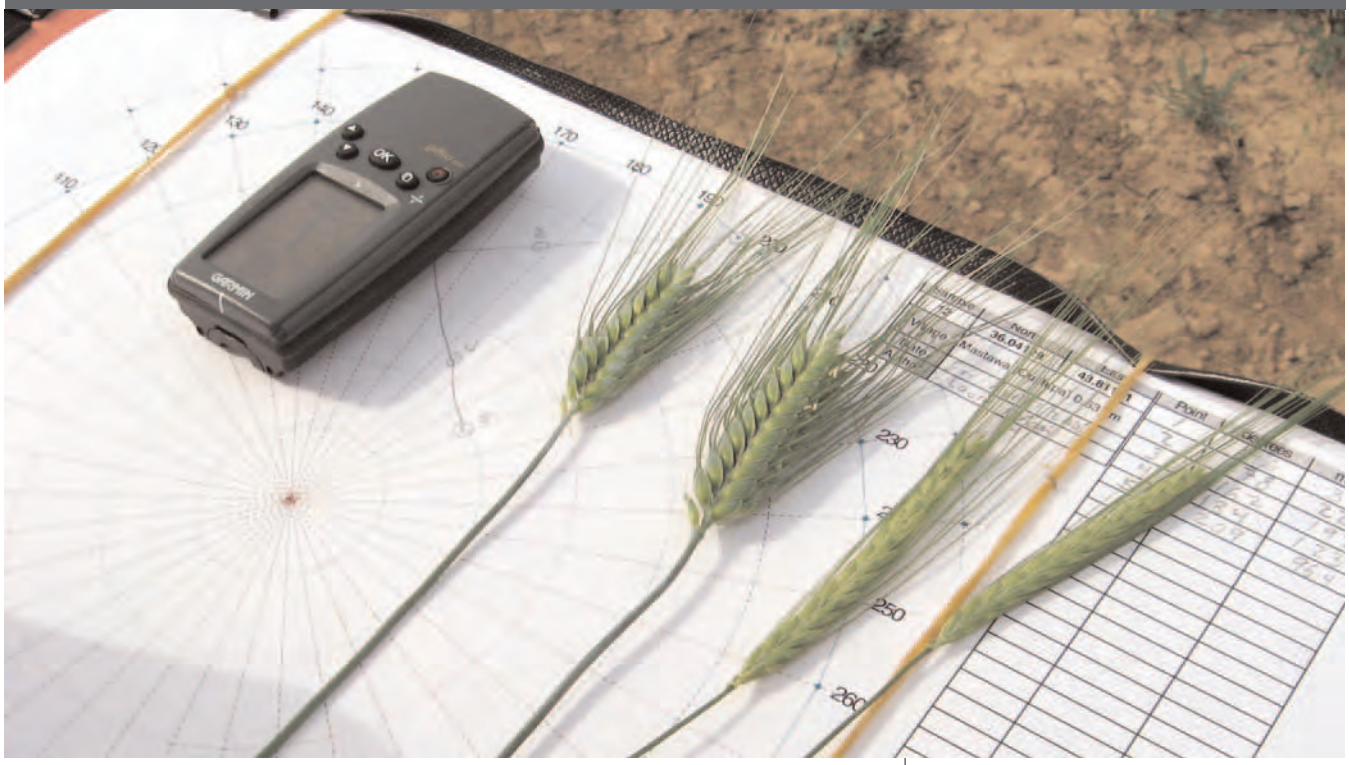
As part of ARDI's technical assistance to the Statistics Unit, we trained about 425 individuals from MOA offices in six governorates in survey enumeration techniques. Training included such subjects as survey methodology, random sampling procedures, and survey administration. Staff involved with data processing tasks received training in Excel, Access, and other data management software programs.

RESULTS

MOA Statistics Units from all of Iraq's governorates are now furnished with basic equipment, have been assigned additional staff, and are fully functional. Armed with new survey methodologies, appropriate tools, and better-trained staff, these units are able to provide timely, good-quality data to both public and private decision makers throughout the country.

In its published reports, the MOA's Baghdad Statistics Unit publicly acknowledges ARDI assistance in building its survey and statistical capabilities. The unit prefaces its reports with an announcement of its intention to conduct annual surveys for all agricultural activities in all of Iraq's governorates beginning in 2007.

CONDUCTING AGRICULTURAL SURVEYS



Surveys involved actual field crop sampling, measuring, and georeferencing.

AGRICULTURAL SURVEYS

ARDI sponsored 14 agricultural surveys for both crops and livestock, which were conducted by MOA personnel. We also introduced a statistical procedure known as Area Frame Sampling to improve the accuracy of winter crop estimates.

TABLE 77 AGRICULTURAL SURVEYS

Activity	Number of Projects	Projects Primary Beneficiaries
Winter Crops	4	3 in Dahuk, Erbil, and Sulaymaniyah governorates for the 2004/2005 planting season 1 in Dahuk, Erbil, and Sulaymaniyah for the 2005/2006 planting season
Agricultural Production	2	2 in Babylon and Diyala for 2003/2004 and 2004/2005
Area Frame Sampling	1	1 Introduction of Area Frame Sampling
Summer Crops	1	1 in Sulaymaniyah for the 2005 crop season
Sunn Pests	2	2 in Dahuk and Erbil for 2005
Poultry Production	3	2 in Erbil, Dahuk and Sulaymaniyah for 2005 1 in Baghdad for 2005
Livestock and Dairy Production	1	1 in Sulaymaniyah for 2005
Beekeepers	1	1 in Diyala for 2005

WINTER CROP SURVEYS

BACKGROUND

The demand for wheat, which has long been the mainstay of the agricultural sector, has fallen dramatically in the past decade, primarily as a result of the Oil-for-Food Program, which distributed imported wheat free of charge to the entire population of Iraq through the PDS. The lowered profitability of wheat in the form of bread flour, in turn, has led to deteriorated grain quality. As farmers' income plummeted, fertilizer and herbicide use declined, resulting in the proliferation of weeds and poor-quality grain. This reduced yields further, and led to large areas being left fallow.

Winter Crop Surveys of wheat and barley can determine area planted to crops, gather information on production methods and variables, and measure crop yields. This information can assist the Ministry, traders, and private farmers to take effective steps to reverse the decline in grain quality and yields

ACTIVITIES

MOA staff conducted three surveys to examine the trends in winter crops (primarily wheat and barley) for the 2004/2005 planting season in Dahuk, Erbil, and Sulaymaniyah governorates. In 2006, they resurveyed winter crops in the same governorates for the 2005/2006 planting season.

The surveys collected data on cropland area and planting trends, output, and

production costs of wheat, barley, and other important staples such as chickpeas, lentils, and winter vegetables. The focus was on wheat and barley because of their dominant role in Iraq as a food source for both humans and livestock. These two crops are also a major source of cash for farmers, and generate additional income and employment in the manufacturing sector.

RESULTS

The principal findings of the surveys included:

Cropland areas. Almost 880,000 hectares were planted to winter crops in the three northern governorates in 2004/2005. Barley was the main crop in terms of area planted, accounting for 49% of the region's cultivated land. This was a somewhat surprising result because wheat (42% of cultivated land) has long been considered to be the region's principal source of food. The survey also revealed that 39% of the governorates' total arable land was not planted during the winter season. The 2005/2006 survey showed little change in cropping patterns, with 48% of the region's land planted to barley and 42% planted to wheat.

There are several reasons that may explain this trend toward increased barley planting. First, barley is more drought-tolerant than wheat, which is sensitive to water stress. As the 2005/2006 survey showed, the ratio of barley to wheat increases in districts with less rainfall. Second, barley is also more resistant to Sunn pest and diseases such as smut. Third, the production costs of barley are lower because this crop requires less fertilizer and inputs. Last, although the price for barley is less than the price of Grade 1 wheat, it is about the same price as Grade 3 wheat. At most, one-third of the wheat produced in Iraq is Grade 1 or 2; the rest is used for poultry or livestock feed.

Planting trends. The areas planted to wheat and barley in the three northern governorates changed a great deal between 1990 and 2005, which may be largely attributable to overall economic and policy conditions. The area dedicated to wheat increased rapidly in 1990/91 following the threat of economic sanctions against Iraq. During sanctions, the government kept production in this area at nearly double the prewar levels, while barley continued to decline.

Under the UN Oil-for-Food Program, which began in 1997, wheat was imported and distributed free in the form of bread flour to the entire population through the PDS. The reduced demand for domestic wheat was followed by reduced wheat plantings, while areas planted to barley, chickpeas, and other crops increased. By the 2004/2005 MOA/ARDI survey of winter crops, barley cultivation had increased to 431,914 hectares, slightly exceeding the total area planted to wheat in the three governorates.

By 2005/2006, however, the areas planted to both wheat and barley declined. For wheat, this was the continuation of a decade-long decline, while for barley, it was the reversal of an upward trend that began in the 1996-1997 season. The reduction in area planted reflects the increased competition faced by farmers as the government withdrew subsidies, and a trend toward migration to urban areas.

Wheat harvesting in Erbil governorate

Yields and production. On average, the yields for barley in 2004/2005 (665 kg/ha) were lower than those for wheat (803 kg/ha), because of multiple reasons: barley is grown in areas of less rainfall, less fertilizer and pesticide are applied, improved varieties have not received as much attention, and farmers usually save barley seed from their previous harvest rather than purchasing more vigorous seed.

The 2005/2006 survey found that wheat and barley yields increased substantially from the previous year: to 1,160 kg/ha for wheat and 832 kg/ha for barley. The probable reasons for these increases include better distribution of rainfall, improved seeds as a result of ARDI's seed cleaning program (see Section 2.1), and increased access to such inputs as pesticides, fungicides, and fertilizers.

TABLE 78 WHEAT AND BARLEY PLANTED AREAS IN DAHUK, ERBIL AND SULAYMANIYAH 1989/1990 - 2004/2005

Period	Crop Years	Wheat (ha)	Barley (ha)
Baseline Year	1989/1990	295,579	278,611
Kuwait Invasion	1990/1991	806,359	168,337
Economic Sanctions – Trade Embargo	1991/1992	473,550	175,362
	1992/1993	562,519	122,898
	1993/1994	536,664	145,366
	1994/1995	563,739	147,378
	1995/1996	455,777	112,234
Oil for Food Program	1996/1997	363,439	94,426
	1997/1998	327,419	138,177
	2000/2001	305,002	227,269
	2001/2002	417,687	264,069
Regime Change	2004/2005	372,170	431,914
	2005/2006	337,500	391,493

Ministry of Agriculture for the years 1989/1990 to 1994/1995; UN-FAO for 1995/1996 to 2001/2002; and ARDI and Ministry of Agriculture for 2004-2006.

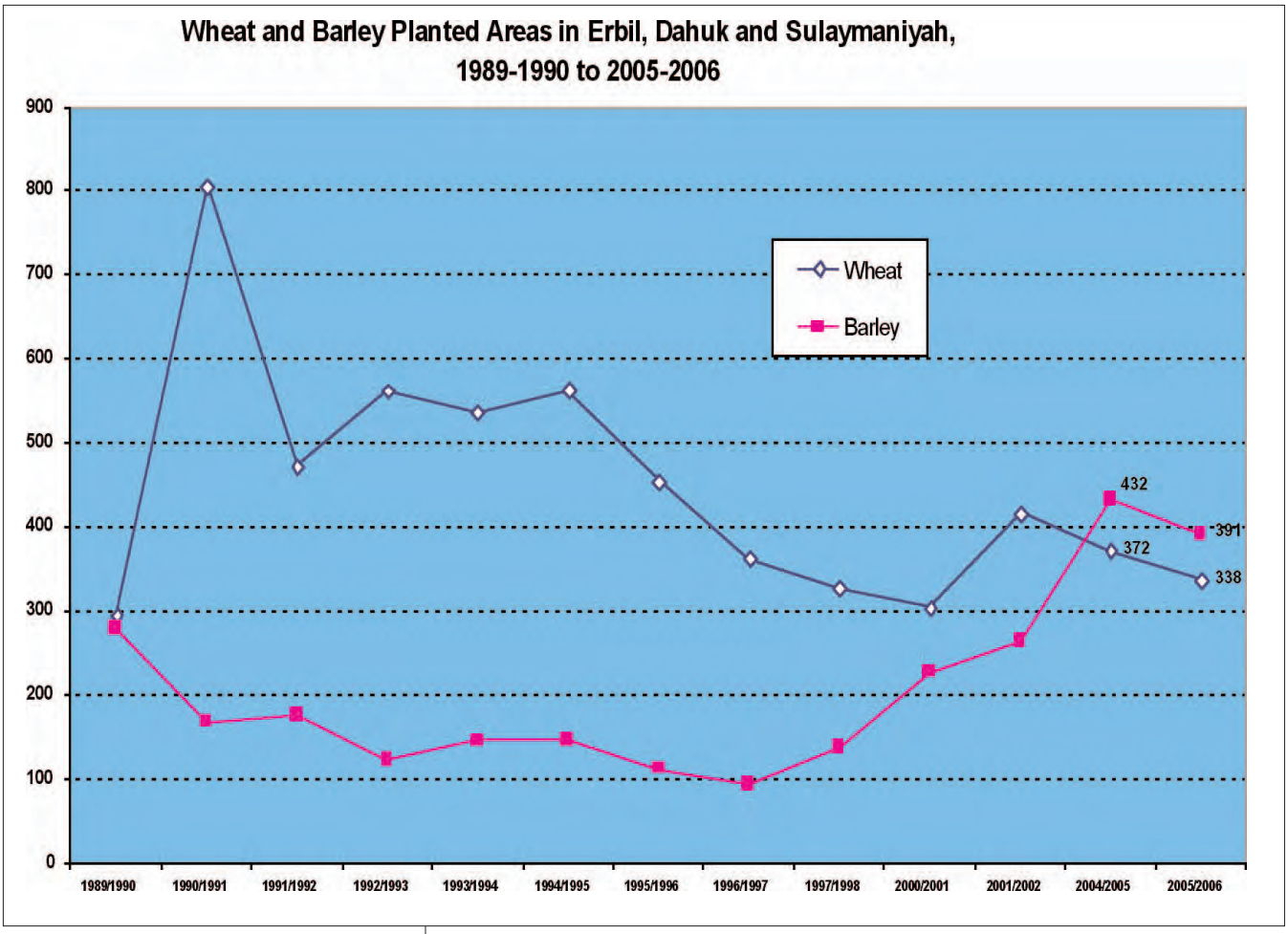
Estimating the yield for wheat in Sulaymaniyah during the 2005/2006 winter crop survey

Production costs. In a survey subset of the northern governorates' villages and fields, farmers were asked to provide information on production costs. Those costs included cash spent for services (e.g., machinery rental, transportation, and marketing activities) and inputs (e.g., seed, fertilizer, pesticides, labor). Wheat was reported as having the highest production costs in all three governorates.

Harvesting was the largest component of production costs in all three governorates, with hand harvesting being at least three times the cost of mechanical harvesting. The amount spent on fertilizers (urea and DAP) and pesticides, on the other hand, was remarkably low; farmers use only small amounts due to their high cost. 42% of the region's wheat farmers and 84% of its barley farmers do not use any fertilizers.

TABLE 79 WHEAT AND BARLEY PRODUCTION COSTS, NORTHERN GOVERNORATES, 2004/2005 (IRAQI DINARS PER HECTARE)

Cost	Dohuk		Erbil		Sulayminayah	
	Wheat	Barley	Wheat	Barley	Wheat	Barley
Plowing and Seeding	27,816	26,800	25,168	24,864	24,572	24,536
Seed	28,928	24,868	28,108	24,132	30,072	22,620
Fertilizer	14,736	1,060	17,240	6,820	13,812	4,764
Harvesting	23,768	44,792	43,916	53,148	48,676	44,168
Weed and Pest Control	2,412	236	1,240	952	2,348	568
Other Costs	18,924	4,748	28,504	14,328	25,584	10,388
Total Costs	114,172	107,980	144,176	124,244	153,064	107,044



Destination of crop production. The survey questioned farmers about their main uses of production, both on and off the farm. They reported that 64% of wheat is marketed, and 15% is kept as seed for the next planting season. Only 5% is kept for family consumption (farmers also receive free flour under the PDS), while around 4% is kept for animal feed. In contrast, around 25% of the barley crop is used for fodder or feed grain, while 20% is kept as seed and 46% is sold. An even smaller fraction (0.2%) is consumed by families.

TABLE 80 CHANGES IN CULTIVATED AREAS, BABYLON, AND DIYALA 2003/2004 TO 2004/2005

Governorate	Available Area (hectares)	Cultivated Area (hectares)		Available Area Cultivated (percent)	
		2003/2004	2004/2005	2003/2004	2004/2005
Diyala	475,964	181,392	192,002	38.1	40.3
Babylon	227,033	n/a	117,152	n/a	51.6

Sunn pest incidence. During the 2004/2005 survey, enumerators took samples of wheat grain from farms they visited in the three northern governorates. On average, about 17.2% of the wheat was found to be damaged by Sunn pests. This has important economic consequences, as a rate of only 3% Sunn pest infestation can render wheat unsuitable for making flour (see Section 2.1 for discussion of ARDI Sunn pest control activities).

AGRICULTURAL PRODUCTION SURVEYS

In view of the large differences among crop estimates from different sources and from year to year in Babylon and Diyala, policy makers and private sector decision makers needed earlier and more accurate estimates of area planted to the main cereal crops in these two important grain-producing governorates. To achieve this, ARDI helped the MOA Statistics Unit staff to conduct a pilot survey in Babylon and Diyala for the 2003/2004 cropping season. In late 2004, they re-surveyed the same locations. In Diyala, field crops (wheat, barley, rice, cotton, sunflower, potatoes, tobacco, groundnuts, and sesame) predominated, while fruits and vegetables (broad beans, tomatoes, cucumbers, etc.) for the Baghdad market are mainly grown in Babylon.

ARDI helped the MOA design a questionnaire to capture information from farmers on crops, varieties, types of irrigation, month and area planted, area harvested, total production, yield per hectare, quantity sold, and average price. The questionnaire also included queries on the area planted to different types of crop as well as the area left fallow during the past year and the reasons it was left uncultivated.

Both surveys adopted a straightforward approach to the problem of collecting crop data quickly and accurately. Ten percent of the farmers in each governorate (about 6,000) were selected as the sample population. Samples were drawn from the same population in both surveys to ensure that the results were comparable.

RESULTS

The results for the 2003/2004 survey are tentative for two reasons. First, when the Iraqi government changed hands in the summer of 2004, government-owned estates on which many of the industrial crops in the country's irrigated areas were produced (e.g., cotton, sunflowers, maize) were abandoned. This had serious negative consequences for the production of these crops. Second, the survey was a retrospective one (it was conducted in late 2004), and asked farmers to recall what they had planted nearly a year earlier. This likely affected the accuracy of the estimates.

The results reveal that slightly more land was under cultivation in the 2004/2005 planting season. However, the percentage of land cultivated was still lower than expected. When asked why they left their land fallow, farmers gave the responses as appearing on the followng page:

FARMERS' REASONS FOR NOT PLANTING WINTER CROPS

BABYLON

Reason	Percent
Lack of Fertilizer	66.9
Low Prices in the Market	41.9
Lack of Pesticides	35.5
Area Planted to Summer Crops	32.7
Machinery Problems	31.8
Soil Problems (e.g., salinity)	30.7
Lack of Irrigation Water	44.8
Seed Problems	22.8
Other (e.g., input costs)	11.2

DIYALA

Reason	Percent
Area Planted to Summer Crops	52.6
Lack of Irrigation Water	45.6
Lack of Fertilizer	19.6
Soil Problems (e.g., salinity)	13.1
Lack of Pesticides	7.2
Machinery Problems	4.7
Seed Problems	4.4
Low Prices in the Market	3.0
Other (e.g., input costs)	11.1

Several of the reasons cited for lack of inputs (e.g., fertilizer, pesticides, irrigation) apparently stemmed from farmers' inability to pay for them. For example, farmers did not have the money (or did not find it cost-effective) to pay for the fuel required to pump irrigation water.

MONITORING WHOLESALE MARKET PRICES

Dahuk wholesale market

BACKGROUND

Farmers make decisions about the types and amounts of crops they grow based on the prices they expect to earn for their products, against what they must pay for their inputs. Knowledge of market prices is also critical for traders to make decisions about when and where to buy and sell their products. Public officials also need price information for policy analyses and decisions.

Before 2005, Iraq had no mechanism for determining prices in the markets and disseminating this information to the public. ARDI instituted a simple yet effective system for collecting price information on a wide variety of wholesale market products and disseminating it to Iraqi producers and consumers. The daily and weekly reports that the ARDI Wholesale Market Price Project produces on fruits and vegetables, animal products, dry goods, and agricultural inputs are the only such reports published in Iraq, and they have received wide attention throughout the country.

Wholesale markets were monitored in all governorates.

ACTIVITIES

This project began when ARDI representatives visited several markets in northern Iraq to get a picture of their structure, the produce available and its quality, and commodity prices and their determinants. They first visited the Erbil wholesale produce market, a warehouse-type facility that houses about 100 stalls that wholesalers rent for a fixed price. Importers and local farmers bring produce to the wholesalers, who in turn sell it to local distributors and supermarkets. The volume of fresh produce sold through these markets in the summer months is about twice the volume sold in the winter months.

WHOLESALE MARKET MONITORING

Like many markets in Iraq, the Erbil market is jointly managed by the Ministries of Agriculture and Municipalities. A committee from these institutions is charged with setting and adjusting daily prices according to perceived market value.

ARDI technical staff next visited a similar central market in Sulaymaniyah governorate and privately owned and managed greengrocer market in Dahuk governorate. They found that the infrastructure in all three markets was weak, with inadequate sanitation, refrigeration, sorting and packing facilities, and storage space. For these reasons, it is not uncommon for wholesalers to throw away about a quarter of the produce that enters the market.

Farmers in all three markets deliver their produce directly to the wholesalers, who sell it on a commission basis. Farmers bear all price and sales risk, and the wholesalers in the public markets typically charge a 5% commission for all produce sold.

The team also visited the largest greengrocer facility in Dahuk, which houses 196 grocers under one roof. Although the facility is old and has limited space, its market area is clean and virtually all of the produce on display is of high quality. Mid- and low-quality produce is not displayed, but is available to consumers. The typical grocer margins are 25% of the wholesale price.

With a good picture of these markets' pricing and structure, ARDI price monitors began visiting wholesale markets at 6 a.m. every day, when retail vendors are purchasing their stock. They consulted five to ten principal vendors at each market and collected data on selected produce, including its origin and price per kilogram. They then sent the price information electronically to the ARDI project office, where it was organized into a daily price bulletin which was, in turn, sent out to subscribers throughout the country.

In May 2005, ARDI issued its first daily report on wholesale market prices for fruits and vegetables. Available in both Arabic and English, the report provided the high and low prices paid that day for 42 fruits and vegetables in the three northern governorates of Dahuk, Erbil, and Sulaymaniyah. The daily reports, which are issued by 12 p.m. on Sunday through Thursday, are consolidated into monthly reports of average prices. By January 2006, the reporting system has been greatly enlarged to cover major markets in all 18 governorates.

The monitoring system continued to expand, and reports on wholesale prices for dry goods, animal products, and agricultural inputs became available in October 2005. These reports are issued on Saturdays because the prices for the

products tend to be less variable than those for fruits and vegetables.

Prices for several varieties of fruits and vegetables (e.g., red, green and yellow apples) were reported. In addition to local prices, those for imports (e.g., apples from Chile, Iran, Lebanon, Morocco, South Africa, Syria, Turkey, and the USA) were reported for the purpose of comparison.

The daily and weekly reports were first distributed to wholesalers, retailer and farmers in two forms. The project disseminated reports via e-mail to hundreds of people who subscribed to this free service, and ARDI monitors brought hard copies of the previous day's reports to the wholesale market each day.

But as the word of this service spread, growing numbers of traders were requesting price information, and most of them did not have easy or quick access to e-mail. The next step was to work with television and radio stations to broadcast the price reports to a wider audience. On December 19, 2005, Basrah

TABLE 81 AGRICULTURAL PRODUCTS MONITORED BY ARDI

Fruits	Fruits	Dry Goods	Animal Products	Agricultural Inputs
Apples	Beets	Barley	Beef	DAP
Apricots	Broad Beans	Chickpeas	Chickens	Phosphates
Bananas	Cabbage	Cooking oil*	Eggs	Urea
Cherries	Carrots	Flour*	Fish	
Coconut	Cauliflower	Lentils	Milk	
Dates	Cucumbers	Maize	Mutton	
Figs	Eggplants	Rice*		
Grapefruits	Garlic	Sugar		
Grapes	Green beans	Wheat		
Kiwi	Lettuce			
Limes	Okra			
Loquat	Onions			
Oranges	Peas			
Melons	Peppers			
Olives	Potatoes			
Peaches	Spinach			
Pineapple	Squash			
Pears	Swiss Chard			
Plums	Potatoes			
Pomegranates				
Strawberries				
Tomatoes				
Watermelon				

* Cooking oil, flour, and rice are part of the public distribution system's food basket; ARDI monitors their prices in both this system and the commercial market.

Radio, which reaches from Basrah to just south of Baghdad, made the first radio broadcast of the daily price bulletin. It reports prices every morning at intervals during its 10 a.m. news program.

The wholesale price program was able to expand its coverage again in January 2006, when it began sending price information to traders by short message service (SMS) via mobile phones. The SMS service allows traders to receive information targeted to their specific needs without having to be at the market daily or near a radio or television at a specific time. Traders simply gave ARDI their mobile phone numbers and the main products they trade. The project then sends a message to their mobile phones with price information on these crops from all 15 governorates.

SUCCESS STORY

WHOLESALE PRICE REPORTS INFLUENCE MARKET BEHAVIOR

Peach and apricot orchards are common in the Dahuk governorate, and during the peak harvest season farmers need to develop additional market outlets for their production. ARDI's wholesale market price reports give early warning signals to interested traders throughout Iraq when local supplies in a region exceed consumption.

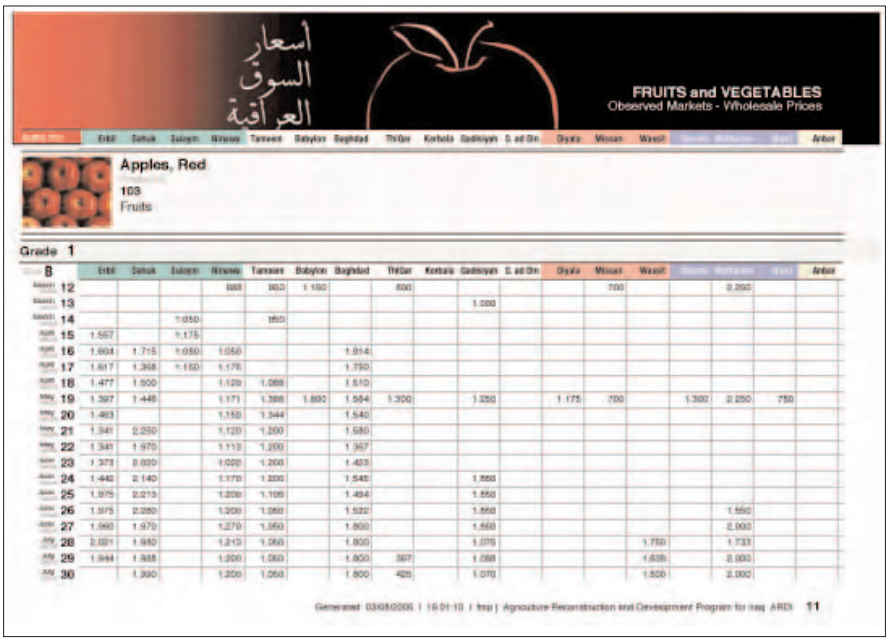
Traders in Dahuk reported that a Baghdad trader came to their market in July 2005. The trader had learned from ARDI's daily price reports that wholesale prices for peaches and apricots were lower in Dahuk than other markets.

Dahuk traders, in turn, noticed that banana prices in their city were consistently higher than those reported in Mosul, even for the same bananas imported from Ecuador. After some investigation, they switched from their Baghdad-based supplier to an agent in Syria, who was supplying Mosul markets at lower cost.

RESULTS

For the first time, Iraq's traders and farmers have access to agricultural price data that helps them make informed decisions about buying and selling produce. The number of people subscribing to ARDI's pricing reports grew to over 200 e-mail subscribers and 280 SMS subscribers by September 2006.

This program formed the foundation of a nationwide price information system for traders and farmers in Iraq. Recently, the MOA indicated that it would like to begin distributing the prices through its Media Unit and publish the reports in weekly newspapers.



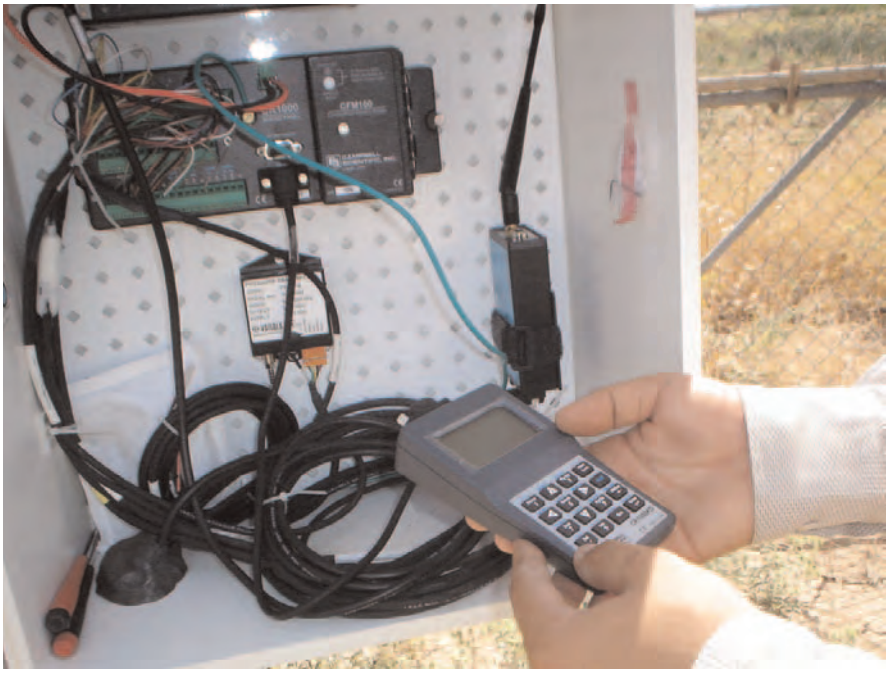
Sample page from a weekly wholesale price monitoring price report, available via web, email, or SMS.

AGRO-METEOROLOGICAL NETWORK

Assembly of a control box for the automated weather stations.

Iraq has extensive arable lands suitable for irrigation, but also a long history of irrigation-related problems and increasing competition for limited water resources, so Iraqi farmers must improve practices for irrigation agriculture and water management. In order to do this, the GOI needs improved data on water use, water demands by crop, and relevant environmental factors. ARDI assisted the GOI to implement a national-scale agro-meteorology program to improve their capacity to collect this data and implement improved water management practices.

Reconstruction and modernization of the existing meteorological monitoring programs was a key element in the establishment of Iraq's agro-meteorology program. Previously, Iraqi meteorological data providers lacked sufficient capacity to collect, manage, analyze, and disseminate data needed to support an agro-meteorology program. GOI staff required training and experience operating



An automatic weather station control box with data logger.

automated data acquisition instrumentation, processing electronic data, analyzing meteorological data and agro-meteorological applications. In addition, the existing network of weather stations and other data collection instruments needed to be updated with modern equipment.

In 2005, ARDI conducted an assessment of the existing agro-meteorological network in Iraq, to determine the status of existing networks, local needs for weather information and weather-based products for agricultural management, internal capability, and potential benefits of this program to Iraq and national interest. Based on this assessment, ARDI determined needs for hardware and for staff training.

An automatic weather station with a solar collector which provides power in remote locations.

One of the main accomplishments of the agro-meteorology project was the establishment of the National Agro-meteorological Steering and Coordination Committee, which included a designated representative from each participating ministry and institution: Minister of Agriculture- Baghdad (State Board of Extension); Minister of Transportation- Baghdad (Iraqi Meteorological Organization); Minister of Environment- Baghdad (Director General of Planning and Technology); Minister of Water Resources- Baghdad (Director General of Management); Minister of Water Resources- North (Director General of Irrigation and Water Resources); Minister of Agriculture-North (General Director of Agro-meteorological Programs); Iraqi Meteorological Organization-North; Minister of Environment- North; and the University of Baghdad.

The purpose of the Committee is to coordinate weather data collection for agro-meteorology; coordinate weather data exchange between the various ministries as well as other organizations; develop an agro-meteorological information program; support training and education; and guide agro-meteorological research. It was especially important that the steering committee take ownership of the National Agro-meteorology Program, so that it can continue to coordinate all agro-meteorological efforts in Iraq. The objectives of the committee can only be met if there is close collaboration between agricultural, hydrological, and meteorological interests.

Extensive hands on training exercises introduced participants to the practical aspects of database management for weather data.

In addition to forming a Steering and Coordination Committee, training was an important element of the Agro-meteorology program. ARDI carried out the following training program:

- Introduction to automated data acquisition. This was a preliminary workshop that introduced the concepts and equipment used for automated data acquisition. Two, two-day sessions were completed in November 2005. Attendees included 58 trainees from the Iraq Ministry of Agriculture, Iraq Ministry of Transportation, Kurdistan Regional Government (KRG)-Ministry of Water Resources and KRG-Ministry of Agriculture and Irrigation.
- Introduction to database processing. This was a preliminary training workshop that introduced concepts of using databases for data management focusing on Microsoft Access database software. Two four-day training sessions were completed in March 2006 and included 59 trainees from the Iraq Ministry of Agriculture, Iraq Ministry of Transportation, Iraq Ministry of Water Resources Kurdistan Regional Government (KRG)-Ministry of Water Resources and KRG-Ministry of Agriculture and Irrigation.
- Database processing and automated meteorological data acquisition. This was a follow-up workshop to the database processing workshop. The training focused on using database processing for management of meteorological data, including generation of reports and preparing data for analysis with other applications, including spreadsheets. There were two workshops, of two and one-half days each, for the 59 trainees who attended the previous database processing session.
- Operation and maintenance of automated weather stations. This workshop provided operation and maintenance training for the 19

automated weather stations provided by ARDI. Two workshops of five and one-half days each were conducted, with 15 participants per workshop. The training reviewed support software, installation, maintenance, data retrieval and review and programming. The workshop included both in classroom computer training and field installation activities.

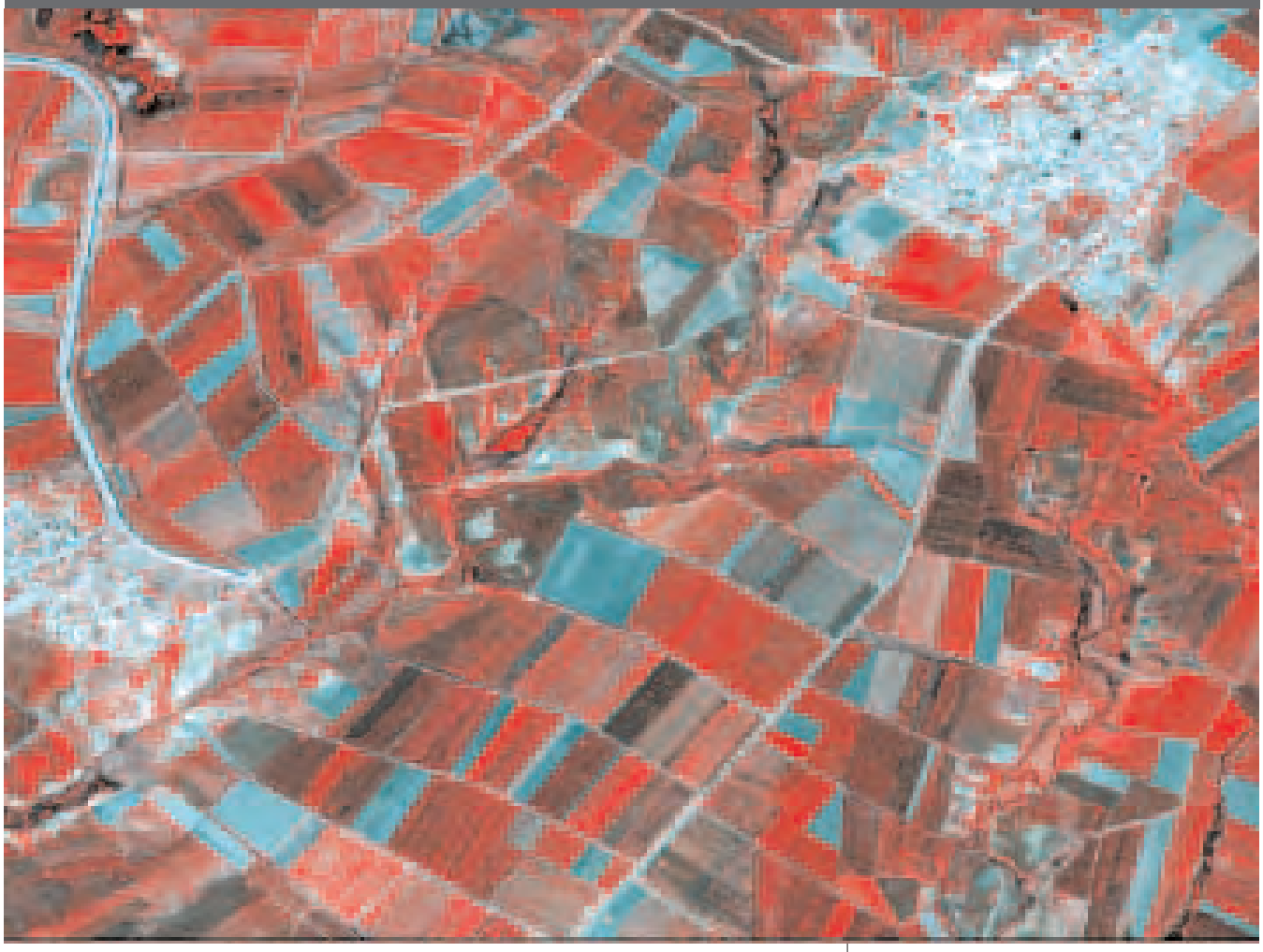
- Follow-up to Operation and Maintenance Workshop. This workshop provided additional training to automated weather station operators to assist in the improved operation of the equipment. The workshop additionally provided a forum for troubleshooting and resolving questions regarding the operation of the Automated Weather Stations.

The final step of the Agro-Meteorological program was the procurement and installation of 19 Automatic Weather Stations, which are modern data collection instruments that enable researchers to record information relevant to agricultural planning, including air temperature, relative humidity, precipitation, solar radiation, wind speed, and soil temperature. These weather stations will be integrated into the existing network to improve data collection capabilities. Three of the stations were installed in the drainage pilot areas of Al Wahda, Al Dujailah, and Al Raied. Five stations are part of a prototype network in Samawa because that area represents the conditions of the southern zone Iraqi irrigated areas. Five stations were installed in Erbil (Erbil Prototype Network), to complement other ARDI on-farm irrigation activities such the installation of drip and center pivot irrigation systems and associated training on irrigation management. The remaining six weather stations were distributed to the other stakeholders, keeping in mind that all of them are part of the National Agro-meteorological Network.

The prototype networks provide a model of an automated data acquisition network that will generate products to support agricultural management decision making, including irrigation scheduling. The lack of experience in Iraq with this technology is a substantial hindrance to effectively utilizing automated meteorological equipment and electronic data processing. The proposed networks are scalable and would provide a model for evaluation and potential expansion into a national agro-meteorological program. The prototype networks would demonstrate many automated capabilities necessary for efficient irrigation scheduling including:

- Real-time data acquisition;
- Improved data quality checking;
- Localized agro-meteorological analysis;
- Centralized electronic data processing and automated network operation;
- Electronic data access and sharing between users;
- Timely dissemination of advisory products.

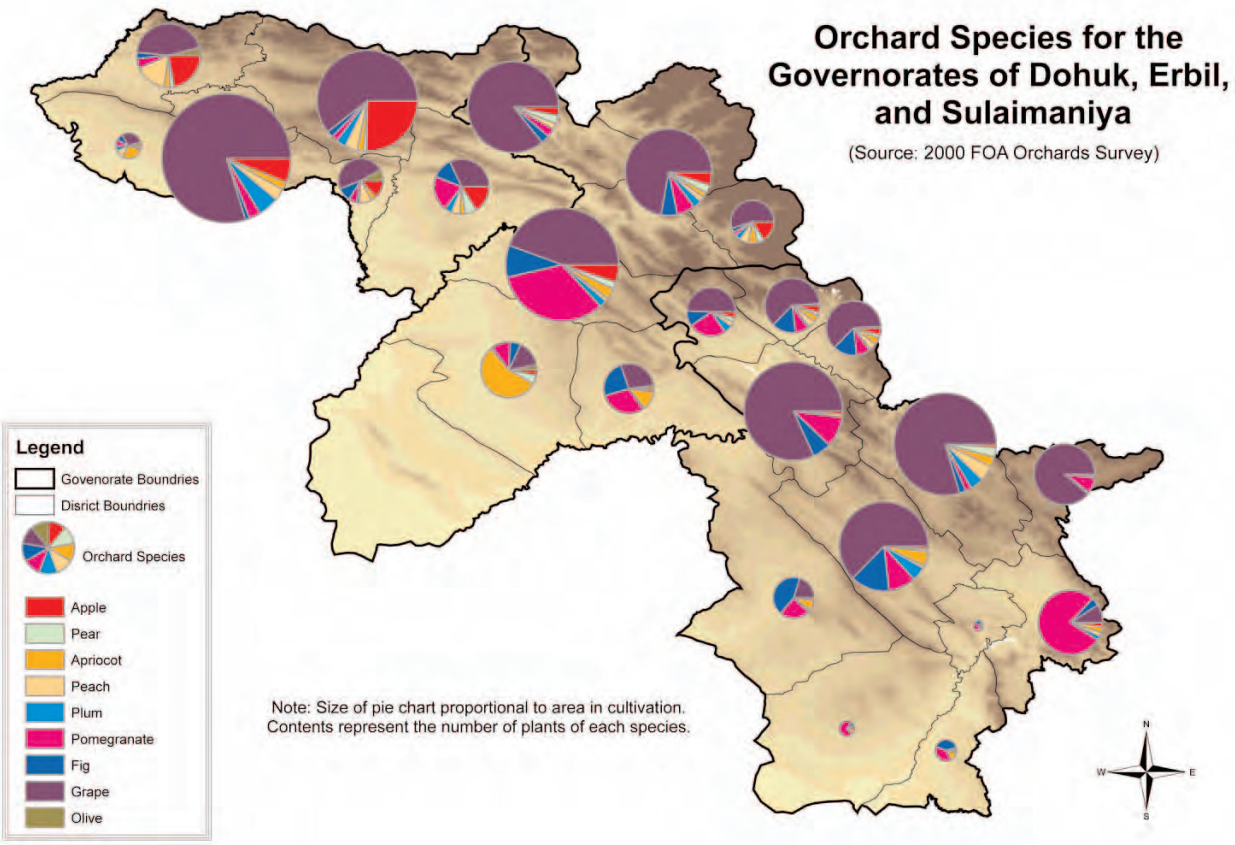
MAPPING AGRO-ECOLOGICAL ZONES



An enhanced photometric graphic used in remote sensing applications.

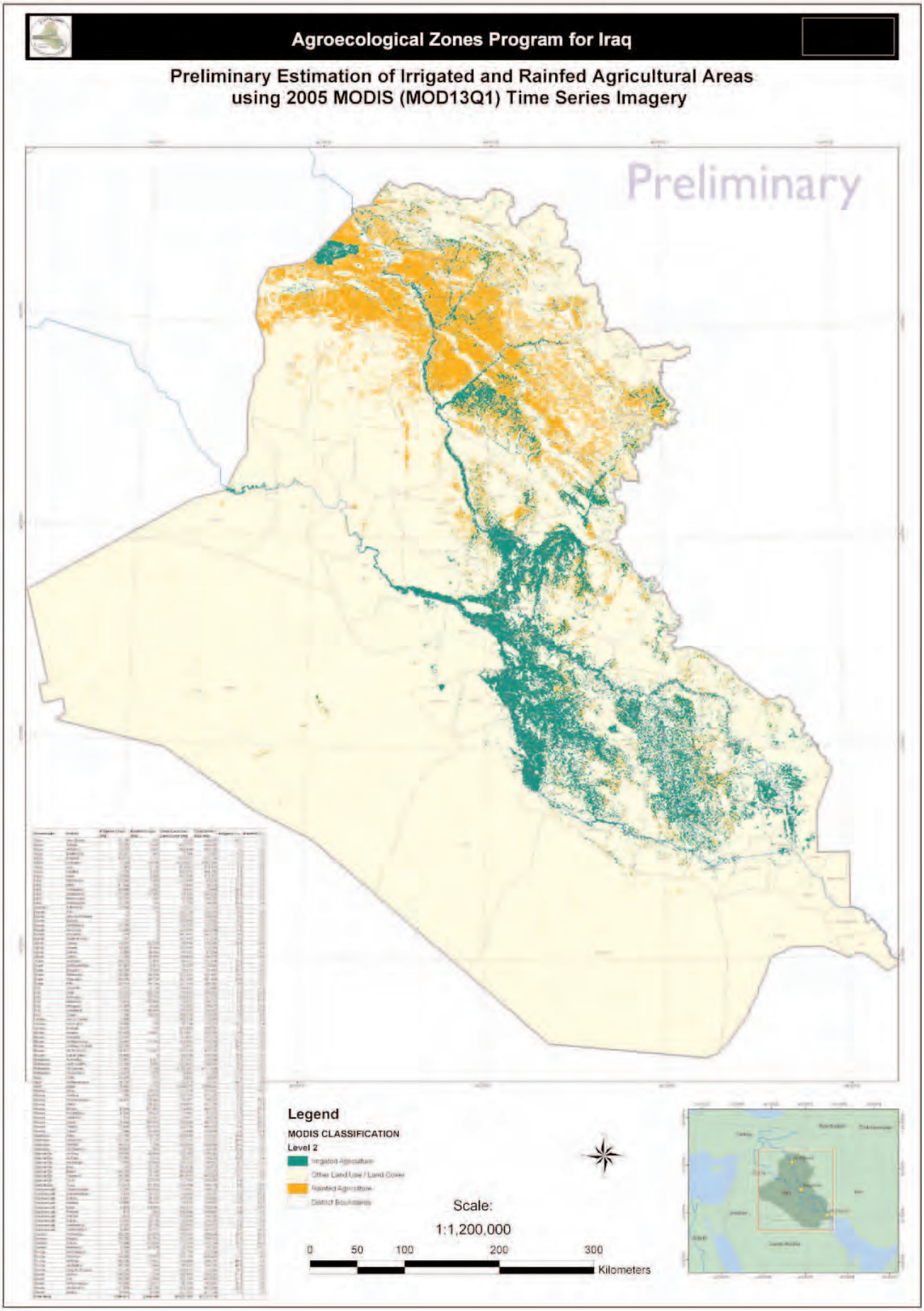
In order to maximize its capacity to assess the health of the agricultural sector and plan and allocate assistance resources to support that sector, the Government of Iraq (GOI) must utilize advanced technologies such as remote sensing and Geographical Information Systems (GIS) for data collection, presentation and analysis. The GOI has initiated a new program for Agro-Ecological Zone (AEZ) mapping, which utilizes these technologies for the collection and manipulation of data relevant to agricultural production. The program is an interministerial effort involving the Ministries of Agriculture, Water Resources, Planning, and Transportation.

The Ministries are in possession of satellite imagery showing areas of agricultural production in Iraq. Two pilot areas have been selected for initial program activities (Al-Jezzira and Middle Tigris areas). Using AEZ technology, this satellite imagery is combined with such inputs of raw data as soil, climate, and socio-



economic data to generate multilayered views, or maps, that illustrate ecological conditions, land use, and other factors that impact agricultural productivity. This information is valuable for agricultural planners, who can use the data to make assessments of the agricultural sector in Iraq, including crop suitability for different agro-ecological zones; water management and use; and water and soil requirements for different crops. These types of assessments will help the Ministry of Agriculture allocate assistance resources and design effective support for farmers, including advising on proper cultivation methods and other practices to help farmers maximize yields and income from agricultural production.

ARDI cooperated with the Ministries to provide support for the Agro-Ecological Zone program, including an advanced AEZ training facility, located in Erbil, equipped with both laboratory and classroom space, along with the hardware and software necessary to create AEZ maps. Ministry and private sector personnel received extensive on-the-job training in all aspects of data treatment to prepare Ministry officials to implement the program and give basic technical expertise to the private sector for civil applications. A team of AEZ professionals, including staff from the GOI and ARDI, worked full-time for over a year at the MOA/ARDI AEZ facilities in Erbil, and a second facility in Baghdad, to create AEZ models and collect the necessary data to produce land use and crop suitability maps.


Agroecological Zones Program for Iraq
Preliminary Estimation of Irrigated and Rainfed Agricultural Areas
using 2005 MODIS (MOD13Q1) Time Series Imagery
Preliminary
Legend
MODIS CLASSIFICATION
Level 2
Irrigated Agriculture
Other Land Use / Land Cover
Rainfed Agriculture
District Boundaries
Scale:
1:1,200,000
0
50
100
200
300
Kilometers

DATA COLLECTION

Systematic and detailed data collection is the basis for an agro-ecological zone mapping program. The extent of AEZ characterization analyses and modeling activities depends on the availability and quality of data collected. The MOA/ARDI AEZ program data collection activities were organized by data production lines corresponding to: climate data, water resources, soils and terrain, land utilization types and farm cropping systems, agricultural statistics, crop parameterization, additional GIS data, and remote sensing data. Each data production line was the responsibility of one or more of the individual AEZ program personnel designated to work in AEZ facilities in Erbil and Baghdad.

AEZ personnel assigned to do this work coordinated these activities with senior level officials at the Ministries that are members of the AEZ Technical Committee. Data obtained by the project constituted the input for the development of AEZ data management tools and database development. These data were complemented with more detailed information to be provided by the MOA and obtained from the field.

Two key components of data collection are land usage and crop modeling. Land usage evaluation is a primary tool to determine if a particular region or area is suitable for growing one or more crops based on land characteristics, climate, and socioeconomic activity. An ARDI land usage specialist worked with the AEZ team to determine the types of information required for the AEZ database, and strategies for collecting that information at the village level, within the current security environment.

Once an area has been deemed suitable for growing a crop, models can be used to simulate or "predict" yield as a function of local weather and soil conditions and crop management regimes. Under the guidance of a crop modeling specialist, AEZ staff created crop requirement tables for five major crops, and began developing calendars that show the cultivation cycle for those crops in the two pilot agro-ecological zones: the Middle Tigris region and the Al-Jezzira region.

With the conclusion of ARDI assistance, the MOA AEZ program has assumed responsibility for the continued development and application of the system, and taken possession of all equipment, satellite imagery, and software necessary to continue the work of the project in Baghdad. Information generated by the system will assist the MOA in the development of agricultural policies that reflect the emerging demands of government and private sector actors in a vibrant agricultural economy.

Upon the conclusion of ARDI, all of the equipment in the AEZ training facility in Erbil was transferred to a purpose built facility of the MOA in Baghdad.

3.2 CADASTRAL MAPPING AND LAND ADMINISTRATION PROJECT: SECURITY OF TENURE

BACKGROUND

Clear definition of land occupancy and use is important for the success of the emerging private agriculture sector in Iraq. At present, most agricultural land in Iraq is government-owned, and these areas are under long-term leases the terms of which generally parallel the kind of tenure found in the West. The leases are established under laws that govern the registration of use rights, inherited rights, and the right, in rare cases, to rent out the lands to others. Thus, Iraqi cadastral maps and registration records maintain, and update, much the same information as western-style plat maps and title or deed records.

Initially (in 2003), the general belief [1] was that Iraq had "no land system." This was

[1] Material from the World Bank and the U.N. indicated that there was no land administration system in Iraq.

*A **cadastre** is a public record, survey, or map of the boundaries, extent, and occupancy of land, and related details. In the West, such records are used as a basis for planning, transfers, and taxation. In Iraq, the first two uses also apply. Cadastral mapping, therefore, is required for (and complementary to) accurate records of land use and occupation throughout a country or other political unit.*

markedly untrue. Iraq has had, in one form or another, a system of land-records and administration for hundreds of years. Since 1958, two central GOI directorates in Baghdad in fact have been responsible for registering and maintaining all records of a cadastral nature. Directorates at the governorate level also maintain the records for their own territories.

HISTORY OF LAND SYSTEMS IN IRAQ

ANCIENT REGIMES

The Egyptians, Persians, and Arabs developed sophisticated mathematical systems that included linear and square measurements of territory. References to these can also be found in the Bible and the Koran. A 9th century Arab mathematician, Shuqr n Ibn Ali, specialized in calculation and the science of inheritance, and wrote a book on the partitioning of successions, which included means for measuring land extent. Linear measurement terms such as "digit" and "cubit" may be familiar today, "remen," "kos," and "zebo" less so. The Persian/Arab/Indian empire had a system of land-area recording and land tax collection called "tehsil," a word which has echoes in the later Iraqi-Arabic term "tesswiya".

THE OTTOMAN EMPIRE

During the Ottoman Empire, the Turkish system of land recording was established in Iraq. It essentially registered private ownership of land by recording land in the names of male heads of household. All owners were issued deeds, called tapus, for each parcel they owned. Thus, the Ottoman Empire established a head-of-household-based land-recording system. The records were used both for taxation and to register transfers, whether by sale or inheritance.

***Adjudication**: the legal process of establishing boundaries, occupancy, and/or use for areas or parcels of land. Generally done through a general court or special lands commission which judges, or "adjudicates" the status of the lands under question.*

BRITISH RULE / IRAQI MONARCHY

The British trained many map makers and surveyors, and from 1932 to 1938 mapped, surveyed, and adjudicated approximately 90% of Iraq, excepting tribal and desert areas over which they had no control, and which were too dangerous to enter. It was during this time that a parcel-based system was introduced with, normally, one 1:10,000 cadastral map per section.[2] Many of the maps created during this era are still in use and being updated into the 21st century. They were supplemented by handwritten registries, also continuously updated.

1958 BA'ATHIST REVOLUTION

The Ba'athists overthrew the monarchy in 1958, and established, under Law 117-1958, an Agrarian Reform on the model of Nasser's 1952 reforms in Egypt. Much agricultural land became the property of the state. (Certain properties, including residential and urban properties, remained in private ownership, and tapus continued to be issued and updated for the private properties by the Ministry of Justice [MOJ]. Privately held agricultural land was limited to 1500 donums per owner.

Government (or publicly owned) agricultural lands came under the

[2] Iraq is divided into 18 governorates. subdivisions of governorates are as follows: districts, sub-districts, sections.

administration of the State Board for Agricultural Lands (SBAL), one of eleven directorates of the Ministry of Agriculture in Baghdad. Agricultural lands were distributed in two ways. Poor farmers and villages received rent-free distributions. Individual farmers received up to 50 donums or 12.5 hectares. Groups or villages that held the land in common received approximately 120 donums, or 30 hectares per 10 farmers. Distributions to wealthier farmers or villages were made on a lease basis. The Government continued to own the lands but permitted long-term occupation, as long as the land was being properly used. However, these distributions and leaseholds had many characteristics of ownership as long as the land was used properly and rent (where applicable) was paid, the distributions were transferable on petition to the SBAL, had limited subdivision rights, and had inheritance rights. Limited subletting was allowed with permission from the SBAL. These and all other changes in the status of state-owned land were subject to approval by the SBAL office in the area in which the change was requested, with a final decision rendered by the SBAL in Baghdad. The particulars of these distributed holdings were maintained, as before the Reform, in record books, and also on the handdrawn 1:10,000 cadastral maps archived by the SBAL in Baghdad. Copies of these maps were held in the land offices of the Agricultural Directorates of every Governorate and in local land offices. The SBAL also participated in other activities, such as settlement of disputes over rights, and easements.

1970: THE RECLAMATION PROGRAM

New legislation in 1970 decreed that all further distributions of agricultural land would be made as leaseholds. There was very little, if any, rainfed agricultural land available for distribution, and the country needed more agricultural production. A large-scale reclamation program began. Generally, this meant building canals and other irrigation infrastructure to make these areas arable as irrigated (as opposed to rainfed) agricultural property. These leasehold distributions had, subject to approval by the SBAL, the same characteristics as older distributions. They were transferable, had limited subdivision rights, and had inheritance rights. Payments from land leases were a significant source of revenue for the Government.

1990-2003

By the early 1990s, the SBAL was backing up many of its paper records on microfilm, using equipment housed in its Baghdad offices.

New restrictions on the areas of leaseholds were set by the Presidential Council in 1997. They were designed to limit the amounts of the more valuable land that any one individual or group could hold. For instance, middle Euphrates rice land is among the most valuable, and therefore has the lowest allotments. The restrictions are shown in Table 82.

During the "Embargo" period of 1990-2003, when sanctions began having a serious effect on agricultural production, the GOI began a new program, giving land allotments free of rent for five years. The requirement for these free distributions was that the new landholders grow certain crops that had been embargoed. After five years, these allocations could become permanent leaseholds, if the possessor agreed then to pay the rent allocated for that type

TABLE 82 RESTRICTIONS ON AREAS OF LEASEHOLDS

	Individual Lessee	Corporate (group) lessee	Amount of rental per donum before 2005 *
Riverside Land	1,000 donums	2,000 donums	1,000 dinar
Irrigated Lands (with drainage and all services)	2,000 donums	4,000 donums	800 dinar
Semi-reclaimed Lands (soil canals)	4,000 donums	8,000 donums	600 dinar
Unreclaimed Land (old irrigation systems)			500 dinar
Rain-Fed Lands, guaranteed 400 mm/year	10,000 donums	20,000 donums	500 dinar
Rain-Fed Lands, semi-guaranteed under 400 mm/year	10,000 donums	20,000 donums	300 dinar
Rain-Fed Lands, unguaranteed (planting every 2-3 years)	10,000 donums	20,000 donums	100 dinar
Desert Areas	30,000 donums	70,000 donums	----
2.5 donums = 1 hectare			
* These amounts are as of March, 2004. Rental rates were raised in 2005			

of land. When reviewing these allocations during the database activities in 2006, the project discovered that every one of these allocations had been successfully planted, and had become full leaseholds. [3]

In 2004, the computer department of the SBAL in Baghdad began entering all agricultural land information into an Access® database. Prior to this activity, no one in the MOA had any acquaintance with computer based work. In 2005, the database effort switched from Access® software to Excel®.

AFTERMATH OF THE AMERICAN INVASION

After the overthrow of the Ba'ath government, there was much destruction and looting of government property. The Baghdad SBAL suffered damage to its archived records and loss of equipment, including its microfilm processing equipment. The microfilm itself was rescued and hidden in the home of one of the staff members. The project proposed providing another layer of security for the records by continuing and expanding them in digital format.

ARDI BECOMES INVOLVED IN LAND ISSUES

SPRING AND SUMMER, 2004

ARDI's Land Administration project director visited the Baghdad SBAL in April, 2004. There he met the Director General of the SBAL and other senior staff people, who were welcoming and eager to discuss the nature of their work. The senior members of the SBAL all had 30 or more years of experience. For several days, this group discussed the history of lands records and land tenure in Iraq, its current situation, and the meaning of various terms.[4]

The SBAL staff showed the ARDI project director their 1:10,000 maps and record books. He photocopied sample records to study them, and saw that

[3] In 1995, when it was recognized that the sanctions were having serious effects on the health of Iraqis, the so-called "Oil for Food" program was established. This permitted the import of grain, cooking oil, and other essentials from abroad. It also allowed purchase of agricultural equipment which, however, was not utilized or installed until after the American invasion.

Old cadastral maps.

entries had been made up until the March 2003 invasion and subsequent looting. There was no question that a good record system for public agricultural lands had been in place for generations, and further that the staff people maintaining them were highly trained, capable, and committed to their work.

Project personnel then visited district SBAL offices in the Baghdad governorate, as well as the Babil (Babylon) governorate SBLA office in Hilla District, and saw similar records and maps. Later they viewed such records in various governorate, district, and section offices.

By late 2004, ARDI personnel had reached a decision to scan all available maps, some of them 70 years old, and to obtain supporting information with newly introduced GPS equipment. Other decisions about technological assistance followed. The project began to introduce existing surveyors to GPS technology, leading to a field day in July 2004, when 40 surveyors were introduced to the technology in Rashdiya, Baghdad governorate.

FALL 2004

The decision was made to scan the maps available from the SBAL and MOJ. This was not implemented until October, 2005 (see below). Security in Baghdad became a critical consideration, and ARDI personnel could no longer travel outside their guarded compound. SBAL personnel instead visited with ARDI staff members in neutral safe houses for continued consultation. The project purchased 23 computers along with internet access and office furniture help the SBAL with the proposed effort to enter their records into database format.

The entire cooperation had to be interrupted when ARDI personnel were abruptly removed to Erbil, Kurdistan. Furthermore, because of the deteriorated situation and inability to conduct field work, the Project Coordinator was not asked to return for further work until a year later, in October 2005.

[4]This concerned in particular, the term 'tesswiya'. Once the project director understood that this term meant "adjudication," that is, the process of deciding and labeling land occupancy and usage rights, it became clear that an entire, well-organized land system was in place in Iraq. because there is no point in adjudicating land unless there is an organized legal structure for land management.

OCTOBER-DECEMBER 2005

The SBAL made a formal request the ARDI support more field work by their surveyors. The component head was then asked to return to Erbil and assess the likelihood of continuing the work that had been discussed in 2004.

The Director General of the SBAL and other senior government staff began to visit and consult with the Director of the Lands Project in Erbil. In addition, delegates from the Baghdad offices of the Ministry of Water Resources (MOWR), the MOA and MOJ came to Erbil for meetings to set up a formal committee to run active field work, and to establish policies for a continuing program. It was agreed that the SBAL's records for agricultural land would be available to the project, and any further field work in all 18 governorates would be handled by the SBAL. A pilot survey training area was designated in a wheat growing village, Jezhnikhan Effendi, north of Erbil. In addition to this area, the project hoped to start two other pilot surveying areas, one in Baghdad governorate and another in Basra but security issues prevented use of these two as pilot areas.

The project purchased 10 new Dell® desktops and Xion® drives for the renewed effort. All were supplied to the Baghdad SBAL office, so that it could move more quickly to enter the land records into the database. At the start, few of the people entering data were computer literate. All learned quickly after some training and are now fully capable.

ARDI purchased two large format HP plotter/scanners and the necessary software. A short-term outside expert assisted the project in setting up the Training House offices. He also provided a sample map with coordinates in place. Project staff again met with officials from MOWR and SBAL, and helped confirm the direction of the overall project. In addition, the local project manager, along with an outside employee, designed a database for the land administration system, on the model provided in ARC-GIS 2014®. The SBAL provided, or obtained, the required data from 11 of 18 Governorates.

An extremely important item in the map database will be the eventual introduction of Unique Parcel Registration Numbers (UPRNs), permitting each separate parcel to have its own identification. The UPRN will also serve as an instant cross-reference between the cadastral maps and the agricultural and private land records database. All governorates, districts, subdistricts, and sections already have assigned numbers, though some of these are inconsistent. The project expected to regularize the numbering of the first four UPRN categories, and also to assign numbers to all the parcels once they were available on the digitized maps (see Table 83).

It is proposed, for the future, that when a parcel is subdivided, the old parcel number be struck from the record (but retained in another section for reference) and new numbers be assigned to each new parcel.

[5] The three northern governorates, Erbil, Dahuk, and Sulaymaniyah, constitute the semi-autonomous Kurdish region of Iraq, but these three have had two Ministries of Agriculture: one in Erbil which also covered Dahuk, and another for Sulaymaniyah. Further, there are political divisions within the three Kurdish governorates which have influenced varying levels of cooperation with the project. Thus, for some time, the project has had good cooperation with the Sulaymaniyah MOA, but none with the Erbil MOA. This changed in the summer of 2006 when the Kurdish MOAs were consolidated into one in Erbil, and the new Minister there ordered full cooperation.

TABLE 83 A SAMPLE UNIQUE PARCEL REGISTRATION NUMBER (UPRN): 01-10-21-156-12345

1	10	21	156	1234 (or as many digits as necessary)
Governorate Number	10th District within Governorate	21st Subdistrict within District	156th Section within Subdistrict	1234th Parcel No. within the Section (these are yet to be assigned)

PROPOSED SYSTEM FOR REGISTERING PARCEL SUBDIVISION: A SAMPLE CASE

Ali Mohammed leases and farms parcel number 07-01-76-543-21. The number -21 represents his parcel; all the preceding numbers indicate the parcel's location (governorate-district-subdistrict-section). Ali Mohammed has three children, Ibrahim Ali, Saida Ali, and Ahmed Ali. The father wishes to divide his parcel into three parts, and transfer them to his children. He appeals to the SBAL of his district which approves his request for subdivision. The boundaries and new possessors (or lessees) of the three new parcels are entered into the lease registration database, in both the governorate and the central Baghdad computers. The new parcel information is also indicated on the appropriate cadastral map and its database. The old parcel number, -21, is retired from the records. The "543" section has 274 parcels already on the record. The three new parcels are numbered following the last parcel number in the record, as follows: Ibrahim Ali, -275; Saida Ali, -276; and Ahmed Ali, -277.

During a visit to Erbil by the Director General of the SBAL and others in December 2005, the group made its first contact with the Director General of Lands in the Erbil Ministry of Agriculture. Together, they looked at one of Erbil's cadastral maps and agreed to a surveying field trip to Jezhnikan Effendi. The group also explained the ARDI Lands project to the DG and her staff. They, however chose not to cooperate with the project, insisting that Kurdish data had to be handled separately from all other Iraqi data. Not until the three Kurdish Ministries of Agriculture were consolidated in August 2006, was cooperation possible with the Erbil MOA's Lands staff.

JANUARY-FEBRUARY 2006 SHAKLAWA MEETING

In the early months of 2006, an important breakthrough occurred. The project held a workshop for about 40 people from the SBAL offices in Baghdad, including the Director General, representatives from the Surveys Department of the MOWR, the Land Registry Office of the MOJ, and others. Members of the directorates of the Erbil and Sulaymaniyah Ministries also attended. At the meeting, the plans for databasing records and scanning maps were presented and discussed.

Following this, cooperation increased, especially in the form of offers to send or bring maps from all over Iraq to Erbil for processing. The Director General of the Tapu Office of the Baghdad MOJ assisted the scanning effort with many of the "sleeping tapus,"—old maps—from the MOJ archives, without fee, in exchange for copies of the scanned maps on CD. A new Director General of the Survey Department of the MOWR offered to continue cooperation, but wanted to

receive payment for inputs to the project. The personal advisor to the MOJ Minister intervened on behalf of the ARDI project, but it became evident that the project already had a more extensive collection of maps than MOWR. This incident led to a termination of cooperation with the MOJ. Because of the full cooperation received from the SBAL and MOJ, the project now has the only nearly complete set of cadastral maps in Iraq.

The project manager and coordinator visited Sulaymaniyah, where the governorate's Director General of Lands promised full support, asking for training for his personnel in the database and map scanning components of the project, and offering to share his department's maps and data. At this point, the MOA of Erbil did not wish to cooperate with the project (see footnote 4).

The project people learned that the Sulaymaniyah directorate had begun, on its own, to adjudicate the Mt. Azimar area south of their city (see "British Rule/Monarchy" section). These lands had not been previously adjudicated. The Directorate has been recognizing occupiers and issuing lease contracts to them, (or, in some cases, recognizing them as outright owners when they had held the land since before the 1958 Agrarian Reform). In this respect, Sulaymaniyah has made moves that anticipated the long-term goal of the present GOI: security of tenure for all land holdings. In any case, these adjudications have helped avoid a number of disputes that had been threatening.

MARCH 2006

GIS training efforts began at this time. (See details under the section on training.) The project also did a test scan of the SBAL's microfilmed records, which was successful. A plan to digitize all the microfilmed records came to nothing, however, because the Minister of Agriculture in Baghdad could not locate a safe way to duplicate the microfilm in Baghdad, and for security reasons was unwilling to ship its only copies elsewhere.

By late March, there was a steady stream of people visiting Erbil from Baghdad and Sulaymaniyah to scan maps. They also developed an index of all the maps that had been scanned.

MAY, 2006, PROGRESS APACE

The Sulaymaniyah MOA's Director General brought himself and 4 staff members to Erbil in May for a two-day training and observation session. They brought with them 600 of their cadastral maps, many fragile, to be scanned. Two of these staffers learned map scanning (and scanned half of their own maps), and map index making. Two others learned database entry. They have continued entering Sulaymaniyah data into the database at the Training House office. At the time, they were the first of the three northern (Kurdish) governorates to have actively cooperated with the project.

May also saw a 12-day GIS/GPS training program held in Erbil, at which 8 staff members from Baghdad and 2 from Sulaymaniyah MOA learned the basics of georeferencing, digitalizing, and editing scanned maps. Additional field surveying at the pilot site in Jezhnikan Effendi backed up the work done in the lab setting.

Finally, May was the month when the project took on an important new

Coordinator. The newly retired Director General of the Baghdad MOA became the formal Baghdad-based Project Coordinator, responsible for cooperative efforts with the Tapu Office of the MOJ, with the Ministry of Water Resources (MOWR), and with the various governorate MOA offices. In particular, he visited areas of Iraq which were unsafe for project personnel, in order to seek hosts for field surveys, etc.

JUNE, JULY, AND AUGUST 2006

Approximately ten thousand (10,000) maps have been scanned, and 110,000 records of agricultural land holdings entered. Maps from Erbil and Dahuk remain to be scanned. In addition, tapu (private holding) information from the Land Registry of the MOJ will be databased at a later date. By the end of August 2006, the vectorization process was proceeding. This involves matching (layering) sections of the scanned maps to the same section coordinates in 8,500 5-meter satellite images, creating a third, completely searchable, version.

ADMINISTRATIVE BACKGROUND: GOI MINISTRIES WHICH COOPERATED WITH THE LANDS PROJECT

THE STATE BOARD FOR AGRICULTURAL LANDS: STATE-OWNED AGRICULTURAL LAND

Iraq's central Ministry of Agriculture (MOA) houses the SBAL, responsible for maintaining a system of land administration in order to enforce the laws related to state-owned agricultural land.

ARDI's Land Administration project has been working with both the Baghdad SBAL and the MOJ's Land Registry (Tapu Office, see below) to update Iraq's land administration system and create secure, digital land registration records. Until this effort began, the SBAL had kept registry (leasehold) records and their handdrawn cadastral maps on paper with microfilm backup. Many paper records and all the microfilm equipment were damaged or looted in 2003. Restoring and recording all data in digital form is essential to allow the Government to meet contractual agreements, register occupants' rights, allocate land for state projects, provide documentation for legal disputes, monitor payments for leases of state land, and conserve historic sites in accordance with existing law.

Further into the future, this standardized, parcel-based registration system will provide the records and stability necessary should the GOI choose to move toward a system of private agricultural land ownership.

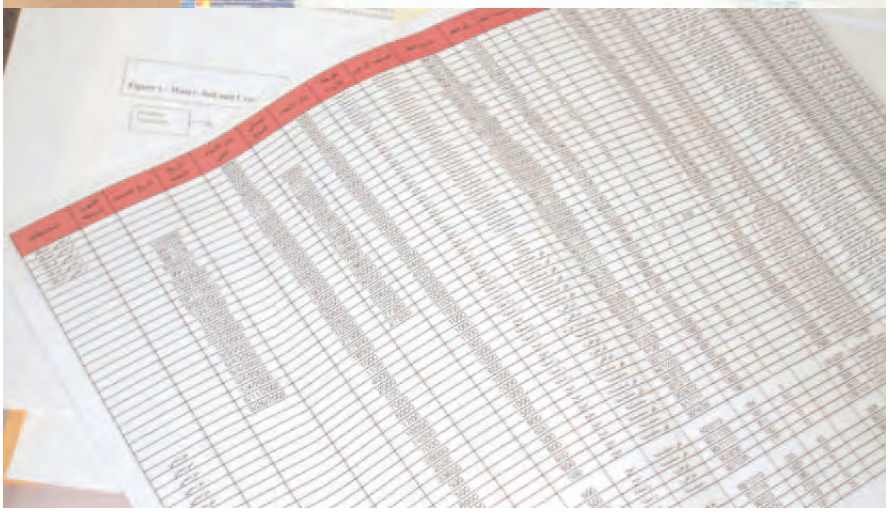
THE LAND REGISTRY (TAPU) DIRECTORATE: PRIVATELY-OWNED LAND

Since the 19th century, the Ottoman system of privately owned land has involved issuing and registering tapus, or deeds. The Land Registry Directorate, housed in the Ministry of Justice (MOJ), administers the tapu system. Like the registry books for state-owned land, the tapus are on paper, and not secure. Eventually, tapu information will also be digitized, and the Land Registry Directorate will continue to hold official, paper copies of tapus while the electronic records will be held by the SBAL in Baghdad. The database format for private land entries will be identical to that for agricultural lands, and indeed tapus will eventually be issued for agricultural lands as well. Part of the need for a security system for the

entire database results from the fact that the MOJ will access its records from the same computer files as the SBAL's records.

MINISTRY OF WATER RESOURCES: SURVEYING DEPARTMENT

The Survey Department of the Ministry of Water Resources (MOWR) keeps a complete "bank" of cadastral and survey maps. Initially, they promised to share these with the project. However, when the project requested access to the



MOA personnel from Baghdad entering State Land information into the Excel® database. Each computer case contains a massive Xion® drive used to store the data and work with the high-powered GIS software. Right: a page of the database. The database columns are (right to left) : Entry number / sector / relevant law or regulation / name of renter / district / plot number / area unit ("olek") / area of plot / lease number / initial date of lease / category of land (e.g., irrigated, rainfed, etc) / irrigation process if any / rate of rent per unit / total owed per annum / total paid over the life of the lease / date of lease renewal / date of rent payment / previous rental arrears / further notes (e.g. seasonal; railroad easement; within municipal boundaries, etc).

material, the Survey Department chose to ask for payment. Consequently, other resources were used. The MOWR did send personnel to various project meetings, but cooperation fell off after the demand for payments.

CREATING DIGITIZED INFORMATION FOR STATE LAND: THE DATABASE

Information about leases of agricultural land at the SBAL, and ownership of private land at the MOJ, were kept by hand and the historical paper records were kept on microfilm. During the looting in 2003 many records were damaged, and the microfilm equipment stolen. The microfilm itself was rescued by a staff member who kept it in his home.

While the SBAL in Baghdad begun some work to place its records in database format, the effort was redirected in 2005. The database categories were refined, and the SBAL began to reenter all their public land records into Excel®. To date, more than 109,000 records from 12 governorates (11 in Iraq proper, and one in Kurdistani Iraq) have been recorded in this database, representing records through 2002. Newer records (following 2002) have been difficult to obtain, but will be gathered. This work will continue until SBAL (i.e., government held agricultural) land from all 15 southern governorates is entered and updated. Records from Sulaymaniyah began to be entered in March of 2006. (The records from the other two northern [Kurdish] governorates, Erbil, and Dahuk, were not obtained until August of 2006, and are being handled post project by the Erbil MOA.) Following completion of the entries, the database will be continually updated as leases change, transfers are made, and so forth.

Security is a significant issue in this process. Procedures have been worked out to create rules about access to the registration material, to prevent unauthorized access and alteration of the records. Initially, all the data will be held centrally, at the Baghdad office for the 15 southern governorates in Iraq. The three Kurdish governorates will most likely keep their own data from the beginning. Eventually, each governorate will have secure access to its own information. The security system was only in a "talking stage" at the termination of the project.

A final goal will be to create tapus for all the state-owned land. Normally, that would not be done, but for several reasons, we felt that tapus would be the best means of providing possessors with security. Tapus for agricultural land will indicate that the land is state-owned, but would be helpful if the GOI opts to go through a process of reform. The stage will be set to change ownership from "state" to the name of the person who is becoming owner. In the meantime, the tapus will show the legal status of possessors of the parcels, use of the land, its boundaries and extent, and other information. They will be a significant step in providing heightened security of tenure.

CREATING DIGITIZED INFORMATION FOR STATE LANDS: THE MAPS

Within the SBAL sits a technical department which oversees mapping activities, and has had an astounding record: for more than 70 years, a succession of dedicated mapmakers had been making, and maintaining by hand, competent maps of property in the country, accompanied by the handwritten books recording property lease holdings, revenue (e.g. rent and other payment) records, and transfers of leases to other parties. Such transfers were sometimes by inheritance, and sometimes made for consideration.

Most of the maps were indexed, also by hand. Certainly the map numbers and land records were cross-referenced. However, a good many of them were

Above: Preparing to scan an original map.

damaged by age, long use, or poor storage conditions. In any case, the system was still one based on predigital technology.

Discovering these maps, and the SBAL workers who had maintained them, was the first step to a digitized cadastral records system for the country. Without such maps, and the data they represent, there can be little or no modern organization of land records, or the stability and security of tenure that creates productive use of land.

Below: Repairing one of the original maps before scanning.

To accomplish the work, the project obtained satellite images at 5-meter resolution. We also obtained satellite images at 1-meter resolution, which were not used. They will be useful when urban areas are remapped, but are not needed for areas that are devoted primarily to agriculture.

Beyond that, the digitized versions of these maps will serve numerous aspects of development. The AEZ effort—the program to provide comprehensive data for agricultural planning—cannot go forward without digital mapping data. Indeed, the lands project serves the entire agricultural infrastructure rehabilitation program which is the ARDI program's core goal.

THE PROCESS

At the time of writing this report, approximately 10,000 maps representing more than a million parcels of agricultural and urban land have been scanned. This includes the maps from the SBAL and maps from other Governorates which are now being processed. The process of layering them with matching areas of the 5-meter satellite images of Iraq has begun. Furthermore, the land records data and other transfer records (at present approximately 109,000) which have been entered into Excel® format will be cross-referenced to the digitized maps. The procedure is as follows:

- Scan the original, handdrawn cadastral map.
- Locate two or more known coordinates on the scanned map (for instance, a fixed boundary, or a natural feature with coordinates well identified).
- Find corresponding coordinates on the relevant 5-meter resolution satellite image.
- Layer the two images: match features on the two maps, and find from the satellite image the boundaries of usage and other characteristics to be included on a third map layer.
- On the third layer, change vectors so that lines on the old map coincide with boundaries or chosen features on the satellite image.
- Vectorize: this is the creation of the edited third layer, essentially an editing of the old cadastral map to reflect features present in the newer satellite map. The digitized version has been created.
- Place individual parcels into proper coordinate areas.
- Features or parcel boundaries and extents on the digitized map will be checked for accuracy by surveyors in a field survey.
- Records are brought up to date and entered into the Excel® database of land records by preparing or updating a uniform registration record for each parcel, based on the field checks by the surveyors.
- Parcels are assigned numbers, permitting creation of the complete UPRN.
- The digitized maps and the database are linked; alterations of the map may be easily made to reflect changes in the database, and vice versa.

The digitized versions of these maps will serve the AEZ effort—the program to provide comprehensive data for agricultural planning—and therefore has direct and indirect impact on the entire agri-cultural-infrastructure rehabilitation program that is the ARDI Program's core goal.

A surveying field day. SBAL staff members hold 3 versions (original, scanned, digitized) of the map of the area which is being surveyed in order to check the map accuracy.

THE DATABASE

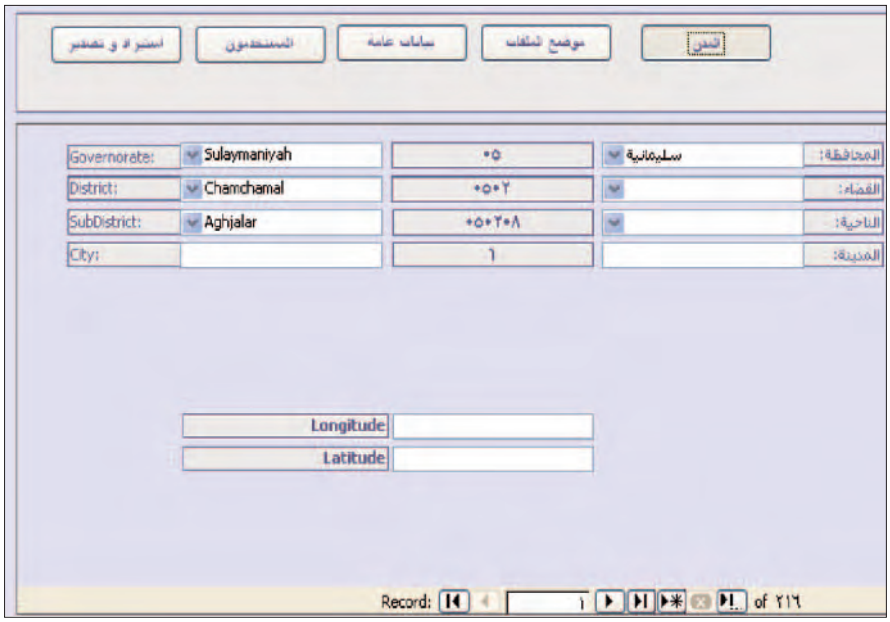
This form is used for entry of data. (see image at right)

The information entered is as follows:

- Governorates, districts, subdistricts and sections or villages in both Arabic and English.
- Location (link) for attached files (images and maps) relevant to this entry.
- General lookup data (land description, rights, irrigation method, etc.)
- Possessors: name(s) of users and their locations.
- Import and export: a function that collects data from other locations—exports entered data and imports the exported data.

DIRECT IMPACT

Every farmer in Iraq, whether a landowner or possessor, will benefit directly from having an accurate and legally binding delineation of property. Easily accessible, secure property records form the most important criterion for determining the rights to exploit that property. Therefore, the number of direct beneficiaries is equal to the number of farms (defined as a discrete parcel of agricultural land farmed by a single family or entity) in the country. The total number of farms in Iraq is estimated by the SBAL at 1.25 million.



Input screen for the cadastral database.

CAPACITY BUILDING AND TRAINING:

- Numerous staffers at the SBAL and Ministries in Sulaymaniyah and Erbil have become computer literate, especially in database skills.
- A full map scanning and vectorizing system, with trained personnel and equipment, will be left in Iraq, to be fully housed in the Baghdad SBAL offices when security permits. This will allow continuation of an extremely sophisticated land registration and management system in all 15 southern governorates. Similar equipment is being left at the Erbil and Sulaymaniyah MOA for management of the same system for the 3 northern (Kurdish) governorates.

Much on-the-job training went on at the Training Center in Erbil, especially in the realm of data entry. Thus, data entry people from Baghdad, Sulaymaniyah, Erbil, and other areas came to the Training House to learn the database structure and to enter the information from their own governorates' records. (The Baghdad material covered many governorates as well.) When the Sulaymaniyah Ministry sent their maps to be scanned, they also sent two of their personnel to learn both scanning (while scanning their own maps) and database management.

Formal training sessions at the Training House took place as well:

- Two GPS training courses
- Workshop, March 2006: Forty officials from the SBAL, the Land Registry Directorate, and the Survey Directorate came together to discuss the progress of the plans for the updated land administration system. Representatives from the SBAL, the primary users of cadastral maps, came from Baghdad, Sulaymaniyah, and Erbil. The project worked with the participants to create a common understanding of the future system and demonstrate prototype digital records. The participants also saw demonstrations of the GIS and GPS technology essential to modern cadastral mapping.

A surveying field day, used to check a newly vectorized map against an actual survey in the agricultural area represented on the map.

A surveying field day, used to check a newly vectorized map against an actual survey in the agricultural area represented on the map.

- Two-Week GIS Training Program, May 27 to June 8 2006: Eight trainees from SBAL in Baghdad joined 2 from Sulaymaniyah to learn to administer the digitized parcel-based land administration system. Five were men and 5 women. They learned to georeference, digitize maps, and edit the scanned maps. In addition, they did field work in Jezhnikhan Effendi, near Erbil, to learn to check map coordinates by surveying in the field.
- 30 surveyors have been trained in the latest GPS surveying technology. MOA offices at all levels, with few exceptions, have cooperated enthusiastically with this effort, and requested training for their personnel. Their expectations about the way to organize and use land information have changed accordingly.
- Training was given to scanner operators, especially in how to judge when to make color scans of particularly faded or damaged originals.

Perhaps as important as technical training has been the style in which instruction is delivered by our training staff. Used to receiving information passively, and passing it on authoritatively, our trainees are instead encouraged to interact with instructors. They learn quite specifically to ask questions of our trainers. They also learned to interact in an empowering, less authoritarian manner with those whom they will train. Above all, they learn to listen to the people affected by their policies, and to take that information into account in planning and policy making.

TABLE 85 TRAINING AND SUPERVISED ON-THE-JOB WORK

Data Entry Specialists, Baghdad, Training and long-term ongoing work	*Data Entry Specialists, Sulaymania, Training and short-term work*	Map Scanning Training and short-term work, Baghdad, Koysanjaq, Sulaymaniyah
2	2	18

TABLE 86 PROFESSIONALS FROM SBAL AND AGRICULTURAL DIRECTORATE, BAGHDAD

Orientation to Digital Cadastral Lands Project	*GIS Training*	*GPS training*
21	8	4

TABLE 87 PROFESSIONALS FROM OTHER GOVERNORATES WHO RECEIVED TRAINING

Professionals, Agricultural Directorate, Kwisinjak, GPS training	Professionals, Agric Directorate Babylon, GPS training	*Professionals Agric. Lands Directorate Qadissiya, GPS training*	*Professionals, Agric. Lands Directorate Wasit, GPS training*	*Professionals, Agric. Directorate Muthanna, GPS training*	*Professionals, Agric. Directorate Diyala, GPS training*
4	2	2	8	2	2

TABLE 88 PROFESSIONALS FROM OTHER GOVERNORATES WHO RECEIVED TRAINING

Professionals, Sulaymaniyah Agric. Lands Directorate, GPS / GIS training	Professionals, Sulaymaniyah Agric. Lands Directorate, GIS training	Professionals, Agric. Directorate Najaf, GPS training	Professionals, Agric. Directorate Kerbala, GPS training	Professionals, Agric. Directorate Kerbala, GPS training
19	2	2	3	3

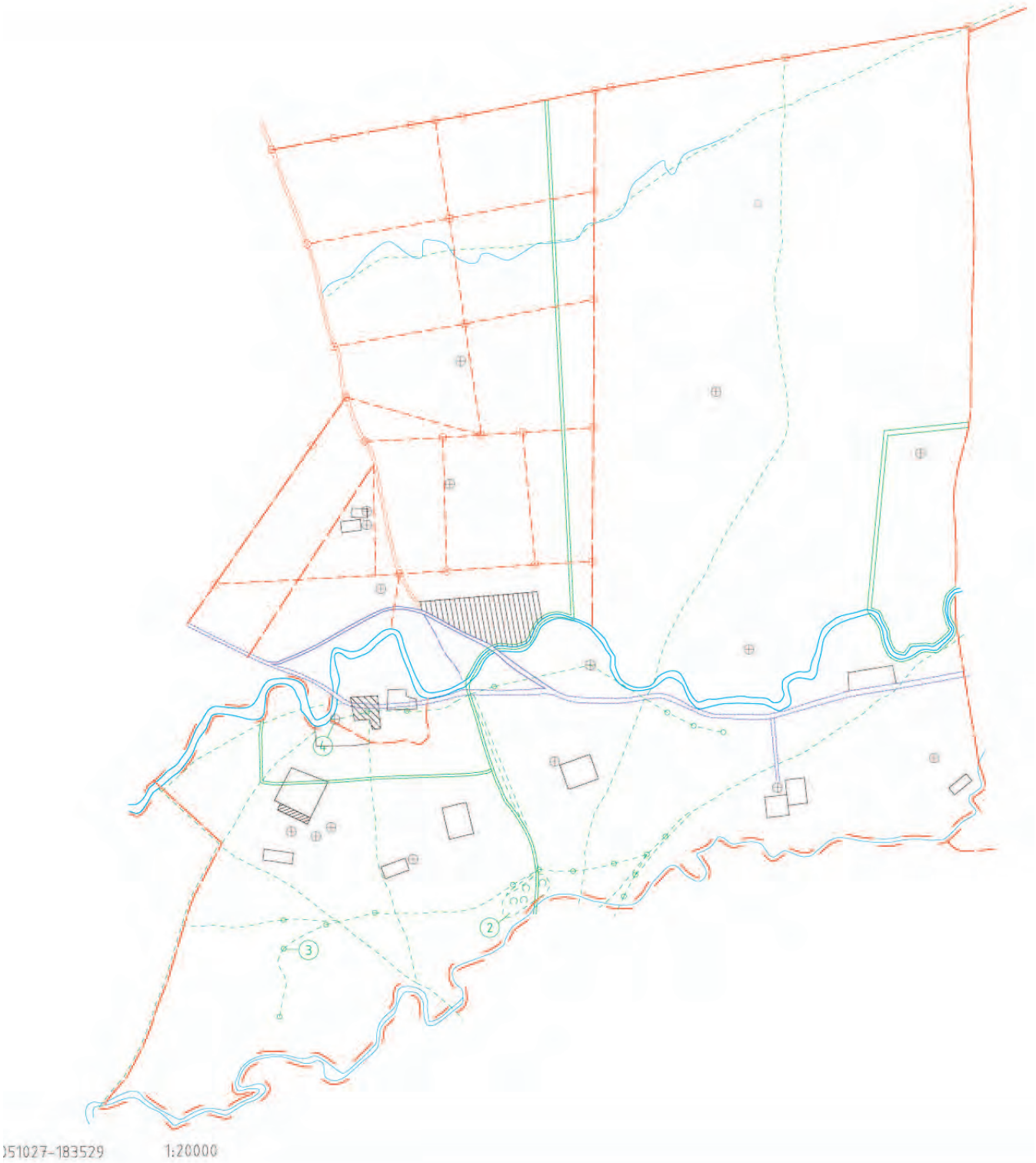
TABLE 89 PROJECT EMPLOYMENT OF IRAQIS

Long term: Project Coordinator	*Short term: Trainer*	*Short term: Programmer*
1	1	1

TABLE 90 TOTAL TRAINEES

Men	*Women*
42	19

Original, pre-digitized map.



Post-digitized map.

- **The most immediate impact** of this project is the restoration and modernization of Iraq's entire land records system. What follows is its use by all landowners, possessors of government land, and planners in government and other sectors. One of the Project's goals was to move toward issuance of tapus for all holdings, whether in possession or privately owned. Ultimately, should the GOI choose to permit direct ownership of agricultural land that is now under lease, it will be a simple matter to change distribution and lease records to reflect that.

- **Every farmer in Iraq,** whether an owner or possessor, will benefit directly from having a sound, accurately administered property registration system, with secure property rights. Therefore, the number of direct beneficiaries is equal to the number of farms (defined as a discrete parcel of agricultural land farmed by a single family or entity) in the country. The total number of such land holdings is estimated by the SBAL at 1.25 million.

- **Adjudication and dispute resolution:** A countrywide, secure, and trustworthy system of registration of property holdings is essential both for security of tenure and for resolution of disputes in the courts. It is also vital to the GOI as it collects revenue from leased agricultural land and tax from private holdings, as well as to conserve historic sites in accordance with the laws in place for those areas.

OTHER AREAS RELATED TO THE LANDS PROJECT

AGRO-ECOLOGICAL ZONE (AEZ) MAPPING

Agro-Ecological Zone mapping is essential to and involved in all aspects of agricultural planning. AEZ compiles, in map and database form, the information about agricultural potential in various parts of the country. The complete scanning and vectorizing of all Iraqi territory which this project accomplished provides a perfect 'base' for mapping of all kinds, including AEZ purposes. A data base which records the use and legal status of every parcel in Iraq also may be adapted to show such matters as soil quality, rotation needs, production per-hectare capacity, and many other kinds of information. Indeed, the existing distribution and lease lands database already provides information about rainfall and irrigation status for agricultural land; expanding that is a simple matter. Already within the project, the AEZ component shares scanners and other soft and hardware with the Lands component.

HIGH-VALUE CROPPING AND EFFICIENT WATER USE

For all the reasons outlined above, the need to make efficient use of the best land in Iraq is served by the Lands project's maps. Planning for irrigation and use of scarce water resources is essential to production of valuable crops, both for internal consumption and export.

STILL TO BE DONE: MAPS SCANNING

The scanning of the cadastral maps started by the SBAL in Baghdad is complete. They have completed the full set of maps for all of the 15 Governorates of Iraq proper. In addition, the full set of maps for Sulaymaniyah was completed by a

team provided by that Ministry of Agriculture when it was a separate entity in Kurdistan. The cadastral maps from the area of Kwisinjak was also completed by a team of individuals provided by the Agricultural Office in that subdistrict. Kwisinjak was treated separately because even though its geographical location was within in Erbil governorate, for political purposes it was allied with the political party giving allegiance to Sulaymaniyah, and therefore administered by that Ministry of Agriculture.

Scanning of the maps for Erbil and Dahuk governorates has not been started. However, members of the SBAL in Baghdad have agreed to assist by providing the cadastral maps of the two governorates for scanning at a time after the project terminates. It is not clear that it will happen, but the hope is that there will be follow-through and the maps will be moved from the source in Baghdad to the Ministry in Erbil, where one of the large map scanners will be located for the postproject.

DIGITIZING THE MAPS

While all available maps have been scanned, the process of vectorizing them—layering them with the 5-meter satellite images—is far from complete. Clearly, they will not be of use as a searchable tool until this job is done.

When notice was received that the project would be terminating, all activities were switched to the digitizing of the maps. Eight of the ten people who went through the GIS training returned to the Training House and worked with the trainer practicing the digitizing process.[7] They layered the scanned cadastral maps with the appropriate five-meter satellite images and created new boundaries on a third layer. It takes a lot of practice to be able to digitize properly. It can only be hoped that the team has had enough practice and will be able to continue on their own.

It was planned, of course, to work on the digitizing, together with the necessary follow-up in the field to check the social and other realities of each parcel, where necessary through the local surveyors. We never got to that stage.

SURVEYING

Random sample on-the-ground surveys must continue, in order to check accuracy of parcel coordinates entered into the database from Ministry records.

UPRNS

Since section mapping exists on all the existing handdrawn cadastral maps, the sections are now being vectorized. Individual parcels will be mappable following the vectorization, because finding coordinates for parcels will be a simple matter of entering the coordinates and "drawing" the parcel boundaries. Following this, district administrators will be able to assign parcel numbers, completing the UPRNs.

DATABASE

The database structure is virtually completed and ready for data to be entered into it. However, there are still many records that have not been prepared and

[7] One was in London pursuing an M, Sc, course and would be gone for approximately two years; and one had health problems and was unable to join us.

entered. There may be problems encountered on the more recent data, and the data from both Erbil and Dahuk have to be watched very closely. It is unclear that the members of SBAL or the teams from the Ministry in Erbil (and Sulaymaniyah) can handle the processing of the data in the database without continued assistance.

There are potential new categories of entries, or additional fields in those that have already been entered, which have not yet been encountered, yet since there have been many changes is Government policy recently. There would need to be changes added to the database when these new categories are encountered. The team members will have to deal with this on their own. It would have been better if the ARDI project could have continued the oversight of the implementation of the database until it was completed properly.

It was anticipated that a Kurdish version of the completed database would be produced. This has not been done.

The SBAL in Baghdad has 154 rolls of microfilmed registration records. Each roll has an average of 2,700 images. Those images have to be converted into a digital form and the database needs to be adjusted in order for this data to be entered in the proper place. The data on the microfilm represents some of the history of each parcel of land which is in the database. Historical factors are considered regularly when looking into questions that arise concerning the individual parcels throughout Iraq. This in not now available for the SBAL, or the Erbil Ministry teams, as part of the database. We hope that the conversion of the rolls of microfilm will take place and the data will be entered eventually in the database.

It was planned to enter the adjudication records for each parcel of land as part of the historical record. This was to go in to the database, but it is not there. There are paper records in Baghdad of the historical factors that should be entered into the database. With the termination of the project, it is not clear that this vital information will be included.

TRAINING

There should be continued training. Additional people should be trained in the GIS process and many additional surveyors should be trained in the operation of the GPS units. The burden is now on the members of the SBAL and the Ministry in Erbil to continue the training process.

Although it is not crucial to continue the GPS training at this time, it will be crucial once the database is operating and there is an attempt to expand it into the registration of all lands, public and private. At present, there has been nothing done about the addition of the private lands to the database. In addition, tapus (the actual record of ownership/possession) have not been prepared (revised to take into consideration the many changes that have occurred over the years). These need to be developed and added to the database. The SBAL members know that this needs to be done, but do not have the skills to do so function at this time. Training will be necessary to prepare people to create the new tapus.

CREATION OF TAPUS FOR STATE-OWNED LAND

It is a goal of this project to create tapus for all the state-owned land. Normally, that would not be done but, for several reasons, we felt that tapus would be the best means of providing possessors with security of tenure now and of making any transition to other forms of possession in the future easier.

ADJUDICATION OF UNADJUDICATED LANDS

There remain a substantial number of parcels that were not adjudicated during the British/Indian systematic adjudication of the 1930s. Some governorates (e.g. Sulaymaniyah) have begun to adjudicate those lands on their own. It was felt that the ARDI project could develop an instrument for general use throughout the country (one compatible with the manner in which data have been entered), and follow through to complete the adjudication process. A visit was made to an area of unadjudicated land in Sulaymaniyah governorate, and all the officials agreed that the process could now be completed. The project terminated before any of this activity could be commenced.

DATA ENTRY

The data entry is not completed, as noted above. It is also relevant to look back at the final section dealing with the database to appreciate that there is a significant number of different categories of data that need to go into the database in order to make it effective, and that these categories are not yet all defined.

The teams were told through lectures how they should function, but there was not time to give them practical experience in the field.

MODIFYING COORDINATES ON THE CADASTRAL MAPS

There are coordinates on the original cadastral maps but they are part of a system of internal coordinates. It was decided by the project that we would use one of the accepted international coordinate systems. The training in how to convert to, and use, the international system never took place. The persons trained in the GIS program understood this was a crucial part of the modernization process, but they were never formally trained in the new system.

SECURITY OF THE SYSTEM

Security is fundamental to maintain the integrity of the computerized land registration system. We had planned to deal with issues of system security in detail. However, time did not allow us to review alternative methodologies for putting a security system into place. This was discussed in the training program, seminars, workshops and whenever an opening allowed. However, nothing concrete was ever proposed to the SBAL or Erbil (Sulaymaniyah) Ministry teams. The issues were explored in some detail with the database developers and the other computer specialists who were assisting with the ARDI project activities. We hope that there will be an attempt to create a security system for the database and all the data.

COUNTRYWIDE COORDINATION

It had been planned that surveyors from the 3 Kurdish governorates would join surveyors from the other 15 Iraqi governorates, at the Erbil project, to coordinate both database entries and field checks on maps. This must be a countrywide effort, in order to make a consistent and accessible structure for a land administration system. Such meetings must now be organized at another venue, perhaps still in Erbil, but in the absence of the Project Coordinator since the project has closed.

The instructor is explaining the use of a GPS positioning device in how it can be used to locate a point on the earth.

"Where are we?" Surveyor and technical staff from the SBAL practicing the use of GPS devices to locate a physical position on a map.

3.3 NATIONAL AGRICULTURE EXTENSION PROGRAM

Farmers attending a field day to observe trials of different wheat varieties and differing technology packages.

The establishment of an effective national agriculture extension service is vital to the development of agricultural capacity in Iraq, where farmers have little access to information on improved agricultural practices.

Extension services in Iraq have traditionally relied on mass media (television, radio, leaflets), formal farmer training in classrooms, and demonstration plots. Mass media efforts are often centrally generated, with little consideration for individual farmers' situations or needs, or even for regional variations. Formal training and demonstrations reach only a small fraction of farmers and are inefficient because farmers must be transported to the training sites, which is expensive and time-consuming for the farmer.

Participatory extension services delivered at the farm level are a viable alternative to help farmers adopt new agricultural methods. Rather then present instructions and recommendations at a central agency to farmers, extension

agents provide a "real world" environment in which small groups of farmers can put what they are learning into practice and test it with their peers. The extension agent facilitates these group meetings, which are held on the fields of one of the participating farmers, and supports farmers in solving their production problems. Farmers are able to provide practical feedback to one another, and direct specific questions to the extension agent.

The first step in building such an extension service is to convince government policy makers, extension agents, farmers, and academics of the need to adopt participatory extension practices, and gain consensus on how to proceed. ARDI for this reason, embarked on a series of workshops and meetings that set priorities for establishing those services and took the initial steps to put them into practice.

For extension agents to change their role from that of instructor to one of facilitator requires that agents learn a new set of skills in participatory extension. ARDI helped the Ministry of Agriculture (MOA) to educate a select core of its staff in new ways of providing farmers with responsive participatory extension services at the field and community levels. This core group of "participatory trainers" then trained more field staff as the foundation for a nationwide network of effective participatory extension agents.

In the absence of private sector extension services (which farmers cannot yet afford), the MOA has established extension centers in each of the country's 18 governorates, as well as 32 model farms. These extension centers needed the basic necessities – from desks to computer equipment – to allow their agents to function efficiently in their jobs. ARDI renovated one public and one non-governmental organization's extension center and provided equipment to eleven others (including training and media centers within those facilities). The improved extension centers and new technologies benefit not only their employees, but also the tens of thousands of farmers they serve each year.

TABLE 91 EXTENSION PROJECTS IN IRAQ

Activity	Number of Projects	Activities Primary Beneficiaries
Developing a Strategy for Participatory Extension	5	3 strategy meeting workshops (MOA) 6 farmer workshops
Training Extension Agents	7	1 training for trainers course (MOA) 12 field agent courses (MOA)
Renovating and Equipping Extension Centers	13	2 to renovate extension and training centers (1 NGO, 1 MOA) 10 to equip training and extension centers (3 NGO, 7 MOA) 1 to provide IT equipment to the State Board of Agricultural Extension (MOA)

DEVELOPING A PARTICIPATORY EXTENSION STRATEGY

Farmers practicing pruning at a farmer meeting in a pomegranate orchard, Sulaymaniyah

BACKGROUND

ARDI helped set the stage for developing a nationwide extension service by bringing together over 300 government decision makers, extension agents, academics, and farmers in a series of workshops and meetings. Over an 18-month period, participants gradually came to understand and advocate nationwide participatory extension services.

ACTIVITIES

Participatory extension was introduced to the MOA in a stepwise fashion. During February 2005, ARDI staff reviewed the current extension situation in Iraq and later in the month began holding discussions with various heads of MOA extension and technical departments, as well as university specialists. At the IPM Workshop (see Section 3.5) held in February 2005, participants noted that there was a strong need to promote good crop husbandry through working with farmers in the field.

National Vision Workshop. The Director General of the State Board of Extension was extremely supportive of the idea that the MOA needed to revitalize its extension services and change its extension methodology. However, to convince extension service staff that these changes were needed, a national extension vision workshop was held in July 2005 to:

- Formulate a national extension vision that the MOA can sustain using its own resources.
- Agree on a basic methodology that can be used in all extension activities.
- Agree on the structure of the extension service, the extent of its coverage, and the roles of extension staff.
- Identify the steps needed to implement the vision.

Sixty-two participants from the MOAs in Baghdad, Erbil, and Sulaymaniyah, state boards, governorate directorates of agriculture, and state-run enterprises attended the two-day workshop. Participants agreed that a program to train extension staff in adult learning and communications methods, and participatory techniques should be developed and implemented. The Director General had a clear vision of what was needed to revitalize the extension service, and agreed to ARDI's proposed methodology of locating extension agents at the village/community level to work with farmers in groups of 12-15 people each. This was a fundamental change to the extension system – taking extension to farmers rather than bringing farmers to extension.

Farmer Extension Workshops. In November and December 2005, after consensus was reached with the State Board for Extension in Baghdad and the MOAs in Erbil and Sulaymaniyah to implement a participatory extension program, ARDI invited farmers to attend a series of workshops in Dahuk, Erbil, and Sulaymaniyah to determine farmers' needs for information and support. The workshops identified major production constraints, compared farmer crop production practices to recommended practices, and obtained farmers' perceptions on extension services and ways to improve them.

Farmers were asked which crops they wished to include in their workshop activities, and chose wheat, apples, grapes, and tomatoes. Many of the major problems they experienced (especially for wheat) could be attributed to past MOA policies of providing equipment, fertilizers, and pesticides at subsidized prices; and both farmers and extension agents looked forward to the return of this system. There was also a general feeling among farmers and extension staff that the government should solve all their problems, especially those concerned with inputs. Surprisingly, lack of production knowledge was not perceived to be a problem.

Poor quality pesticides, from both public and private sources, and lack of certified seed were noted by farmers as major constraints. ARDI was already addressing these concerns through other activities (see, for example, Section 3.5 on the pesticide dealers association and Section 2.3 on high-value agricultural products).

The suggestions made for improving extension services centered on providing more training courses, increasing the number of extension centers and

demonstration plots, and distributing more materials. This was understandable, given that farmers and extension agents had no experience with alternative approaches.

Strategy Meetings with Director General of Extension. Following the assassination of the Director General of Extension in September 2005, ARDI staff met twice with the new Director General and his staff to explain and discuss the training conducted to date (see below) and ARDI's collaboration with state board programs. In October, ARDI obtained his views on the new extension activities. After much discussion during this meeting, those present largely agreed that training in participatory methodology should be provided by qualified participatory trainers with practical experience, rather than by university professors.

The December meeting was held to build a common understanding on how to develop and expand the extension program, identify criteria for selecting field staff for the facilitator participatory training courses, and agree on facilitator field activities following the courses. It was agreed that field staff would be based at the model farms and would work closely with groups of farmers in the immediate vicinity. As more staff were trained, they would be located in villages and establish farmer groups closer to the villages. ARDI estimated that a minimum of 5,000 facilitators would eventually be needed to provide regular services, across the country, to farmers at the village level.

Farmers at an orchard pest management meeting in Dahuk

National Extension Workshop. To help introduce the new methodology in Iraq's governorates, ARDI organized a national workshop in May 2006. Led by 15 ARDI-trained participatory trainers, the workshop described the program to senior governorate extension staff. This two-day workshop was also an opportunity for state board trainers to demonstrate their new skills to governorate staff.

RESULTS

Most of the participants at the national vision workshop left with a better awareness of the need for change in Iraq's extension service and a greater understanding of the participatory methodology. By the end of the workshop, they had agreed to use participatory methods and to provide extension agents with the support they need.

From the farmer extension workshops, it became apparent that new extension activities needed to be planned carefully. Based on farmer responses, participants decided that pesticides application and pest management techniques, alternate crops to wheat, beekeeping, and tree pruning were good starting points for extension activities.

The meetings with the new Director General and other MOA staff proved extremely productive in that agreement was reached to develop and implement an extension system based on active farmer participation; activities would be undertaken on the farmers' own fields. This was a complete reversal of the previous system where farmers were brought to formal training at demonstration plots and extension centers.

TABLE 92 EXTENSION WORKSHOPS AND STRATEGY MEETINGS

Activity	Participants
National Extension Vision Workshop	62
Farmer Extension Workshops	222
Strategy Meetings	13
National Extension Workshop	38
Total	**335**

TRAINING EXTENSION STAFF

ACTIVITIES

After the Director General of the State Board had agreed to introduce participatory extension methodology, the Centre for Development Services/Near East Foundation from Cairo, Egypt, gave a nine-week training-of-trainers course in Erbil. Fifteen 15 MOA staff from across the country were trained. These staff, who then became "participatory trainers," will form the core group of the new extension service and train other extension agents in agriculture extension approaches, communication skills, adult learning theory, and facilitation.

Between January and July 2005, 12 courses were held in Erbil. There, the participatory trainers instructed additional MOA field staff from all of Iraq's governorates. For this first round of courses, the trainers were monitored and coached by the Near East Foundation. ARDI requested that the criteria for field staff selection for training emphasize that candidates be young, open-minded,

A farmer who participated in a sheep mating farmer group meeting for 15 female breeders in Dahuk.

"We need her to teach us again and really appreciate her working with us. If all Agricultural engineers sit with us as you did, then you can expect more and more improvement from us."

ARDI provided nationwide extension services in all governorates.

willing to learn and adopt new methods, deal with farmers on a daily basis, and be "people oriented." The MOA and participatory trainers observed the training sessions to identify future trainers and master trainers.

RESULTS

Following the first round of training, farmer groups were established by MOA staff in Dahuk, Erbil, Muthanna, Ninewa, Salah al-Din, Sulaymaniyah, and Wassit, while after the second round additional groups were established in Kerbala. In total, 27 farmer groups were established, involving 416 farmers.

The facilitators provided information on improved cultivation techniques and other technical information. The farmer groups shared their knowledge with each other, allowing the extension agents to adapt crop production recommendations suited to local knowledge, farmers' resources, and local conditions. The improved extension services will provide more effective assistance to farmers to raise agricultural production and increase farmers' income.

Field implementation was slower than anticipated because the State Board/MOA Baghdad was slow to issue official approvals to the governorates to implement the participatory program with farmer groups. The groups that were established were the result of individual trainers and facilitators who became convinced of the benefits of the methodology and were willing to proceed without official approval.

Two NGO staff members were included in the second round of training because they were horticultural technicians who were working with farmer groups on other ARDI activities. These two technicians established 4 farmer groups in Dahuk and 7 in Sulaymaniyah, involving 115 farmers.

On September 12, 2006, the Deputy Director General (Rural Development) of the State Board for Extension informed ARDI that the Minister had approved the participatory methodology and that the State Board had issued instructions to the governorates to proceed with implementation. This instruction also applied to the Extension Divisions of the governorates' Departments of Agriculture.

TABLE 93 EXTENSION TRAINING

Activity	Participants
Training of Trainers	15
Field Agent Training	174 (including two NGO staff)
Total	**191**

The participatory trainers drew this "extension tree," which illustrates the extension methodology they learned during the training course. The soil represents research-extension-farmer linkages, supporting the trunk of participatory extension, while the leaves correspond to the structure and contents. The date palm's fruits symbolize trainers and trainees.

3.4 PARTICIPATORY ASSESSMENT AND PROJECT IDEA DEVELOPMENT (PAPID)

Village leaders worked closely with ARDI facilitators to identify priority needs for each village.

When ARDI began working in Iraq in late 2003, one of the urgent priorities was information gathering through extended discussions with major stakeholders in agricultural development in Iraq. Through its offices in Baghdad, ARDI staff had close and regular contact with the Ministry of Agriculture and the University of Baghdad Schools of Agriculture and Veterinary Sciences. ARDI also conducted formal meetings with prominent figures in agri-business, and major producers in the agricultural and animal production sectors. These sources of information and deep experience, together with a concentrated search of available literature, enabled ARDI to begin planning a comprehensive and coherent strategy for reconstruction and development of the agricultural sector in Iraq.

However, ARDI staff also recognized the need for knowledge and information at the grass-roots level, in order to gain a deeper understanding of the state of agricultural development from the perspective of small farmers, their priorities

and needs, and how planning and policy making at the national level was likely to impact individual farmers far removed from the centers of decision making. This information was especially important to design community-based project activities, especially direct grants, which were most often implemented at the level of the individual community, or small group of communities. This rich body of knowledge could only be tapped through direct contact with small farmers at the village level, utilizing a series of activities designed to elicit reliable information from people who might otherwise be reticent to speak frankly with outsiders.

ARDI staff designed the Participatory Assessment and Project Idea Development (PAPID) project specifically to obtain detailed information from individual producers at the village level, and to understand the constraints that villagers confronted in meeting their goals. Launched in May, 2004, ARDI worked closely with a local NGO in the northern governorate of Sulaymaniyah to select and train local facilitators who could implement the project. The facilitators were selected for their background in agriculture, sense of commitment to community action, and awareness of the importance of gender and ethnic background. Eight facilitators were chosen, 3 women and 5 men, and they received extensive training in PAPID techniques by an ARDI specialist working through the local NGO. ARDI and the NGO also collaborated in determining criteria for village selection, which included (apart from security concerns) agriculture as the principal source of employment and income, and capacity for a strong working relationship through committed community leaders.

The first phase of the project was designed as a pilot, and included two villages in Sulaymaniyah. All interested adults (men and women), together with community leaders, were invited to participate in a three-day series of workshops and activities designed to elicit issues of greatest concern, unique needs of the village, possible solutions to existing problems, and constraints to development. The focus was on consensus building, and the trained facilitators used a variety of techniques, including brainstorming sessions, prioritization methods, and village map construction to visualize problem areas and sources of community strength.

Using the experience gained through implementation of the first phase of the project, ARDI launched PAPID Phase II, which covered 5 additional villages in the governorate. The final results of the activities in the 7 communities were

analyzed, and proved to be extremely useful for ARDI programming and project implementation.

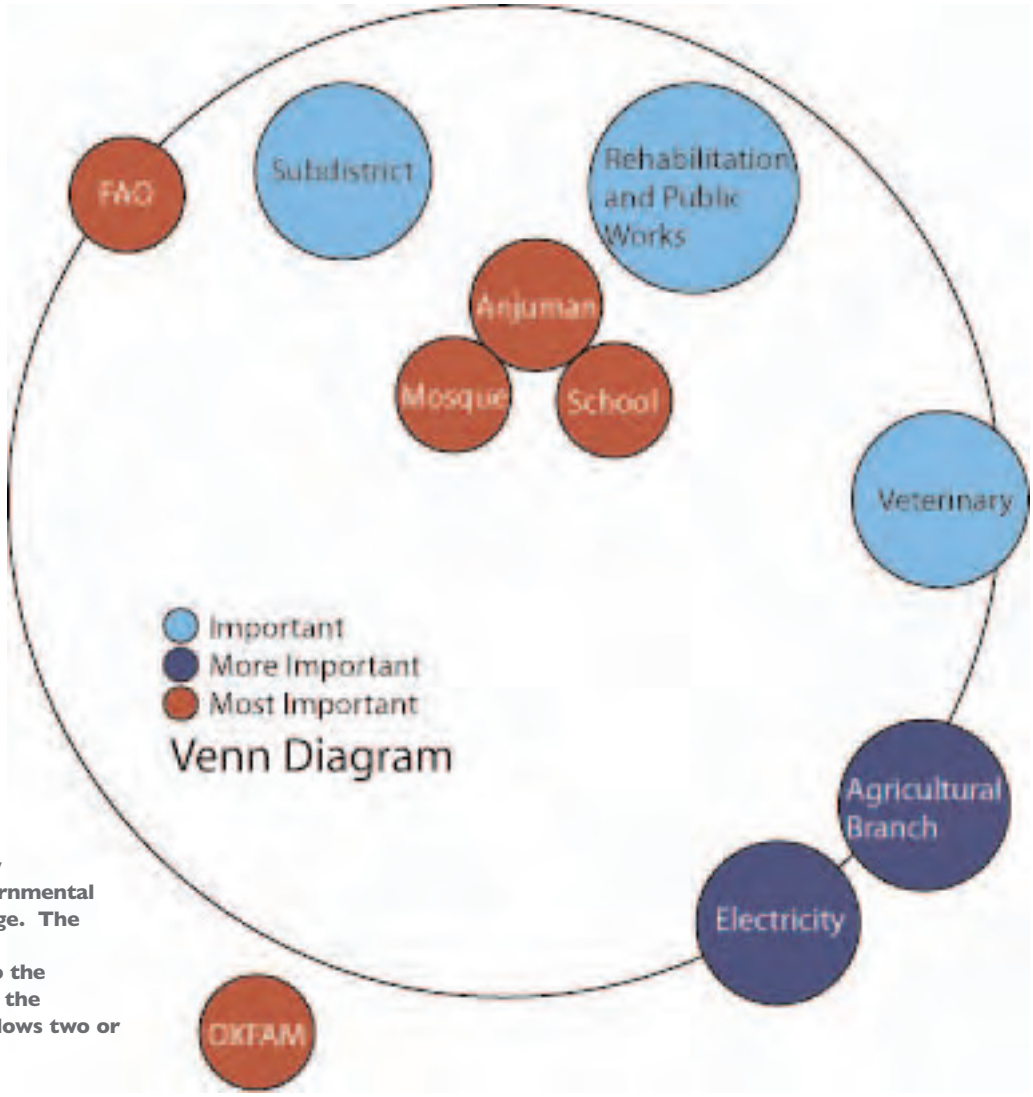
First, the results confirmed that ARDI was on the right track in terms of "macro" level project design. The villagers repeatedly mentioned the lack of high-quality seed, the poor repair of farm machinery, and the shortage of water for irrigation and animals as major concerns, and these were all areas of ARDI program concentration. This information also proved valuable to ARDI staff in

understanding how best to implement the various projects (such as wheat seed multiplication, or tractor repairs) to the greatest benefit of individual farmers.

The information gleaned through PAPID I and II was also critical to grants programming and implementation. A majority of the village irrigation projects were based on information obtained through these community studies, as well as other projects such as orchard improvements and training of village tractor mechanics. One major grant activity area that was a direct result of PAPID was the selection of honey production as a viable community-level alternative for agricultural development. From initial results obtained through PAPID I the first beekeeping project was designed, and 82 participating farmers from the first two villages began working with bees, and eventually became members of the Sulaymaniyah Beekeepers Association. The beekeeping project expanded even more after the conclusion of PAPID II, and eventually reached 8 communities in the governorates of Sulaymaniyah, Tameem, Ninewa, and Diyala (see Section 2.3.).

The farmers in these villages claimed that the high degree of success of the projects was due, in large part, to the fact that they, themselves were instrumental in developing the project.

Women played a key role in PAPID implementation and were included in all decisions reached during the exercise. The women and men who helped develop the beekeeping project also actively reached out to specifically include women heads-of-household, widows, and other disadvantaged members of the community. As a direct result of these concerns, 44% of the original 82 participants in the beekeeping project were women.



This diagram illustrates how governmental and non-governmental institutions impact this village. The colors represent the relative importance of each entity to the villagers who participated in the workshop. This technique allows two or more items to be linked by characteristics or attributes.

3.5 NATIONAL PROGRAM INTEGRATED PEST MANAGEMENT (IPM)

Fruit pests, as shown in this photograph, are common in fruit orchards in the North.

The prevalence of destructive pests has severely reduced production in many parts of Iraq. The Sunn pest, for example, destroys about 17% of the wheat crop in the northern governorates, and renders much of harvested wheat unfit for human consumption (see Section 2.1 for discussion of Sunn pest). Several exotic species (e.g., screw worm, jasmine white fly, citrus leaf miner, Colorado potato beetle) have invaded Iraq in the past ten years, affecting livestock, citrus and potato.

Integrated Pest Management (IPM) is the use of all available techniques – cultural, mechanical, chemical, and biological – to manage pest populations. Cultural and mechanical methods involve crop agronomy practices, so good crop management is essential to successful IPM. (ARDI's work to improve cereal grain and high-value agricultural crops is summarized in Section 2 of this report.)

IPM uses pesticides only when they are absolutely necessary. Pesticide use is

ARDI provided nationwide IPM services in all governorates.

normally reduced when farmers practice IPM, decreasing their input costs and increasing their profits. In addition, IPM uses pesticides of lower toxicity and persistence wherever possible. This, together with rational and reduced use, has benefits for food quality, human health, and the environment.

While Iraq had made modest attempts to introduce bio-control agents, much of the infrastructure required to support biological control programs was destroyed or looted in 2003. The MOA was able to rebuild some of these units, but still needs additional infrastructure to further develop the government's program for mass-rearing beneficial insects. [1]

The Iraqi government recognizes the potential for IPM in Iraq, and the MOA has stated that IPM is "a vital issue to Iraq rather than an option." Yet many obstacles remain to be overcome on the part of the government, private sector, and farmers. For example:

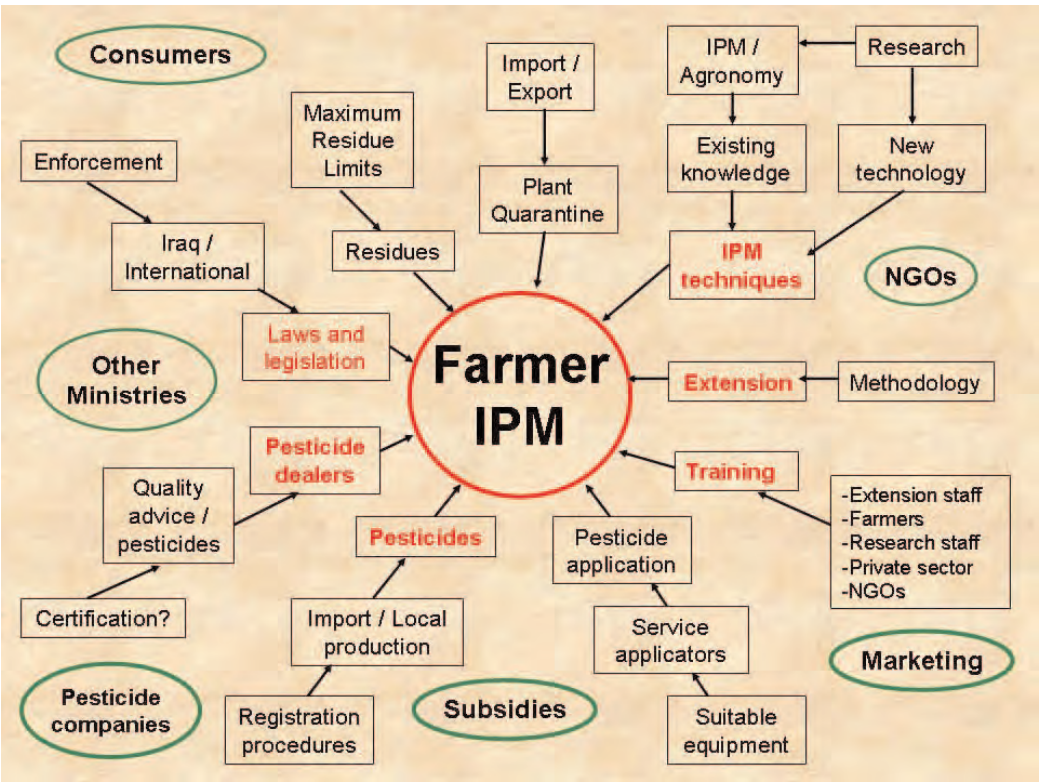
- Crop agronomy and pest/pesticide recommendations exist for all major crops in Iraq, as do many nonchemical pest management strategies. However, this information is fragmented and has not been incorporated into overall crop production recommendation packages. There is thus a need to develop overall crop production recommendations for extension programs, as well as to establish priorities and coordination for crop and IPM research packages.
- The MOA's pesticide registration and control programs need to be improved to ensure that farmers can confidently access quality and safe pesticides for IPM.
- Pesticide dealers provide both pesticides and advice to farmers on their use. At present, the quality of both products and advice is poor in Iraq.
- Iraqi farmers are used to relying on chemical pest control, so they need to change their perceptions and attitudes to adopt IPM. This change requires education through extension, using messages and techniques that educate and persuade farmers rather than send direct instructions. (see Section 3.5).

When developing the IPM program, ARDI was conscious that sustainable farmer IPM is not simply a case of having a) suitable strategies for farmers to implement, b) an effective extension service to educate farmers and c) available inputs. External factors can support or hinder the implementation of IPM, and these need to be considered when promoting IPM. The diagram illustrates all of the factors affecting sustainable farmer IPM. Those marked in red are factors on which ARDI concentrated its activities.

ARDI undertook two major activities to lay the foundations for a national IPM effort in Iraq. First, we worked with stakeholders from all sectors to develop a vision for a national IPM program. Second, we helped private sector pesticide dealers to improve their services and businesses. Additional activities included training farmers to use pesticides safely and preparing the USAID-required

[1] ARDI had planned a project to supply greenhouses, growth chambers, and laboratory equipment to the MOA for the mass-rearing of beneficial insects in seven governorates. However, this project was canceled because of the prolonged illness of the MOA staff counterpart responsible for this activity.

INTEGRATED PEST MANAGEMENT FACTORS



Pesticide Evaluation Report and Safer Use Action Plan (PERSUAP).

Together, these activities should contribute to increased crop production from farmers using improved-quality pesticides, and over time, increased revenues for pesticide dealers once farmers begin to trust the products they sell.

- Laying the foundation for a national IPM program
- Improving pesticide dealer services
- Training farmers to use pesticides safely
- Preparing the Pesticide Evaluation Report and Safer Use Action Plan (PERSUAP)

TABLE 94 NATIONWIDE IPM PROJECTS

Activity	Number of Projects	Projects Primary Beneficiaries
Laying the Foundation for a National IPM Program	5	1 IPM workshop (MOA) 1 national IPM vision workshop (MOA, universities) 1 wheat IPM workshop (MOA, farmers, universities) 1 pesticide registration procedures meeting (MOA) 1 date palm conference (MOA)
Improving Pesticide Dealer Services	2	1 to form a pesticide dealers association (private sector) 1 to train pesticide dealers (private sector)
Training Farmers to Use Pesticides Safely	2	1 to train trainers 1 to train farmers in 480 villages (farmers)
PERSUAP Evaluation	1	1 Pesticide Evaluation Report and Safer Use Action Plan (Internal ARDI – USAID activity)

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FROM THE AMERICAN PEOPLE

AGRICULTURE RECONSTRUCTION AND DEVELOPMENT PLAN FOR IRAQ

PESTICIDE EVALUATION AND SAFER USE ACTION PLAN (PERSUAP)

November 2006

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LAYING THE FOUNDATION FOR A NATIONAL IPM PROGRAM

A series of workshops were held to prepare for a National Integrated Pest Management Program.

Although Iraq's government has recognized the need for IPM, little was done previously to put it into practice. Thus, ARDI arranged for a series of workshops to gain consensus on the most pressing pesticide management needs in Iraq, to begin setting priorities for more comprehensive programs, and to give Iraqi pest management specialists wider exposure to pest control efforts in neighboring countries.

Activity	Participants
Initial IPM Workshop	88
National IPM Vision Workshop	74
Wheat IPM Workshop	71
Pesticide Registration Procedures	2
Date Palm Conference	3
Total	238

INITIAL IPM WORKSHOP

BACKGROUND

ARDI staff had little information on the status of IPM in Iraq when the project began. To correct this situation, it held an IPM workshop early in 2005.

ACTIVITIES

The workshop was held in Erbil on February 23, 2005, and a total of 88 participants from the Ministries of Agriculture in Dahuk, Erbil, Sulaymaniyah, and Baghdad attended. During the workshop, the participants:

- Discussed the core concepts of IPM.
- Explored nonchemical strategies to minimize pest and disease levels.
- Identified perceived needs in pest management knowledge and skills.
- Began developing national strategies for extension and pest management services to farmers.

RESULTS

The workshop evaluated participants' understanding and knowledge of core IPM concepts, identified major crop/pest/disease problems, identified non-pesticide control methods, and discussed the needs for skills training, IPM practices, and extension practices.

NATIONAL IPM VISION WORKSHOP

BACKGROUND

Following discussions with MOA staff in Erbil, Sulaymaniyah, and Baghdad, agreement was reached on the need for an expanded workshop to discuss IPM implementation in Iraq, the factors affecting farmer IPM, and to establish priorities. More specifically, the purposes of the workshop were to:

- Formulate a national IPM vision and establish objectives for its implementation;
- Set priorities to address crops and associated pest/disease/weed complexes;
- Identify activities to address problems and provide support to sustainable farmer IPM;
- Determine the role of the private sector in the provision of IPM services and how to promote this role;
- Identify ways to coordinate among relevant authorities in different sections of the government.

ACTIVITIES

The workshop was held in Sulaymaniyah on July 17-18, 2005. The 74 participants included staff from the Ministries of Agriculture in Erbil, Sulaymaniyah, and Baghdad; State Boards for Plant Protection and Agricultural

Participants at the National IPM Vision Workshop

Research; governorate directors of Plant Protection; College of Agriculture at Baghdad University; Ministry of Science and Technology; and Ministry of Environment. The participants were divided into working groups and asked to formulate a vision of the state of IPM in Iraq in 2010.

RESULTS

The working groups developed a vision for IPM in 2010 that included farmers, research and extension institutions and the private sector, and considered laws, regulations, and codes for pesticides. They also established priorities for crops and their associated pests/weeds/diseases by Iraq's three principle geo-ecological zones. Last, the participants identified several areas where improvement was needed (IPM techniques, extension, dealers, etc.) and possible activities to overcome them.

WHEAT IPM WORKSHOP

BACKGROUND

The National IPM Vision Workshop identified wheat, date palms, vegetable crops, and orchards as priority areas for IPM development. Following its recommended priorities, a more focused workshop was held for wheat.

The identification of constraints to an effective IPM program occupied much of the discussion during the workshops.

ACTIVITIES

The two-day workshop was attended by 71 people (farmers, and representatives from the MOA, State Boards of Research and Extension, and universities) from Baghdad and 10 governorates. The participants divided into six working groups to discuss their current activities, identify constraints and the techniques available to overcome them, and the research and extension activities Iraq needs for IPM in the wheat subsector.

RESULTS

In plenary sessions, the participants agreed that Iraq needs more IPM techniques, particularly in determining treatment thresholds for Sunn pest and smut, and also needs to establish beneficial insect laboratories. They also recommended that the National Center for IPM should prepare a strategic plan for research programs, provide for coordination between different institutions and disciplines, and develop capacity improvement training programs. A number of weaknesses were also identified at this time, requiring more work on overall program implementation.

PESTICIDE REGISTRATION PROCEDURES MEETING

BACKGROUND

The enforcement of pesticide registration procedures is weak in Iraq, as are the monitoring and control of pesticides on the market. As a result, many of the pesticides sold are of poor quality, black-market, fraudulent, decanted into smaller containers such as soft drink bottles, expired, or relabeled. The use of such products is inefficient and incurs additional input costs and crop losses for farmers, as well as increased health and environmental risks to pesticide users and consumers of agricultural produce. This situation is exacerbated by a lack of information from the government and the often poor advice pesticide dealers provide to farmers.

There is a need to review the framework of legislation and regulations, regulatory bodies, implementation of the regulations, distribution, retail sales, and use by farmers. Further, certain active ingredients registered are extremely toxic, and should not be available to farmers, while there is a need to register more pesticides that are IPM- and environmentally-friendly.

ACTIVITIES

CropLife Middle East North Africa and the Arab Organization for Agricultural Development are sponsoring a regional program for the harmonization of pesticide registration procedures, as well as pesticide labeling and registration trial data acceptance. The MOA nominated two members of its Pesticide Registration Committee to attend the CropLife-AOAD annual meeting, held in Casablanca, Morocco in September 2005.

The meeting's participants discussed how countries should prioritize implementing the FAO's International Code of Conduct for the Distribution and Use of Pesticides, the introduction of a harmonized pesticide container label, and registration procedures for biological pesticides, among other topics.

RESULTS

This important initiative exposed Iraqi regulators to pesticide registration developments within the region. Their participation in this initiative will help to support the introduction of improved pesticide registration, basic controls, and monitoring procedures in Iraq. Importantly, the meetings enabled Iraqi pesticide registrars to establish contact with their counterparts in other Middle East countries and allowed them to compare Iraq's pesticide registration procedures with regional and international standards.

Subsequent to Iraq's participation in the meeting, the Director General of the Arab Organization for Agricultural Development invited Iraq to join its regional initiative to harmonize pesticide registration procedures. Ten of the region's 18 countries are now fully implementing harmonized protocols.

DATE PALM CONFERENCE

BACKGROUND

In the early 1960s, Iraq was planted with between 30 and 40 million date palm trees; today, the number is about half that, at 16 to 19 million trees. Once a major exporter of high-end date varieties, Iraq was not permitted to export during the period of economic sanctions, and lost its overseas markets to regional competitors. To regain its position in the international date market, Iraq needs a concerted and coordinated effort among growers, processors, exporters, and the MOA to improve its competitive position.

Major pests of date palm in Iraq include Dubas bug, dust mite, and various scales and borers. Date palm and citrus are commonly grown together in the same orchard, which presents a complex situation in which to develop IPM strategies.

ACTIVITIES

ARDI sent three date palm specialists in plant protection (IPM and pesticides) and biotechnology (tissue culture) from the State Board for Agricultural Research to the Third International Conference on Date Palms in Abu Dhabi on February 19-21, 2006. Two of these specialists presented papers at the conference. Other Iraqi participants from universities and the private sector (producers) also attended.

Invasive insects are found in most crops currently grown in Iraq. Many have become resistant to pesticides due to overuse.

Apricot borer damage.

RESULTS

Since Iraqi scientists had been virtually cut off from direct interaction with their counterparts in other parts of the world, the conference was particularly helpful in building the capacity of the MOA by exposing date specialists to the latest developments in date production. It also gave them the opportunity to interact with IPM and date palm specialists from other countries and discuss their experiences.

- Laying the foundation for a national IPM program.
- Improving pesticide dealer services.
- Training farmers to use pesticides safely.
- Preparing the Pesticide Evaluation Report and Safer Use Action Plan (PERSUAP).

IMPROVING PESTICIDE DEALER SERVICES

A typical pesticide dealership in Iraq.

Iraq's pesticide dealers do more than supply pesticides to farmers; they also act as private sector extension agents by providing advice on pesticide use. Government staff, farmers, and pesticide dealers alike have identified problems in the private sector's provision of pesticides, including the large amount of substandard pesticides on the market, the poor quality of advice dealers offer, and the absence of information on IPM. ARDI implemented two sets of activities to help raise the standards of pesticide dealers: the establishment of a pesticide dealers association and training for dealers.

FORMING A PESTICIDE DEALERS ASSOCIATION

BACKGROUND

During the February and July 2005 IPM workshops, the MOA identified the need to improve the pesticide dealer subsector. Establishing a pesticide dealers

association in Iraq was viewed as a way to alleviate some of the problems dealers face in providing good pesticides and advice to farmers, as well as to establish an element of self-regulation in the subsector. In addition, an association would provide a single point of contact for developing wide support to a large number of individual dealers.

ARDI arranged for a series of workshops in preface to forming an association of pesticide dealers. A total of 217 dealers and MOA staff participated in these events.

ACTIVITIES

An agrochemical association consultant from Egypt assisted with dealer association and training activities. Work with pesticide dealers had begun by the time of the National IPM Vision Workshop in July 2005. In order to evaluate the opinions of dealers regarding the formation of an association, ARDI held seven workshops nationwide, followed by two workshops to establish the association.

The initial workshops, which were held from 18 May to 14 September, familiarized dealers and government staff with the structure and activities of agrochemical associations in Egypt and their relationship with the Ministry of Agriculture, and to obtain responses regarding dealers' problems and perceived training needs.

TABLE 95 WORKSHOPS ON THE FORMATION OF A PESTICIDE DEALERS ASSOCIATION

Date	Location	Attendees	Number
18-May-05	Dahuk	MOA staff	5
19-May-05	Dahuk	Dealers	21
24-May-05	Sulaymaniyah, Tameen	MOA staff	16
25-May-05	Sulaymaniyah, Tameen	Dealers	33
29-May-05	Erbil, Mosul	Dealers	24
30-May-05	Erbil, Mosul	MOA staff	8
14-Sep-05	Babylon, Baghdad, Basrah, Kerbala, Missan, Muthanna, Naja Qadissiya, Thi-Qar, Wassit	Dealers	19
15-Sep-05	Babylon, Baghdad, Basrah, Dohuk, Erbil, Kerbala, Missan, Muthanna, Najaf, Ninewa, Qadissiya, Sulaymaniyah, Tameer Thi Qar, Wassit	Dealers	38
January 26-27, 2006	Babylon, Baghdad, Basrah, Dahuk, Erbil, Kerbala, Missan, Muthanna, Najaf, Ninewa, Qadissiya, Sulaymaniyah, Thi Qa Wassit	Dealers	53
Total			**217**

The participants agreed that the biggest problems facing pesticide dealers are expired pesticides, poor dealer knowledge, and poor quality. They agreed that the formation of a pesticide dealer association would help to overcome some of these problems, and that the association should have a code of conduct for its members. They also concluded that dealer training is essential and a certification and licensing system for pesticide dealers should be implemented gradually.

The first workshop for dealers from all of Iraq was held in Dahuk on September 15, 2005. The participants, 38 dealers from 15 governorates, met to agree on whether or not to establish an association. Here, dealers were almost unanimous in their support for forming an association, and defined its aims.

Following this workshop, dealers who had been nominated as contacts met with

other dealers in their governorates to explain the contents and outcomes of the workshop, and to elicit their opinions and ideas.

ARDI then surveyed pesticide dealers nationwide, 153 dealers responded with data on the major crops, pests, diseases, and weeds in their areas; the pesticides they sold; the types of training needed; and the value of forming a pesticide dealers association. Their responses helped to shape the development of training courses for dealers.

On January 26-27, 2006, 53 dealers from 15 governorates came together for a workshop in Erbil. The participants agreed on the basic structure for the association and elected three committees to handle its registration, management, and finance. One pesticide dealer from each governorate was designated as the point of contact for his or her governorate.

The interim committees met again on May 22-23 in Erbil to assess the progress made toward registering the association. They also identified and discussed next steps, proposed activities for members, and discussed the association's fee structure and management. The new association was named The Iraqi Association for Agriculture Development and Promotion.

The Association's first general meeting was scheduled for August 20, 2005 to elect a board of directors. The majority of members were unable to attend because of a three-day curfew in Baghdad, and the general meeting was postponed to a later date.

"We are from all over Iraq. We have friendly discussions and come to agreements. Why could the constitution not be like this?"

A participant at the September 15, 2005 pesticide dealers workshop

RESULTS

Iraq's first pesticide dealers association – The Iraqi Association for Agriculture Development and Promotion – was formally registered on May 24, 2006. This organization will enable members to work together to ensure that all dealers in Iraq are qualified and follow the necessary laws and regulations, are able to provide advice on rational and safe pesticide use to farmers, and only sell appropriate, high-quality products, so as to protect the environment, consumers, and human health. This, in turn, will help pesticide dealers improve their business, as it will reduce the amount of fraudulent pesticides sold to farmers and increase farmers' trust in the pesticide industry.

The Association is now preparing a code of conduct for its members, which will be the first step toward self-regulation to stem the sale of substandard pesticides. It is also looking forward to establishing a good relationship with the government, and working toward a certification scheme for pesticide dealers.

PESTICIDE DEALER TRAINING

BACKGROUND

A project IPM specialist noted, "While not in itself overcoming the problem of poor-quality pesticides on the market, dealer education can assist in decreasing their incidence. Dealers require training in pesticide handling, storage, sales, use, disposal, and safety. They should be encouraged to improve the standards of shops."

PUTTING THE GOOD SERVICE = GOOD BUSINESS CONCEPT INTO PRACTICE

Three months after the dealer training was completed, surveyed dealers reported that their advice to farmers had improved. They counseled customers on the safe use of pesticides and disposal of empty containers, and non-pesticide control methods, even when their customers did not ask for it.

Trainees also reported that their relationships with their customers (farmers) have improved and their sales increased between 15 and 35% as a result.

ACTIVITIES

An agrochemical association consultant from Egypt assisted with dealer association and training activities. Eight five-day training courses were held between February and May 2006 in Erbil and Dahuk; they were attended by 119 dealers from all of Iraq's 18 governorates. Each course used a participatory methodology and covered:

- Working with farmers
- Principles of pest management
- Biological control
- Pesticide classifications and formulations
- Pesticide labeling
- Transport, mixing, applications and disposal
- Toxicity, health, and safety
- Nonchemical pest control techniques
- Environmental aspects
- Pesticide storage, handling and sales
- Local, regional, and international pesticide regulations.

Promoting rational pesticide use and IPM often means selling less pesticide to individual farmers, which goes against dealers' business instincts. The courses thus provided guidance on correct and safer pesticide use, while emphasizing the concept of "good service = good business." For example, maintaining a clean, tidy, and well-lit shop with attractively displayed posters and products; treating the farmer as a friend rather than a source of money; being knowledgeable about farmers' problems and appropriate solutions; providing practical advice that farmers can easily understand and remember; and being honest all help dealers maintain sales and gain repeat customers. To help them retain what they learned at the course, each dealer was given a manual with essential information on pesticides and pest management.

RESULTS

Dealers were given tests of their knowledge both before and after the training. They showed substantial improvements in their knowledge of shop management (e.g., keeping powders on shelves above liquids, improved ventilation, keeping stock records) and the advice they should be giving to farmers (before the course only 27% of participants scored 80% or higher on the test; this number rose to 71% at the completion of the course).

The 119 dealers who completed the training course are now prepared to provide better assistance to farmers. This assistance, which constitutes a private sector extension service, will improve the relationship between farmers and pesticide dealers, improve the dealers' business, contribute to the safer use of appropriate pesticides, and help farmers improve their agricultural production.

BACKGROUND

Iraq's farmers are generally unaware of the risks involved in pesticide transport, storage and use. Some of the problems in this area include purchasing/using

TRAINING FARMERS TO USE PESTICIDES SAFELY

Farmers received practical training in safe application methods in the proper use of personal protective equipment (PPE).

products that are unsuitable for the pest situation, dangerous transport and storage practices, decanting pesticides into soft drink bottles, and lack of knowledge of pesticide safety, application rates, and preharvest intervals.

ACTIVITIES

In June 2006, two pesticide specialists from the Sulaymaniyah MOA trained 16 plant protection specialists from a local NGO, all of whom had previously worked for the FAO. These specialists were to serve as trainers on an ARDI project to educate governorate farmers on safe and proper pesticide use. The three-day training course covered the topics that would be addressed at the village meetings:

- Pesticide selection and purchase
- Safe transport, storage, use, and disposal of pesticides and containers

"If we had had this training on safe pesticide use before, these deaths would not have happened."

A farmer from a village where five people had died from pesticide poisoning since 1991.

- Precautions to protect bees from pesticides
- Pesticide first aid
- Principles of IPM.

Training meetings for farmers began in July 2006, and consisted of one-day pesticide training workshops for a total of 5,383 farmers in 480 villages throughout Sulaymaniyah governorate. The 16 plant protection specialists instructed farmers on points they should consider when buying and transporting pesticides, calibrating and cleaning pesticide sprayers, applying pesticides and choosing dosages, protecting useful insects when spraying, and discarding remaining solutions after spraying. The specialists also gave farmers essential information on how to respond to accidental poisoning or misuse of pesticides.

RESULTS

Four hundred eighty training meetings were held for farmers. The meetings proceeded on schedule, with additional trainers being recruited to complete the program within ARDI's shortened timeframe. Approximately 15 farmers attended each of the meetings. Some of them had attended earlier FAO awareness programs, but considered this program to be much better because the meetings were held in the farmers' own villages rather than extension centers, the meeting structure was more comfortable, and farmers felt more free to become involved in discussions.

ARDI trained 16 IPM specialist to handle additional training at the village level. This group of 16 held 480 village meetings and trained 5,383 farmers.

PREPARING THE PESTICIDE EVALUATION REPORT AND SAFER USE ACTION PLAN

Generic name of Pesticide (or accepted common name)/EPA and Iraq ACB Status	IPM program	Toxicological and Environmental Hazards	Primary con
1. Insecticides (including Miticides)			
Abamectin 18% EC (Vertimec) Syngenta. Registered-USEPA. Toxicity Class IV CAUTION; Registered in Iraq. Controls spider mites, leaf miners. Uses: Tomato, citrus, avocado, mango, pear, peach, apricot, pistachio, sweet pepper, hot pepper, pineapple, cucumber, eggplant, broccoli, artichoke.	Constant monitoring of crops by trained scouts to detect presence of pests. Use minimum effective dosages. Use resistant plants. Conservation of natural enemies for biological control.	A mix of natural avermectins (derived from a soil bacterium). EC concentrations may cause eye and skin irritation. Pupil dilation, vomiting, convulsions, tremors, coma. Not readily absorbed through skin. Possible teratogenic and reproductive effects. Can kill fish, crustaceans, and aquatic invertebrates. Highly toxic to bees. Harms mollusks, aquatic plants and zooplankton.	Potential imp fish, aquatic and aquatic p Special conc fish, bees, aq invertebrates, plants. Do n water. Spray morning to a
Bacillus thuringiensis (Dipel, Condor, Deliver, Foray, etc.) Valent Biosciences, Certis Corp. Registered-USEPA Toxicity Class III-slightly toxic; **not yet registered in Iraq.** For use on moth larvae on all crops.	Constant monitoring by trained scouts to detect armyworms, bollworms, and caterpillars. Not likely for pests to develop resistance to Bt, but rotating pesticides is still encouraged.	Very safe by acute oral or dermal contact. An eye irritant. Practically non-toxic to humans and animals by acute exposure. No known mammalian chronic health effects. No reproductive effects; non-mutagenic; non-teratogenic; an unlikely carcinogen; not an endocrine disruptor. No known effects on non-target organisms from normal use. Not toxic to birds, fish, aquatic invertebrates, earthworms, bees, domestic/wild mammals, aquatic plants, and beneficial arthropods, except possibly predatory mites and insects used for biocontrol of weeds.	Potential imp humans.
Carbaryl 10% D (Sevin) Generic, *and* Carbaryl 85% WP (Sevin) Generic; Registered-USEPA Toxicity Classes I DANGER to Class III CAUTION (depending upon percent of active ingredient present in formulation). Only Formulations of Toxicity	Constant monitoring by trained scouts to detect the presence of insect pests. Minimum effective dosages used. Insecticides	Skin, eye, ingestion hazards. May affect the lungs, kidneys, liver, and nervous system with chronic use. Highest risk to public is from residues in food. No reproductive or fetal effects, although lowered sperm counts and sperm morphological abnormalities have been noted. Possibly evidence of minimal teratogenic effects. Unlikely to be mutagenic. Potential carcinogen. Possible endocrine disruptor. Moderately toxic to fish and	Potential imp humans, fish, invertebrates, earthworms, target insects and other dor wild mammal Special conc

USAID's environmental regulations require that an Initial Environmental Examination (IEE) be prepared for all of the Agency's activities. Because pesticide use poses a risk to the environment where pesticides are to be used in an activity, the IEE must include specific pesticide factors. A Pesticide Evaluation Report and Safer Use Action Plan (PERSUAP) must be submitted with the IEE to address these factors.

PESTICIDE EVALUATION REPORT AND SAFER USE ACTION PLAN = PERSUAP

ACTIVITIES

An IEE and PERSUAP were prepared for the ARDI program in 2005 to:

- Review the pesticides used in the program's demonstration plots and activities, against US Environmental Protection Agency registration and use criteria
- Develop a list of approved, conditionally approved, additionally

The use of recycled containers particularly soft drink bottles is customary practice for many pesticide dealers.

approved, and rejected pesticides for the program

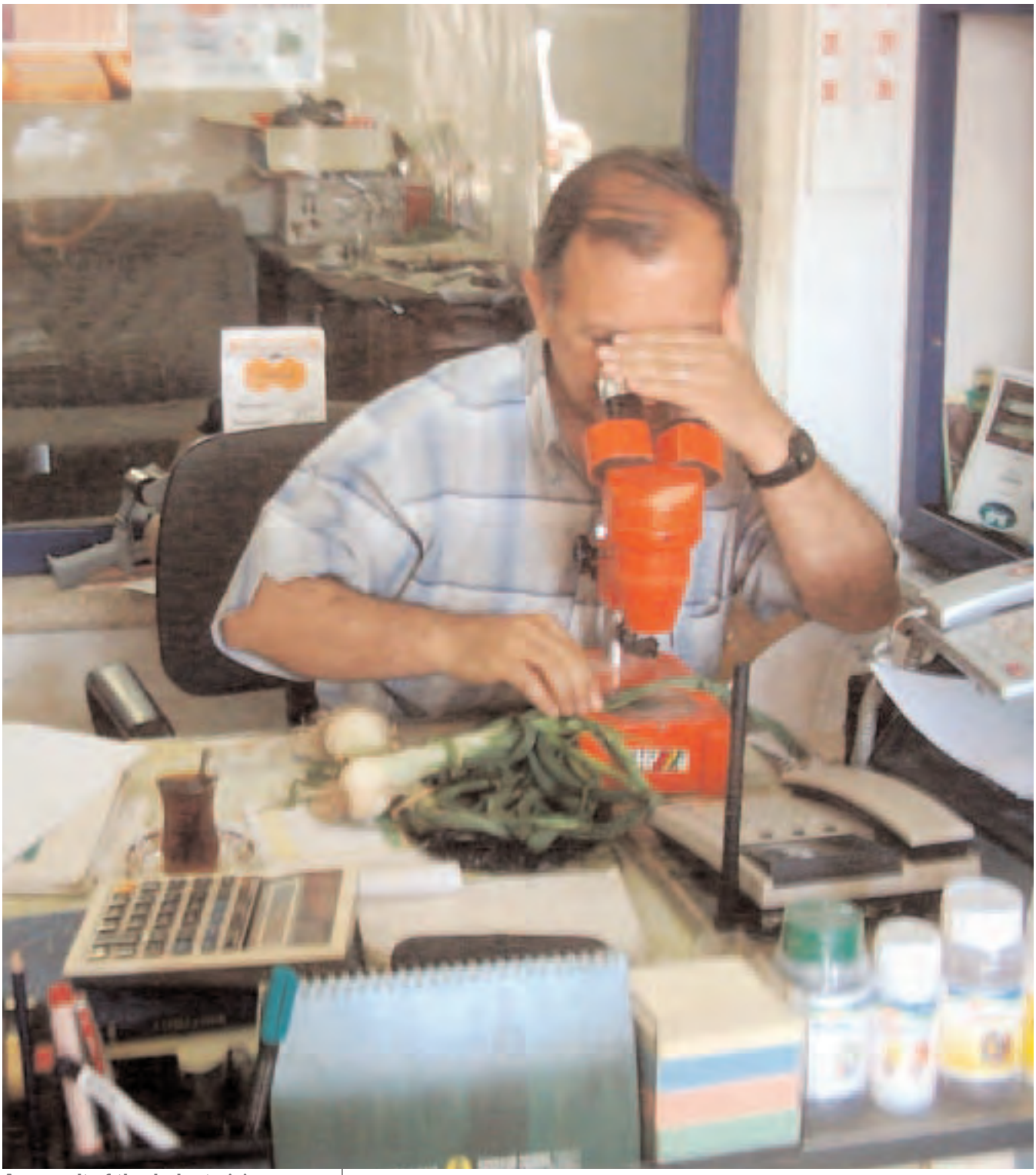
- Develop recommendations to mitigate the potential adverse environmental and health effects of pesticide dealers.

A specialist consultant was retained to undertake the required evaluations. All ARDI component managers provided details on their programs that used pesticides, including the crops, pests, pesticides, application rates, and application methods. The data were compiled into tables by ARDI staff, one for each crop/pesticide combination, and reviewed by the consultant against relevant EPA registration and use criteria for the pesticide.

RESULTS

The consultant developed a list of pesticides (13), herbicides (10), fungicides (5) and rodenticides (1) that were approved for program use. Another four pesticides were conditionally accepted and six were additionally accepted. An IEE and PERSUAP were prepared for the project, as well as a set of recommendations. Recommendations implemented by ARDI consisted of the preparation of information sheets for all approved pesticides; preparation of nonchemical pest management guidelines for tomatoes, apples and date palms; distribution of a pesticide application record form to all ARDI components; and completion of a pesticide use checklist by ARDI partner organizations prior to initiating activities using pesticides.

Date Palm
Pest Management Guidelines
Tomato
Pest Management Guidelines
Apple
Pest Management Guidelines
Agriculture
Reconstruction and
Development Program for
Iraq
Pesticide Reference Guide
ARDI Pesticides Safe Use Action Plan
March 2006



As a result of the dealer training activities conducted in coordination with the newly formed Pesticide Dealers Association, dealers are able to provide better extension services to farmers. ARDI developed several tools to assist the dealers with information, technical bulletins and diagnostic tools. The dealers and farmers have both commented on the better level of service and knowledge of the pesticide dealers after the training and workshops sponsored by ARDI.

3.6 SUPPORT TO PRIVATE SECTOR ORGANIZATIONS

Upon starting the project in 2003, ARDI found that Iraq had a vibrant and enthusiastic private agribusiness sector with great potential to provide the foundation for growth and development of agriculture. At the same time, the Ministry of Agriculture was committed to redefining its role in the agriculture sector by shedding many of the production and marketing activities it had assumed under a system of central planning. This made way for the emerging private sector to thrive, and ARDI worked to build private sector involvement in coordination with nearly all of our other programmatic work to increase production of agronomic crops, high-value crops, and livestock.

With the phased withdrawal of the GOI from direct intervention in the agriculture economy, agricultural producers were free, and indeed obligated, to make individual business decisions about their farms, which are rightly viewed as production enterprises. At the same time, there was a growth of private sector

organizations, including cooperatives, professional associations, and NGOs, seeking to contribute to the reconstruction and development of the agriculture sector.

ARDI implemented a variety of programs to assist private sector development and facilitate the transition to the market-based economy in a way that strengthened the agricultural economy. ARDI worked with private sector groups, including NGOs, cooperatives, and associations to strengthen their capacity through a series of skill-building workshops in business management and farm and financial management. There was also a Senior Policy Roundtable with policy makers and individual stakeholders. These workshops were designed to build the capacity of private individuals, cooperatives, NGOs, and government officials to operate in a market based economy and provide assistance to both farmers and agriculture-based enterprises.

ARDI also conducted many public-private sector stakeholder workshops. The purpose of them was to build a shared vision of public and private sector roles in a particular subsector or service area to promote public-private sector dialogue, and to recommend ways to strengthen the subsector or service area. Stakeholder workshops were held on integrated pest management, input supplies, agricultural extension, horticulture, honey production, avian influenza, marshlands restoration, and rangeland improvement. These workshops were designed to be highly participatory (small and large group discussions) and included representatives from MOA (local and national), other relevant ministries (e.g., irrigation, health, municipal government), NGOs (from across the country), associations, and farmers or business people. They typically included 60-120 participants.

As mentioned previously, private sector development activities were coordinated with efforts to improve agricultural production in agronomic crops, high-value agriculture, and livestock production. This section contains references to other parts of this report where those activities are discussed.

COOPERATIVE ASSOCIATION AND NGO DEVELOPMENT

Iraq's transition to a market-based economy after 2003 was accompanied by the emergence of private sector groups that sought to contribute to the reconstruction and development of the agriculture sector. These organizations are flourishing, and promise to play vital roles in the transition to the new economy. These organizations include:

- **Cooperatives:** Groups of individual producers who form a business to achieve economies of scale that will help increase production and/or improve marketing to increase revenue and profits.
- **Associations:** Groups of private sector producers or businesses working together to improve a specific agriculture subsector, e.g. beekeepers/honey producers or pesticide dealers.
- **NGOs:** Private sector, community-based groups working to improve

the agricultural sector through the implementation of agriculture development programs or extension activities.

Building the capacity of these private sector groups was an important element of the ARDI program. Private sector development was a cross-cutting activity that complemented ARDI efforts to improve agricultural production. For example, ARDI provided direct assistance to honey producers through specific and targeted projects. At the same time, we worked to build the capacity of honey producer associations, to increase private sector extension assistance to honey producers, and to assure continued assistance to many more producers in a sustainable way. Building the capacity of NGOs, associations, and cooperatives provides the foundation for a stronger private presence in Iraq's agriculture sector.

It is important to note that ARDI chose to focus its private sector development efforts on small-scale local businesses, rather than larger-scale internationally-oriented agribusiness conglomerates. This deliberate focus emerged from an understanding that many small-scale businesses are better placed to generate employment in those places needing it most than are larger scale agribusinesses. This is not to imply that large-scale businesses are not important to economic growth. They are. But ARDI sought to get money, knowledge and resources into the hands of as many people as possible to chip away at the pockets of poverty that beset Iraq at the time of regime change.

SUPPORT TO COOPERATIVES

ARDI's private sector development component emphasized the development of cooperatives. A cooperative is a business model in which members or owners purchase the right to participate, and all owners have equal shares in the business. Cooperatives permit a group of individual small-scale producers to achieve economies of scale and thus greater income and profits not possible to them operating alone. Cooperatives also bring economies of scale in technical know-how and business acumen, allowing less experienced producers or marketers to benefit from the knowledge and experience of fellow cooperative members or outside resources. As mentioned above, ARDI focused on developing cooperatives a means to create employment and income for as many families as possible. Much of ARDI's work took place in volatile areas, where the support of local governments and traditional leaders was critical, and where cooperatives offered alternatives to the less savory opportunities available to local populations.

When ARDI began working in Iraq, there was already much interest and activity in building cooperatives. The US civil affairs teams, for example, strove to develop cooperatives, although their focus was primarily on construction of buildings, community centers, and other assets that did not necessarily produce immediate income. USAID's Iraq Community Action Program (ICAP) also had a cooperatives program which had a much greater business orientation than that of the military. ARDI determined that the ICAP model was best suited for sustainable cooperative development, and adopted many of the principles formulated for ICAP's use. ARDI's programmatic focus was based on: 1) business training and financial analysis before investing in a cooperative project, during which ARDI would work with cooperative members to determine the feasibility

of a given investment; 2) member financial commitment, which required that individuals or families be willing to commit their own funds to the enterprise; and 3) procurement only of assets that produce income. ARDI cooperative projects did not invest in buildings or vehicles; rather, ARDI's investment was confined to such assets as seed cleaners, sheep, cattle, and veterinarian supplies, all of which produced income for the cooperatives.

ARDI's comprehensive program to establish cooperatives in the agriculture sector was implemented using the following process:

1. Identify cooperative groups

ARDI Private Sector Development Coordinators, with the assistance of local governments and NGOs, identified groups that were interested in establishing themselves as cooperatives for agricultural production or processing. The Coordinators met with the groups frequently to determine if they were likely to succeed as a cooperative, using such criteria as ability to work together to maintain a business structure, and capability to manage a large and complex project.

2. Establish the cooperative structure

Once a group was selected, the ARDI Private Sector Development Coordinators worked with it to build a cooperative administrative structure. The cooperatives elected a board of directors and officers, including a president, accountant, and technical supervisor. The Coordinators helped the group to select candidates with appropriate skills for each position.

3. Register the cooperative

The current law governing cooperatives still considers them to be social or political organizations and not business entities, so ARDI helped the new organizations to register accordingly, to achieve basic legal recognition and status. Each cooperative registered with district and governorate administrations, and the offices of the appropriate Ministry (usually Agriculture or Justice). When a new law is created to govern business-oriented cooperatives, these groups will be positioned to reregister under the new statutes.

4. Conduct feasibility study

Before project implementation could begin, the ARDI Private Sector Development Coordinators conducted financial and technical feasibility studies. They assisted the groups to construct cash flow and income statements, showing starting and ending balances, projected cash disbursements and income, and projected profits and losses. If the preliminary study revealed faults, the Coordinators helped the cooperative to improve the business model. For example, the Coordinators worked with a cooperative formed to breed dairy cows. After completing the initial feasibility study, they realized that the business plan called for the purchase of too many expensive calves of a breed that was not locally available. Based on the recommendations of the Coordinators, the cooperative changed its business plan to reduce the

initial purchase of calves, and decided to buy a locally available breed.

5. **Provide business management training and implement cooperative project**

   ARDI conducted business management training courses for all of its cooperative projects. Few cooperative members have any business background or education in basic finance or accounting. The training course included a discussion of Iraq's transition from a centrally planned economy to a market-based economy, and the significance of the change to agriculture producers.. Training also covered basic business, finance, and accounting principles, addressing specific business management skills, including developing a business plan, creating an income statement, managing cash flow, and strategic planning. At the conclusion of the training course, the cooperatives developed their own business plans, income statements, and cash flow statements.

   When the members of a cooperative complete the training course to the satisfaction of the Coordinators, they are prepared to begin project implementation.

6. **Monitoring and evaluation**

   ARDI staff continued to provide assistance to the cooperatives during project implementation. The ARDI Private Sector Development Coordinators visited the cooperatives at least once a month to monitor progress and ensure that each cooperative was operating according to its business plan. The Coordinators updated the cash flow and income statements based on actual results, and compared them to the original estimated statements to evaluate progress.

COOPERATIVES ASSISTED WITH GRANTS:

During the period May 2005 to September 30, 2006, ARDI assisted in the formation of 12 cooperatives, of which 10 were officially registered. The types of businesses included sheep raising, feedlots, beekeeping or honey production, and date processing, among other agricultural activities. Not all of these cooperatives were able to benefit from ARDI grants, as the end of ARDI's project funding grew near. However, the organizational groundwork was completed for the new cooperatives, and other donors or future USAID projects could very easily step in where ARDI left off, to provide continued technical assistance and matching grants. Below are examples of cooperatives that benefited from ARDI technical assistance and grants.

FEEDLOT COOPERATIVES

The ARDI Private Sector Development Coordinators identified two groups of farmers, one in Tameem and on in Ninewa, with an interest in increasing beef production. There is an growing consumer demand for beef in Iraq that presents an opportunity to farmers. However, most individual farmers rely on rangeland feeding of their animals, which can take years to reach optimal market weight. Also, the beef produced this way is inferior. Most farmers are limited in their capability to fatten cattle in feedlots due to the high cost of establishing

infrastructure such as barns and fenced areas, and the up-front expense of high-protein feeds. The two groups of farmers were interested in working together to invest in this infrastructure. They established cooperatives of 35 members each, to share the costs of feedlot construction (shelters and fencing). The ARDI coordinators provided assistance in establishing and registering the cooperatives, and trained the members to write a business plan and prepare cash flow statements.

Calves in the cooperative feedlot in Tameem

Each cooperative required that each of its members invest $300 cash, plus their labor for construction of the barns and fences to house the cattle. Each of the cooperatives also includes a veterinarian among the members. ARDI grants provided each cooperative with 125 starter calves, high-protein fodder, and maintenance equipment such as sprayers. The cooperative will use the revenue from the first batch of fattened cattle to procure inputs for the next batch, including additional calves and high-protein feeds. Any profits are reinvested in the organization or distributed to the cooperative membership.

SHEEP RAISING COOPERATIVE

Sheep production is a lucrative economic activity in Iraq. Sheep herders gain income principally from the sale of meat, for which there is high consumer demand. However, most sheep holders adhere to traditional production methods, and rely having their animals graze on sparse rangeland. This is often due to the initial costs of improved feed, which can be prohibitive for many breeders. (For a more detailed discussion of improving nutrition for sheep, see section 2.5). A group of breeders working together, can however, overcome this initial barrier to entry. ARDI identified a group of 33 farmers interested in producing fattened lambs for market, as well as milk and milk products. ARDI Coordinators helped the group establish a cooperative, by offering assistance with organizational development and legal registration. As always, ARDI Coordinators trained the group in business administration and accounting practices.

Each member of the cooperative paid a subscription fee to cover some of the initial start-up costs, including infrastructure for sheep shelters and inputs including sheep, grain, and basic equipment. In addition, the group included three agricultural engineers and a veterinarian, who will participate in the project as well as provide training to all members and employees of the cooperative.

To help the cooperative get started, ARDI provided an in-kind grant of sheep, grain for feed, and basic equipment. This enables the cooperative to produce the first batch of lambs and gain additional income from the sale of milk, milk products, and wool. Income from animals and animal products will be reinvested in new inputs for the operation, and profits can be either reinvested for growth or distributed to members.

"One of the PSPs told us that he was gasoline seller and he was shamed of this job because it was in the black market but now his dream became true and he is proud of his job."

PRIVATE VETERINARY SERVICE PROVIDERS

In addition to cooperatives, ARDI focused attention on the development of Private Veterinary Services Providers (PSPs). While the Ministry of Agriculture does maintain veterinary clinics that provide a minimum of services (mainly vaccination campaigns) to small-scale animal breeders, the Ministry clinics are not equipped to provide they many additional services required by animal breeders to maintain the health of their herds and flocks. Additionally, most government-operated clinics are located in the larger towns, leaving the farmers in rural areas without easy access to veterinary services. ARDI, while working with the MOA on the rehabilitation of its veterinary clinics network, determined that there is room in Iraq for a parallel and private network of veterinary services to augment the work of the government. Importantly, there are thousands of unemployed veterinarians in Iraq, many of whom welcomed the opportunity to work out of their own private clinics.

ARDI planned and implemented a program to establish private veterinarian services in the rural areas underserved by government facilities. ARDI project coordinators first contacted the Veterinary Syndicate (VS) in each governorate. The VS is a professional organization, funded by membership dues and partially by the government, that supports the technical and social needs of its members. Every governorate in Iraq has a Veterinary Syndicate, and every veterinarian graduating from a certified veterinary school is required to be a member. In order to achieve efficiencies in costs and time, each project was planned to establish 10 PSPs in each governorate. Each new start-up business would be operated under a partnership of two or three professionals, providing employment and income to a minimum of 20 veterinarians in each governorate, and extending services to 10 rural areas.

The Veterinary Syndicate presidents helped ARDI to select willing and qualified professionals to set up small businesses to provide veterinary services. Selection was based not only on professional skills. Candidates were sorted by probable business acumen as well. The veterinarians who were selected were charged with locating and renting or purchasing suitable space to start their businesses. The VS and ARDI conducted feasibility studies on each group of 10 PSPs, taking into account the number of animals in each governorate and the estimated demand for services based on potential incidence of disease. ARDI private sector coordinators then assisted each new PSP to secure a business license, and trained the veterinarians in business and accounting principles. In addition, ARDI

provided a grant in the form of medicines and other equipment considered most important for operation of a private sector clinic. ARDI administered these in-kind grants through the Veterinary Syndicates, which were responsible for ensuring that each private sector provider received the materials promised under the grant award.

ARDI supported the establishment of 40 private sector veterinary clinics, ten each in Ninewa, Tameem, Dahuk, and Salah al-Din governorates. These 40 clinics provided business ownership and employment to 100 formerly unemployed veterinarians. In the governorates of Tameem and Salah al-Din, clinics were established with two partners, and in Ninewa and Dahuk each clinic was operated under a partnership of three veterinarians. Following the establishment of these clinics, other Veterinary Syndicates in other governorates contacted ARDI about implementing a similar program. While we were not able to respond to those requests, due to project close-out, the project model has been established, and the Syndicates are likely to pursue other opportunities for assistance.

The initial results of the PSPs for veterinarian services were encouraging. Animal breeders were quick to seek the services of the PSP vets, not only for medicines and vaccines, but also for surgeries and diagnoses.

ASSOCIATION DEVELOPMENT

Associations are groups of producers or agribusinesses working together to improve a subsector of the agriculture economy. Associations can investigate, plan, and act for the benefit of all members, providing advantages that most individuals could not obtain on their own. An association represents members' interests to the government and other groups, enables the implementation of industrywide standards and regulations to strengthen the sector, and also can provide extension services to the membership, to help improve production or marketing practices. ARDI worked extensively to help establish and strengthen beekeeping/honey producer associations at both the regional and national levels. We also helped pesticide/agricultural input supply dealers to establish and strengthen a national association.

In August 2004, ARDI published in English and Arabic two manuals to support association development: Technical Manual – Forming and Strengthening Associations in Iraq; and Facilitator Manual – Forming and Strengthening Associations in Iraq. These manuals, based on DAI's work with associations in Egypt, focus on organizational development, forming effective committees, strategic thinking and planning, creating and implementing policy advocacy programs, and building effective communications programs. The manuals were later translated into the Kurdish language and published in December 2004.

The strategic thinking and planning module of the Facilitator Manual was modified to become a two-day workshop, piloted in June 2005 for the Mar Oda Farmers Association. A facilitator training course was then developed around this 2-day workshop in June and August 2005, so that NGO facilitators would have the capacity to replicate the workshop for other associations and NGOs. In July 2006, the ARDI Private Sector Coordinators prepared to conduct the Strategic Thinking and Planning Workshops for more advanced cooperatives.

Equipment such as this honey centrifuge can be share among association members.

The expected outcomes of the 2-day Strategic Thinking and Planning Workshops were:

- An agreed-upon mission statement that answers questions such as, "What kind of organization is this?" "Why does it exist and whom does it serve?"
- Agreed-upon strategic objectives that determine future direction over the next 2 to 3 years.
- Agreed-upon organizational structure that is both feasible and desirable.
- Agreed-upon plans (action items) for what the association will do in the upcoming year, and who will be responsible.

Associations that think and plan strategically are better focused, have better member commitment and participation, and achieve better results than those that are more reactive in nature. Planning is important because it causes discussion, debate, and generates consensus among the association leaders about direction and priorities. Good planning requires consensus building, which is an integral part of an effective association. Associations should not be predominantly "top-down" structures. In reality, these organizations by their very nature are consensus organisms. If this consensus breaks down, it will have a negative impact on results.

BEEKEEPING AND HONEY PRODUCER ASSOCIATIONS

There are tens of thousands of apiaries in Iraq. Every governorate in the country has thousands of small-scale honey producers whose small amounts of honey are used for home consumption and sale in local markets. In some parts of the country (particularly in the cooler northern governorates) honey production is a significant part of total on-farm earnings. Early in project development, ARDI found that focusing efforts on honey production would be a means of improving the welfare of thousands of farmers across the country. Honey production in Iraq at one time competed well in regional and international markets, and producers were eager to reclaim their formerly strong position. ARDI staff and key leaders of this important subsector accordingly planned a schedule of activities to rehabilitate the industry. The plans called for the development of producers' organizations, improved technologies for production and marketing, effective controls against disease and pests, and assuring accessibility to best equipment and supplies in local markets. The goal of the project was to displace imported honey in local markets, followed by strategies to achieve economies of scale that will permit the export of Iraqi honey.

In February 2005, 15 delegates from the governorates of Baghdad, Basrah, Diyala, Kerbala, Najaf, Qadissiya, and Wassit met at an ARDI-sponsored workshop in Erbil. These delegates, who represented a total of 548 producers, discussed the beekeeping situation in their areas and identified concerns and areas of opportunity to improve beekeeping and honey production. The leaders agreed on three priorities for the future: the establishment of strong regional and national associations, setting standards for all packaged products and labels, and organizing a trade fair to promote beekeeping.

Honey producers display their products at the National Trading Fair

This meeting illustrated the importance of cooperation between honey producers to improve the subsector. ARDI set out to strengthen beekeeper/honey producer associations in Iraq on the regional and national levels, to give their voices weight in policy matters. Their purpose was also to set commercial standards for honey production, and to provide extension services and information to help beekeepers nationwide improve honey production and increase their income. ARDI provided resources to help establish governorate-level associations in Basrah, Dahuk, Erbil, Ninewa, and Tameem, by providing funds for meetings to form the associations, as well as a series of conferences, and workshops. The first priority of these new associations was to help honey producers improve their marketing practices and increase their sales. One focus was to help beekeepers introduce better packaging and labeling, to make their product more attractive to the domestic market and better able to compete with imported products.

ARDI also provided organizational development assistance to strengthen the new and existing associations. The ARDI Private Sector Development Coordinators delivered a two-day business management training course for members of honey production associations from 14 governorates (Baghdad, Babylon, Basrah, Dahuk, Diyala, Qadissiya, Erbil, Kerbala, Najaf, Ninewa, Anbar, Sulaymaniyah, Tameem, and Wassit). The participants, all of whom manage their association's administration and finance activities, learned basic skills to help them better manage funds and operate their associations more efficiently.

The beekeeper/honey producer associations are now working to provide a range of services to their members, including:

- Providing assistance to increase the quantity and quality of honey produced through improved technologies and practices, such as the correct use of

ARDI SUCCESS STORY: BEEKEEPING TRAINING CENTER FOR BEEKEEPING ASSOCIATION

In early 2005, ARDI established a beekeeping training center for the Kurdistan Bee Professionals Association (KBPA), to give them the means to improve beekeeping in the region. An ARDI grant provided funds for construction of the training center, and the inputs (concrete blocks, wood, cement, sand, gravel, mats, hives, boxes, tools, medication and other beekeeping equipment) necessary to begin conducting training courses. The new training center maintains 30 beehives to conduct training courses for local beekeepers, and the center is also used by the local university and agricultural college for research and development of new beekeeping methods. Since the center was established in 2005, the KBPA has completed over 20 training courses and demonstrations for beekeepers and students; they were attended by more than 1,000 people.

modern beehives, packaging materials, medicines, and pesticides;

- Promoting cooperation among beekeepers and providing forums to discuss problems and potential solutions;
- Representing the interests of their governorate's beekeepers before the national beekeeping association, government agencies, and international donors.

The successful launch of these associations can serve as a model for other producer groups (e.g., dates, poultry, fruit, and vegetables) throughout the country. With good leadership, which seems to come naturally to passionate beekeepers, ARDI supported significant improvements in the marketing and production of honey, and some of the associations are hoping to export honey towards the end of 2006.

Table 96 shows ARDI efforts to establish new beekeeping associations, and strengthen existing ones.

TABLE 96 BEEKEEPERS ASSOCIATIONS ESTABLISHED AND STRENGTHENED

Newly Established Association		Existing Associations Strengthened	
Governorate	**Members**	**Governorate**	**Members**
Basrah	70	Diyala	230
Dohuk	200	Sulaymaniyah	2,535
Erbil	450	Iraq Beekeepers Association*	750
Ninewa	50		
Tameem	30		
Total	**800**		**3,515**

* This association has branches in Anbar, Baghdad, Babylon, Kerbala, Muthanna, Najaf, Thi-Qar, and Wassit.

PESTICIDE AND AGRICULTURAL INPUT SUPPLY DEALERS ASSOCIATION

Working with pesticide dealers was an important element of ARDI's efforts to improve integrated pest management (IPM) in Iraq. ARDI found that there was very little regulation of the pesticide industry, which resulted in large quantities of expired, counterfeit, and generally poor quality pesticides appearing in the market. (See Section 3.5 for a full discussion on ARDI work with Integrated Pest Management.)

In 2005, ARDI met with dealers throughout Iraq to gauge their interest in forming an association of pesticide dealers to improve the industry. At these workshops, the dealers revealed that they considered the lack of regulation of pesticides in Iraq to be a major problem, as the abundance of expired and fraudulent pesticides in the market made it difficult to operate a business selling good quality pesticides. The dealers agreed that a pesticide dealers association which would include an element of self-regulation would be an appropriate means to alleviate some of the problems that they face in providing high-quality products and sound advice to farmers.

From May 2005 to January 2006, ARDI held several workshops to facilitate the establishment of a pesticide dealers association. These workshops, which were attended by a total of 217 dealers from all parts of Iraq, were led by

representatives of an agrichemical association in Egypt, Crop Life Egypt. They discussed the structure and activities of the association and their relationship with the Ministry of Agriculture in that country. The workshops also served to determine the dealers' training needs. On January 26 – 27, 2006, 53 dealers from 15 governorates reached consensus on the basic structure for the association and elected committees to handle registration, management, and finance. Formal registration of the Iraq Association for Agriculture Development and Promotion was official on May 24, 2006.

One of the main objectives of the association is to agree on self-regulatory guidelines within the pesticide industry, to ensure that all dealers in Iraq are qualified and follow the necessary laws and regulations, so that only appropriate high-quality products are on the market. The association assigns high priority to the protection of the environment and human health, and to assuring consumer satisfaction. The association also plans to work with the GOI to introduce appropriate pesticide legislation on the national level.

In addition, the association will provide technical assistance to its membership. In a survey of pesticide dealers in 2005, ARDI found that they were looking for increased access to training in pesticide use, in order to provide better service to their customers. Association leadership is familiar with ARDI training templates and methods, and is equipped to continue providing technical training to an expanding membership.

NGO DEVELOPMENT

NGOs can play an important role in agricultural development. These organizations, in many countries around the world, work in partnership with government and donor organizations to provide complementary skills and management capability. They are very often able to contact, in a nonpolitical and nonsectarian way, groups of farmers who are outside the reach of government, or on projects that the government is not equipped to address. These organizations can also monitor government and private activities to ensure that services are delivered fairly and that policies do not do adversely affect people or the environment. In both developed and developing countries, NGOs perform services that are unique.

When ARDI arrived to Iraq in October 2003, there was a handful of small newly-established NGOs. Over time, in part through ARDI's help and the assistance provided by other USAID projects and donor organizations, the nascent NGO community developed and expanded into a dynamic actor in national development.

A number of these new nongovernmental organizations work specifically with agriculture development, and focus on small to mid-sized farmers to increase production, income, and standard of living. These NGOs often fill gaps in government extension work, especially in rural areas where there are few government resources for extension services. These organizations have proven to be valuable partners in implementing development projects. They are able to travel freely throughout most parts of the country, they are quick to gain the trust of beneficiaries, and they help to assure Iraqi "ownership" of community-based projects. Seeing these groups as valuable partners, especially as time went

ARDI SUCCESS STORY:
NATIONAL TRADE FAIR FOR HONEY PRODUCERS

In 2005, ARDI sponsored a national trade fair, hosted by professional beekeeper associations in Basrah, Dahuk, Diyala, Erbil, Ninewa, Sulaymaniyah, and Tameem, in addition to the Iraq Beekeepers Association. Fifty-two beekeepers and honey producers from 14 governorates attended the fair, which showcased the country's beekeeping industry and promoted Iraqi honey production and sales. Beekeepers exhibited their honey and honey products (medicinal products, food, and beekeeping equipment). One of the carpenters trained by ARDI displayed the modern beehives and other equipment he had built. The fair also gave beekeepers an opportunity to share information and experiences through two seminars on marketing and common problems beekeepers face in producing and selling honey.

NGO members at a facilitation skills training workshop

on and working conditions on the ground became more difficult, ARDI formulated a program to work closely with NGOs to strengthen their capacity for project implementation. We also assisted them to become self-sustainable engines for development, with the ability to develop, fund, and implement projects independently.

INCREASING CAPACITY FOR PROJECT IMPLEMENTATION

ARDI worked closely with NGOs to implement development projects, and provided guidance which increased their capacity, especially in terms of project monitoring and reporting. This was particularly important, since the NGOs were able to reach and work directly with large numbers of farmers where ARDI staff were prohibited from travel for security reasons.. We partnered with a total 40 Iraqi NGOs to implement nearly 90 grants and subcontracts, including cleaning canals, training mechanics on agricultural machinery repair, community beekeeping, and a range of other projects. A smaller number of these organizations proved to be especially capable, and they increased their capacity and outreach significantly while working in partnership on ARDI projects.

In addition, ARDI offered formal assistance to develop the capacity of NGOs to implement projects. We held two workshops to train staff of NGOs that work with farmers in Muthanna, Basrah, Kerbala, and Qadissiya on grant management and implementation. The courses included training in how to recognize grant opportunities, write grant proposals, organize labor, handle payments, and maintain records and reports. The courses emphasized the importance of developing and implementing self-sustaining projects to avoid reliance on international or other donors. A series of shorter sessions was held with NGOs to provide guidance on budget and management rules associated with US government grants and contracts, as well as training in budget and financial management to assure full compliance with statutory requirements.

Participants at an NGO leadership skills development workshop.

IMPROVING INTERNAL ORGANIZATIONAL CAPACITY OF NGOS

In addition to building specific capacity for project management and implementation, ARDI provided assistance to NGOs to build their internal organizational capacity. This included workshops on strategic planning, which helps an organization define its priorities to use its resources in a focused manner that achieved its goals. A strategic plan is a written statement of short and long-term goals that are agreed upon by the organization's members, and the tasks that must be completed to achieve them.

Facilitation is another skill that is important for organizational development, as facilitation enables participatory decision making that helps groups reach agreement and solve problems by consensus. Decisions reached though a participatory process lead to a more efficient and effective organization. Much of the Iraqi workforce is unfamiliar with this type participatory decision making, due to decades of top-down management under the former regime.

ARDI created a training course in facilitation and a manual entitled Technical Manual: Forming and Strengthening Associations in Iraq, which contains exercises to foster facilitation skills. The training course was presented as a series of two workshops. During the first workshop, the participants learned the four basic skills of facilitation: 1) asking questions; 2) paraphrasing; 3) summarizing; and 4) encouraging, and applied them in practice discussion sessions. During the second workshop, participants learned how to use tools such as a flip charts to facilitate discussions and build consensus. In small groups, the participants chose a topic for discussion, designed flip charts and facilitated a discussion with the larger group. The participants also learned how a facilitator should interact with a client, including how to identify a client's needs and plan an agenda. This two-part workshop format was repeated three times to include NGO leadership from all parts of the country.

NGO LEADERS WORKSHOPS AND NGO NETWORK

In addition to working with individual NGOs to develop capacity, ARDI encouraged them to coordinate their efforts to assist in developing Iraq's agriculture sector. In September 2005, We held the first NGO Leader's Workshop to bring together representatives from ten NGOs working in the governorates of Basrah, Muthanna, Ninewa, Tameem, Sulaymaniyah, Erbil, and Dahuk. During that workshop, ARDI representatives introduced concepts of leadership and management, with emphasis on the leadership role of NGOs and NGO leaders. This role includes bringing stakeholders together to develop a shared vision for agriculture development and "collective strategies" for achieving this shared vision. Also taught was the importance of building alliances and coalitions and bringing these coalitions behind the shared vision and collective strategies. ARDI provided an overview of our activities in the agriculture sector, as well as an outline of priorities for the coming year. The NGO representatives shared their organizations' areas of focus in the agricultural sector, and worked in small groups to discuss strategies for broad-based action in the agricultural sector, through collaborative work with government agencies, private entrepreneurs, farmers' organizations, and the international community.

At the conclusion of this first workshop, the participants agreed that it would be beneficial to build strong relationships between their groups to share technical experience, and discuss collaboration. To this end, the group proposed the creation of a coalition of NGOs working in the agricultural sector.

In late December 2005, a second NGO Leaders Workshop was held to bring together the original NGOs and nine additional ones that work in the agriculture sector. The workshop built on the leadership themes of the first workshop, especially in bringing about major change. The NGO leaders established the NGO Leaders Network, and worked toward the development of a vision and mission statement.

In addition to the creation of the NGO Leaders Network, the participants discussed the need to work together to build a stronger relationship with the Government. The lack of sufficient communication with the Government was identified as the major constraint to accomplishing the mission of the NGO Network. To address that, the NGO leaders planned to invite MOA officials to a seminar to demonstrate the value that the NGOs bring to developing agriculture in Iraq, and to clarify the role that private sector organizations should play in informing the government decision-making processes.

SENIOR POLICY ROUNDTABLE

Participants at the Senior Policy Roundtable.

The transition from central government control to a market-based economy demands certain changes in both government policy, and the private sector stance in regard to the government. ARDI provided assistance to all actors to facilitate this transition in the agriculture sector, one of the most important in terms of income generation and employment. As part of this effort, ARDI sponsored a Senior Policy Roundtable workshop in February 2006 to bring together representatives from the Ministry of Agriculture and the private sector, including nongovernmental organizations that work in the agriculture sector, farmer associations, and farm owners to discuss the transition to a market economy, and agricultural policy development in Iraq. A total of 39 participants from eleven governorates (Baghdad, Basrah, Wassit, Qadissiya, Ninewa, Tameem, Najaf, Diyala, Erbil, Sulaymaniyah, and Dahuk) attended the event..

The workshop, which was facilitated by ARDI training staff, included a

presentation of economic concepts that are essential for participating in, and creating, policy for a market-based economy. These concepts include supply and demand, price determination and discovery, developing market orientation, and the consequences of alternative agricultural policies affecting production, consumption, and trade, and their impacts on producers, consumers, and taxpayers.

Workshop facilitators encouraged discussion about agriculture in Iraq and comparisons to other market-based economies, including the United States, the European Union, Egypt, and Brazil. The importance of understanding all policy consequences, costs, benefits, and implications before the policies are implemented was emphasized. ARDI staff illustrated this point using the example of farm payments, which can raise land values and farm rental rates, and lead to higher costs and long-term competitive decline.

The example of agriculture credit in Brazil was also presented, with an emphasis on strengths, weaknesses, opportunities, and possible implications of similar policies for agriculture in Iraq. In discussion groups, the workshop participants raised pressing concerns about lack of production inputs, including capital and credit, fertilizer, high-quality planting seed, fuel, new technology, and ability to market crops and livestock nationally and internationally. The participants agreed on the necessity for new policies that will clear obstacles to increased production and profitability, and create employment.

The workshop was successful in clarifying the role of the Government in making policy in the agriculture sector. At the beginning, many of the participants believed the Ministry of Agriculture to be both creator and implementer of agricultural policy. By the end of the workshop, they understood that it is the role of the elected legislature to make policy, and the role of the Ministry to implement it. The participants then recognized the need for a broader discussion of agricultural policy with elected officials, the Ministry of Agriculture, and the private sector.

FARM AND FINANCIAL MANAGEMENT

Several of the NGOs who attended this training utilized the materials to provide additional training to farmers and their local areas.

In a market-led economy, the role of the MOA shifts from direct intervention in commercial activities to providing an institutional framework and environment in which the private sector will prosper. Farmers also have an enhanced role in the market-led economy, as free agents whose business decisions are primarily driven by economic factors. The MOA, therefore, has an essential function in economic analysis, policy formulation, and provision of basic farm management. MOA must also give technical advice to farmers, so that they can make good business decisions regarding the choice for levels of inputs, cropping patterns, marketing and storage options, livestock feeding rations, and a host of other factors.

In order to strengthen the economic analysis and policy formulation functions of the MOA, and upgrade the management skills of the farmers in order to provide them with a better opportunity to run financially successful farms, ARDI implemented a series of short courses in Farm and Financial Management. The

objective of the courses was to teach MOA crop demonstration field staff, and members of NGOs working in agricultural development, the concepts for operating a farm according to a business model, and to prepare them to work directly with farmers to impart these concepts.

The training courses, which were developed and delivered by an ARDI agricultural economist, taught methods to assess the economic returns of alternative crops compared to existing production cycles, as well as the following topics:

- Basic record keeping;
- Developing and using budgets and break-even analysis;
- Whole farm planning and strategic planning;
- Using balance sheets and income statements;
- Farm performance and financial ratio analysis;
- Investment analysis; and
- Computer applications in investment analysis.

Participants included governorate Ministry of Agriculture officials and members of private sector agricultural development organizations. A total of four courses was delivered, attended by 140 participants from 15 governorates.

The course was extremely popular, and many of the NGOs expressed interest in replicating it for additional staff members. ARDI gave interested NGOs the Basic Farm Management workshop materials to use in repeating the course, and also provided assistance to the NGOs to help them train additional staff to run these workshops for farmers. We held a "training of trainers" (ToT) workshop for five NGOs in order to provide a refresher on the Basic Farm Management course material, and to provide assistance with the workshop logistics. A total of 14 members from these NGOs who had attended the original ARDI workshop participated in the ToT course. ARDI staff reviewed the Basic Farm Management course material, and the participants discussed the importance of using examples and case studies from the Iraqi environment to enable their audience to relate better to the material. The NGOs will collect real information for case studies from Iraqi farmers, to use as examples during their workshops. The second part of the course concentrated on planning and coordinating the Basic Farm management workshops. The participants discussed different methods for farmer outreach, to include delivering the course to the farmers in their own villages, in a familiar environment, and the use of appropriate visual aids to illustrate concepts.

3.7 STRATEGY FOR WATER AND LAND RESOURCES IN IRAQ

A temporary water reservoir created for a field trial and using a distant water supply.

INTRODUCTION

There is a pressing need for a new, comprehensive master plan for management of Iraq's water and land resources. Many of the current guidelines for water use are based on a plan that was developed between 1972 and 1982 by Iraq's Ministry of Irrigation, working with Soviet advisors. The plan, which was developed through data collection, mathematical modeling, and evaluation of various scenarios, covered water, salt, and soil management, agriculture and irrigation, fisheries, water supply, hydropower, flood control, erosion control, and navigation. This plan proposed action over a twenty-year period, which ended in 2000.

Iraq's newly-formed Ministry of Water Resources (MoWR) recognized the need for a new effort to create an updated integrated master plan for developing and managing Iraq's water resources. In early June of 2005, ARDI brought together several of the relevant ministries to discuss the formulation of an updated master plan for water and land resources management.

The participating ministries agreed that there was a need to create a mechanism for coordination on matters of water resources planning. At the time, each government ministry or institution managed its own water use with limited consideration for the needs of other stakeholders. There was little knowledge of, or capacity to accurately determine, the actual amount of water available to Iraq, nor the capability to allocate the water between sectors in a rational manner.

Governorates with water projects.

During the initial meeting, the parties agreed to collaborate to develop a Strategy for Water and Land Resources in Iraq (SWLRI), a precursor to the development of a new master plan. They further agreed to establish a SWLRI Steering Committee under the chairmanship of the Minister of Water Resources, with key representatives from all ministries with an interest in the appropriate management of Iraq's water and land resources.

Once agreement was reached with all relevant ministries to cooperate in the development of the SWLRI, ARDI helped create a Planning Approach (Fig. 1) which has three stages: collection of necessary data, evolution of the strategy plan (including model development), and strategy reporting.

There was consensus that the development of the SWLRI would occur in two phases. Phase 1, a collaboration between ARDI and the participating Ministries with extensive oversight from the MoWR and SWLRI Steering Committee, would focus on collecting relevant data from all ministries and creating a framework for management and development of Iraq's water and land resources over the next few decades. Phase 1 activities would be carried out over a 14-month timeframe and consist of data collection under Stage A (see Fig. 1) and the initiation of activities under Stage B. Phase 1 includes:

- Data collection across all ministries to compile data sets of current information, needs in the water sector, and future opportunities (project and program development);
- Development of models and tools to inform the planning process, with a schedule to demonstrate the planning process through a run of all the models;
- Training and capacity building within the Government to ensure that staff have the necessary capability to proceed with implementation of the SWLRI in Phase 2.

Phase 2 of the SWLRI project will be led by the MoWR and will involve selection of appropriate interventions and identification of priorities in the water and land sectors using the data sets, tools, and models developed during Phase 1. This phase will also initiate the development of a "rolling" master plan that can be updated periodically upon receipt of new data and/or policy changes.

To facilitate its leadership role in the development of the SWLRI, the MoWR established a special SWLRI unit with dedicated staffing resources, including two senior chief engineers, an expert agronomist, two irrigation engineers, and two IT engineers. ARDI provided funds for the establishment of the unit, including equipment for the offices and some of the initial staff positions. The SWLRI unit took the lead coordinating efforts, both within MoWR and between ministries within the Steering Committee.

In addition ARDI subcontracted to Mott MacDoland (MM) and US Army Corps of Engineers, Hydrologic Engineering Center (HEC) to assist in the effort, based on their previous work in Iraq and their knowledge of the water resources in the region. The following sections of this chapter provide a summary of the outputs and accomplishments of the SWLRI team.

DATA COLLECTION

The first step in the development of SWLRI was to create a mechanism by which the relevant ministries could share water sector data. Because each ministry managed its own water use and needs data, other ministries did not necessarily know what kinds of information were available in other sectors. The SWLRI Steering Committee met on a monthly basis to review the data collection process.

To facilitate data collection and coordination, ARDI funded the creation of a Claromentis database, a web-based data management system that was designed to give each ministry a secure, customizable intranet in which to upload and manage its own data. One of the major challenges in the SWLRI effort was transparency of the data. Many ministries, particularly the MoWR, were resistant to the idea of giving full access to all water-related data. The Claromentis system solved this problem by storing all the information on a single server, with only the MoWR as the lead ministry and ARDI consultants able to access all the data.

The Planning Approach (see Figure 1) gave the outline of data collection needs. ARDI consultants worked with the Steering Committee to clarify what types of data were needed from each ministry. There are five types of information that needed to be compiled to provide the basis for strategic planning for water and land resources:

1. Inventories that list and map the locations of physical infrastructure (dams, boreholes, canals, drains, weather stations, pumping stations, etc.) and monitoring points. The inventories reflect the number and status of facilities in Iraq as they are now, and in some cases as they were in the past.
2. Time series records of river, canal, and drain flows; water quality; population details agricultural production statistics, etc. These should be regularly updated at a frequency to suit each type of data.
3. Aerial features of the natural environment and anthropogenic activities (soil type, forestry, land classification, population distribution, cropping patterns, urban areas, seasonal flooding, salinization, etc.). When linked to remote sensing and to GIS, aerial information can be presented in many ways that contribute to the overall planning process.
4. Planning framework: details of national goals as expressed in government policies and legislation that provide the context for strategic planning for the water and agriculture sectors. This includes the policies and plans for other sectors (energy, health, trade, etc.) that are linked directly or indirectly to the water and agriculture sectors. The water sector cannot be considered in isolation, and up-to-date information on the activities in other sectors will be needed.
5. External pressures, including economic status and relations, migration, international relations, climate change, international commodity prices, etc.

With the planning approach in place and data collection needs outlined (Information, Needs, and Opportunities), the process of data collection began. The Steering Committee appointed Data Collection Leaders (DCL) from each ministry to facilitate the data collection process. These DCLs worked with other

SWLRI STEERING COMMITTEE

Ministry of Water Resources

- Ministry of Agriculture
- Ministry of Electricity
- Ministry of Transportation
- Ministry of Environment
- Ministry of Municipalities and Public Works
- Ministry of Agriculture and Irrigation in Erbil*
- Ministry of Agriculture and Irrigation in Sulaymaniyah*
- Ministry of Planning and Development Cooperation
- Ministry of Trade
- Ministry of Industry
- Baghdad Municipality

* Now the Ministry of Agriculture and Ministry of Irrigation of the Kurdish Regional Government.

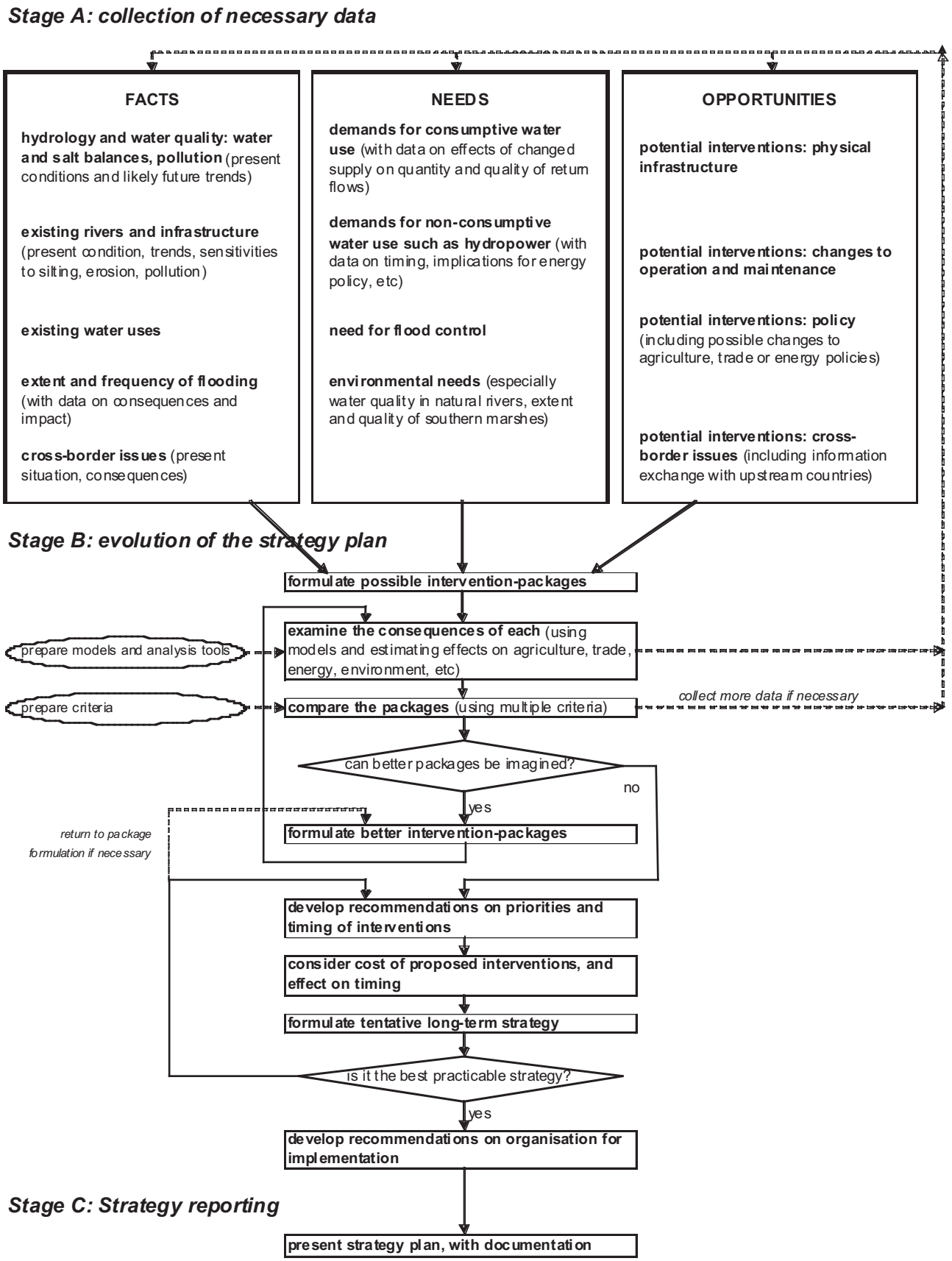


Figure 1 - Planning Approach for SWLRI

government and Iraqi consultant staff to collect the required data. This data collection process was a 14-month effort, and ARDI provided constant support to the DCLs and the Steering Committee to clarify data collection needs and prepare data for use in the development of models and other analytical tools.

These activities included:

- Scanning hard copy data sheets, reports, drawings, maps, etc, in order to build up an electronic archive of available information in the selected Claromentis data base system;
- Transferring numerical information from hard copy data sheets to digital format (spreadsheet is the most common format, but optical character reader (OCR), database, delimited text files, HEC-DSSVue were also used);
- Translating where necessary to allow key information to be shared between all parties;
- Identifying gaps, tracing missing information; and
- Reviewing data for quality control.

There was a significant lack of good historical data and a lack of information on future programs. The historical data were reviewed and corrected, based on additional data collection, additional sources, or analysis of trends to determine more reasonable values. Some of the historical data have been destroyed and cannot be recovered. The information on future plans was difficult to get, mostly due to resistance within various ministries to making their plans known to other government ministries and outside entities. This issue was partially resolved and information was more forthcoming as ministries began to see the importance of carrying out a comprehensive master planning effort for the rational utilization of water and land resources in Iraq.

Data were also collected from other sources within the ARDI project, most notably the Agro-Ecological Zone program and the Agro-Meteorological Network program, both of which are working to improve collection and use of data relevant to agricultural production (see Section 3.1). Data collected under these projects, including weather, crop water requirements, and agricultural land use were entered as part of the SWLRI data collection effort.

The inflow data feeding the water management system model also received attention under SWLRI. This work carried out by HEC included reviewing data collected through Claromentis, coordinating with the MoWR on quality control, and updating of hydrologic data records developed earlier under the IMRP. In addition, HEC improved modeling datasets reflecting the 1930- ("natural"), 2004- ("present"), and 2030- ("future") conditions of impairment based on updated information regarding water resources projects and associated utilization and planned development upstream of Iraq. For the convenience of the MoWR, these analyses were performed in spreadsheet tools that estimate historical impairment and generate datasets for years 1930 through 2004 for the Mosul, Bakrman, Bekhme, Dokan, Adhaim, and Derbendi-khan reservoir locations. The spreadsheet-generated flow datasets were imported to, and stored in, the HEC-DSS (Data Storage System) database for the Tigris River Basin.

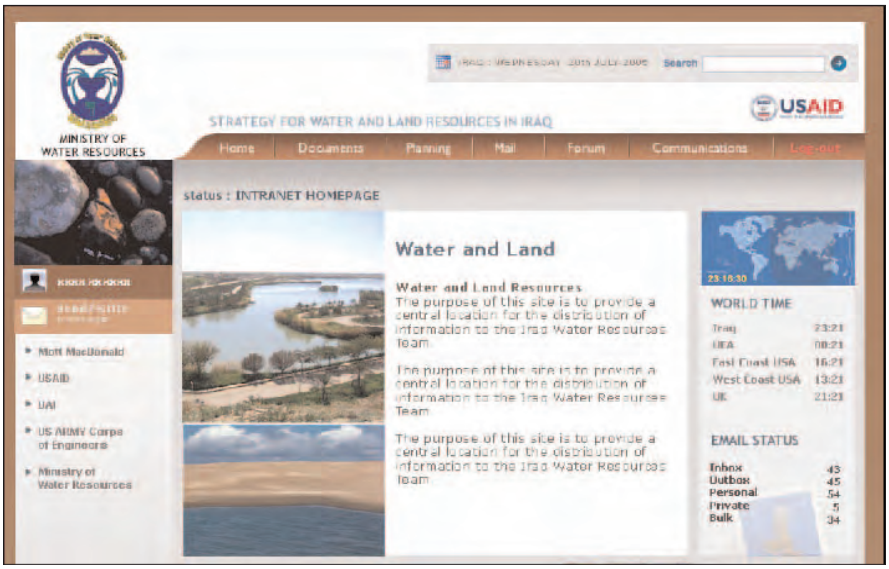


Figure 2 - Claromentis database web-based interface for SWLRI data collection

During Phase 1, the data sets were completed to the extent that they cover the whole country and include all significant rivers, channels, lakes, and other storages, all major structures, and details of land and water use for agriculture, urban centers, and industry. Over 10,000 documents were collected and stored on the Claromentis server. The collection of data will never really be finished, in the sense that these data sets will periodically or continually needs to be updated for years to come, to reflect the changing information, needs and opportunities in Iraq's water and land sectors.

A PLANNERS TOOLKIT

Just as a workman's toolbox contains a variety of implements, so the SWLRI planners toolkit is made up of a number of types of tools. Within a particular type there may be several items, some for general use, some very specific. Some tools have been developed during Phase 1, others have been prepared elsewhere and have been included in the toolkit because they are highly relevant to the SWLRI objectives. The toolkit should continue to develop in the future.

The toolkit presently contains four types of tools:

- Reference material: relevant reports and papers, links to web sites, best practice examples etc.
- Software: modeling packages, custom-built models, and their associated manuals.
- SWLRI technical reports and guidance notes.
- SWLRI templates and worked examples.

The development of models has been a key part of Phase 1, and these are highlighted below.

The SWLRI technical reports and guidance notes are the start of a series of occasional publications addressing issues relevant to strategic planning for the sustainable use of water and land resources in Iraq. The distinction between the two series is on the basis of function: technical reports describe work undertaken, discuss results, and make recommendations, while guidance notes

are highly focused, often short, documents that give advice, instructions, and warnings on how to use a model or technique and to interpret the results. Generally there is a guidance note to accompany any modeling software developed for SWLRI.

The Phase 1 toolkit, installed on the Claromentis system, contains three such technical reports, which cover the development of various models of the water resources system. There are currently up to 15 guidance notes in preparation.

DEVELOPMENT OF MODELS AND TOOLS

Modeling studies of water volumes and quality form a key component of SWLRI. Iraq's highly developed system of reservoirs, barrages, and irrigation facilities offer many possibilities for managing the nation's water resources, while ongoing upstream development in Turkey, Syria, and Iran introduces significant uncertainty into any comprehensive planning analysis. Under SWLRI, ARDI developed/updated sophisticated models capable of representing the complex operations of Iraq's water management system, in response to widely varying inflow conditions and regulation priorities.

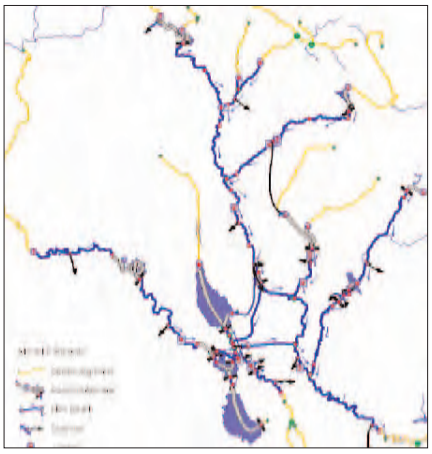


Figure 3 - Network Schematic

RESERVOIR SYSTEM SIMULATION

This effort built on the work performed for the recent USAID Iraq Marsh Restoration Project (IMRP), under which MoWR and the US Army Corps of Engineers Hydrologic Engineering Center (HEC) engineers worked together to build and calibrate a reservoir simulation model called ResSim. The Tigris-Euphrates model demonstrates a configuration of the physical layout of all projects and control points that have a bearing on the formulation of the MoWR regulation plan. Digitized stream alignments and project elements are laid over a GIS-based background map of the region, making a georeferenced schematic of the watershed. Routing reaches, which link upstream junctions to downstream junctions, complete the network connectivity of the Iraq water control system model. Figure 3 shows the schematic view of the reservoir system network for the upper system, which contains all of the nation's storage reservoirs.

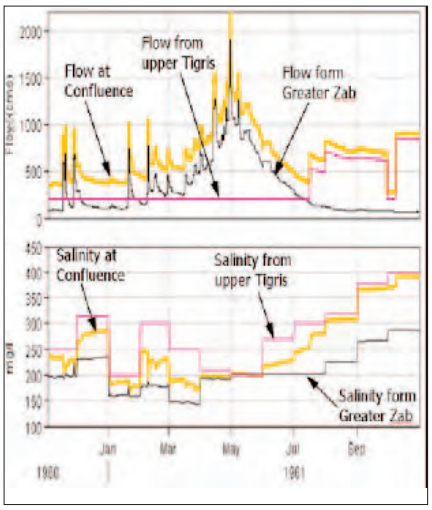


Figure 4 – Salinity Balance Simulation

The most significant enhancement to the ResSim model was the incorporation of scripted rules governing operations across reservoirs to accommodate systemwide demands. This provided extended HEC-ResSim capability for simulating water supply operation based on MoWR water management system goals. The extended capability also lends itself to answering many important questions about water management in Iraq, such as rebalancing flood control priorities in view of recently built upstream storage reservoirs, satisfying a new demand for marsh restoration, satisfying additional irrigation and water supply demands, evaluating storage reallocation strategies among the major reservoirs, or understanding the impacts of operational policies on water quality at municipal intakes or irrigation diversions. Investigations and collaboration with Mott MacDonald regarding the last topic also benefited from another enhancement to the Iraq water system management model, which handles simplified salinity accounting in the major reservoirs and throughout the Tigris and Euphrates river network.

The enhancement and expansion of the ResSim model represents a significant development for conducting difficult planning studies in the future. These state-

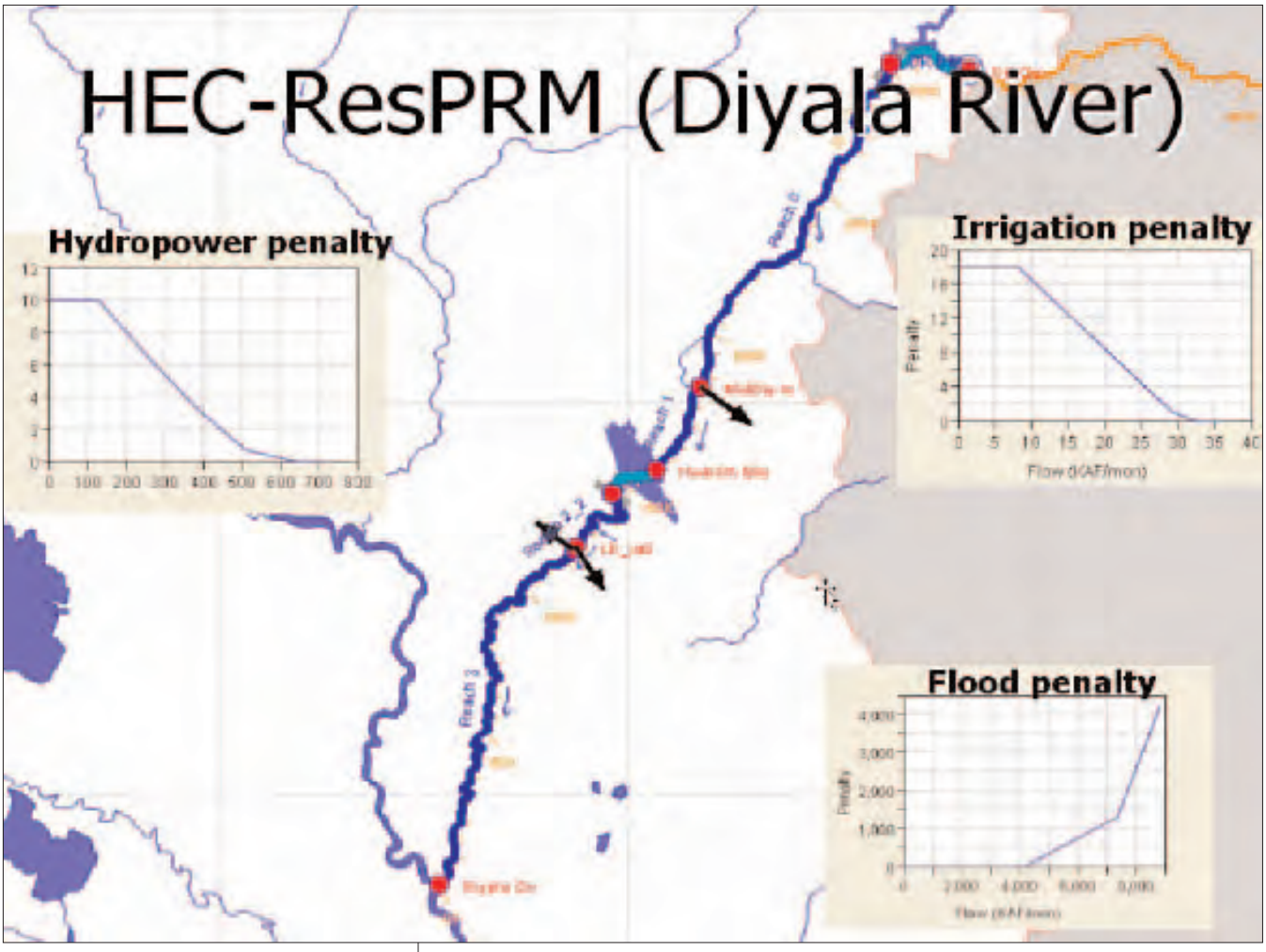


Figure 5 – HEC-ResPRM Network Schematic

of-the-art analysis tools are now available for the MoWR to perform structured and exhaustive system assessments.

PILOT SALINITY BALANCE SIMULATION

In addition to the quantity of water available for various needs in Iraq, the quality of the water plays a huge role in determining water management strategies. Salinity concerns dominate many aspects of planning for irrigation, water treatment, or environmental restoration in Iraq. SWLRI extended the ResSim model to determine salinity concentrations at each significant location, so that this water quality information is computed directly as part of the water management simulations. Using specialized software, HYDRO-1D, ARDI developed a model to compute water quality in the major reservoirs and to establish upstream boundary salinities for the ResSim Tigris-Euphrates model. A comprehensive model for the Tharthar Reservoir that simulates the salinity for selected inflows and salt load into the reservoir has recently been developed. Recent work included modeling water quality in selected channel reaches of the Tigris and Euphrates to refine parameters used in the ResSim model. Figure 4 demonstrates selected salt balance computations.

PILOT RESERVOIR SYSTEM OPTIMIZATION

At the request of MoWR engineers, SWLRI also initiated a completely new model, using the HEC Reservoir Optimization (ResPRM) modeling software for

multipurpose, multireservoir systems. This allows a different type of analysis than alternative-based simulation modeling. The ResPRM applies criteria, often economic-based, in the form of penalty functions to optimize reservoir system performance. The pilot ResPRM model focuses on the Diyala River Basin, which features two reservoirs, three major irrigation diversions, and operates for irrigation, hydropower, and flood control objectives.

The use of ResPRM (Figure 5) by the MoWR serves as an important demonstration of the link between alternatives for water usage and the economic costs and benefits, given that the economic consequences of development options are a major concern in the strategic planning process.

ARDI and the MoWR worked to create documentation and user manuals for the models, which will be useful, going forward, to train additional staff in the ministries that will ultimately be responsible for managing and running the models.

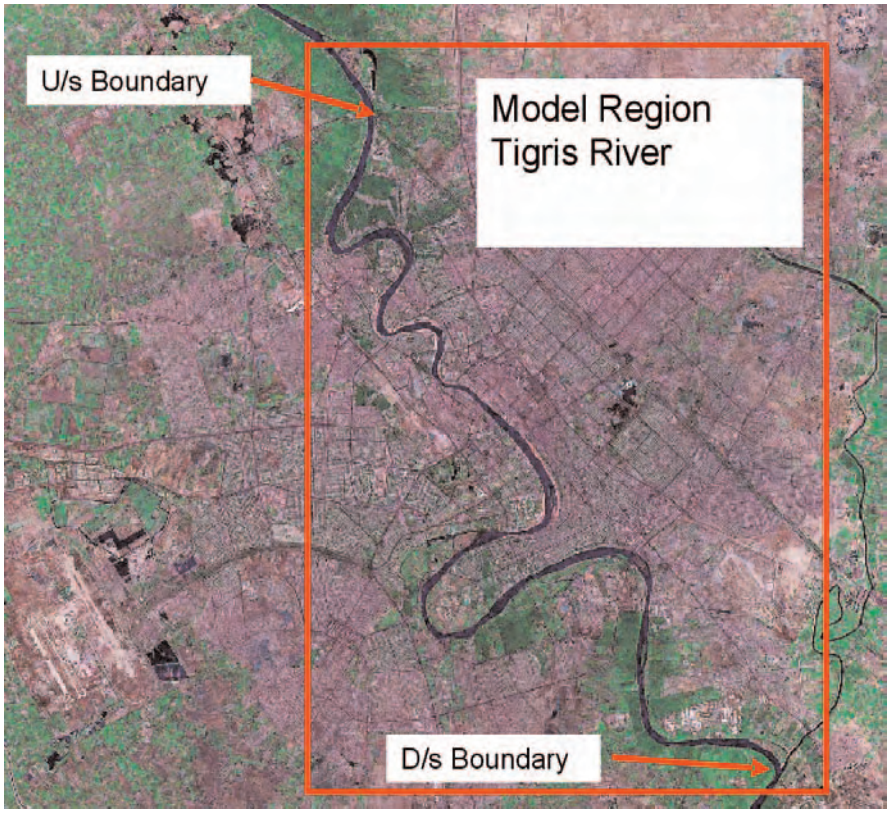


Figure 6 – Location of HYDRO-1D model reach through Baghdad

PILOT FOR LOCALIZED WATER QUALITY MODELING

Resource planners also have to deal with localized pollution problems, such as the downstream spread of pollution from large sewage works or industrial sources. The HYDRO-1D software tools mentioned above can be used to model this type of situation. Demonstrating such an application requires adequate water quality sampling data for parameters relevant to the pollution problem. To date, the model has only been tested for salinity (as part of the ResSim development), but any of the following parameters can be modeled if the data are available: biological oxygen demand, dissolved oxygen, and any

conservative or nonconservative determinant with a known degradation rate. The 1-D hydraulic model behind this can also be used to establish flood levels and current channel capacities.

MULTI-CRITERION DECISION MODEL FOR IRAQ

Multicriterion analysis (MCA) is designed to help decision makers who may be faced with several, possibly conflicting, objectives and to make the decision making processes more transparent to stakeholders.

To set up a model (a MCDM) it is necessary to define a set of criteria and to assign a relative importance weight to each one. The model also needs a value function or scoring rule for each criterion. The scoring rule describes how a score is assigned to each alternative under each criterion. The model operates on a set,or long-list of alternatives, each of which is assigned a score under each criterion. Once these elements are in place (the set of criteria, their weights and scoring rules, and the list of alternatives), the model works by computing an overall merit index value for each alternative. When the merit index values have been computed, the alternatives can, if desired, be ranked and sorted to give a priority list, with those scoring high index values at the top of the list. This prioritized list can then be used to draw up investment programs to match annual budgets or other constraints.

To be appropriate to Iraq, the MCDM needed to be developed in an iterative manner, trying out early versions with real alternatives, before it could give a good representation of the decision makers' preferences and values. The Iraq MCDM was developed with MoWR staff during the first Study Visit to Cambridge in 2006. The Guidance Note on Multicriterion Analysis was prepared with their active participation. They then went on to make a presentation to the July 2006 Steering Committee meeting which described the technique and how they had already applied it to more than 10 projects. The team had also arranged to give MCDM training to others in MoWR.

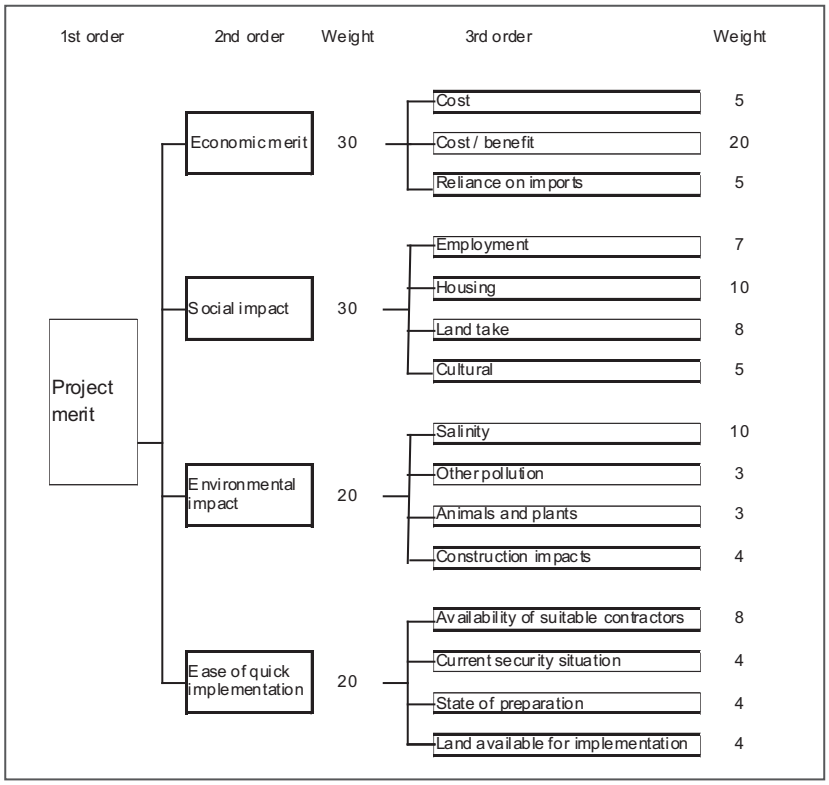


Figure 7 – Value Tree for the Iraq MCDM

OTHER TOOLS

TRAINING AND CAPACITY BUILDING

Capacity building was an essential element of the SWLRI effort, since the GOI will be taking complete control of the process during Phase 2 and onwards, using the SWLRI unit to plan the management of water and land resources in Iraq. The planning capacity of staff in the MoWR and other ministries was enhanced through their involvement in Phase 1, which was collaborative on many levels. Drafts of working papers, models, analytical tools, and other elements were circulated for discussion, both to further their preparation and to foster wide involvement in project development. This collaboration prompted considerable numbers of Iraqi professionals to become more familiar with the planning process and better equipped for future involvement in water resources management and planning. The Claromentis data management system also provided an opportunity for extensive collaboration and capacity building, as it enabled close and constant contact between ARDI and the ministry staff.

More formal training opportunities were also provided to government staff through eight in-country training courses to build capacity in specific skills. This training included GIS training, stream gauging, use of Claromentis, and hydrologic database construction.

Figure 8 - Staff from the Ministry of Water Resources receive training in stream gauging

In addition, ARDI sponsored two study tours. Four MoWR staff traveled to Cambridge, England to work with ARDI staff in home offices there for six weeks. The assignment included data sorting, development of Multicriterion Decision Analysis (MCA), and training in model development. Also, two senior MoWR staff undertook a one-week study visit that focused on transboundary water management, looking at practical experience from other river basins. Of particular interest, this visit offered insights into the implications of the European

Water Framework Directive that might come to apply to the Tigris-Euphrates basin, if Turkey continues on a path towards eventual membership of the EU.

These collaborations enhanced MoWR staff capabilities to assist in planning future water and land uses in Iraq.

GIS TRAINING

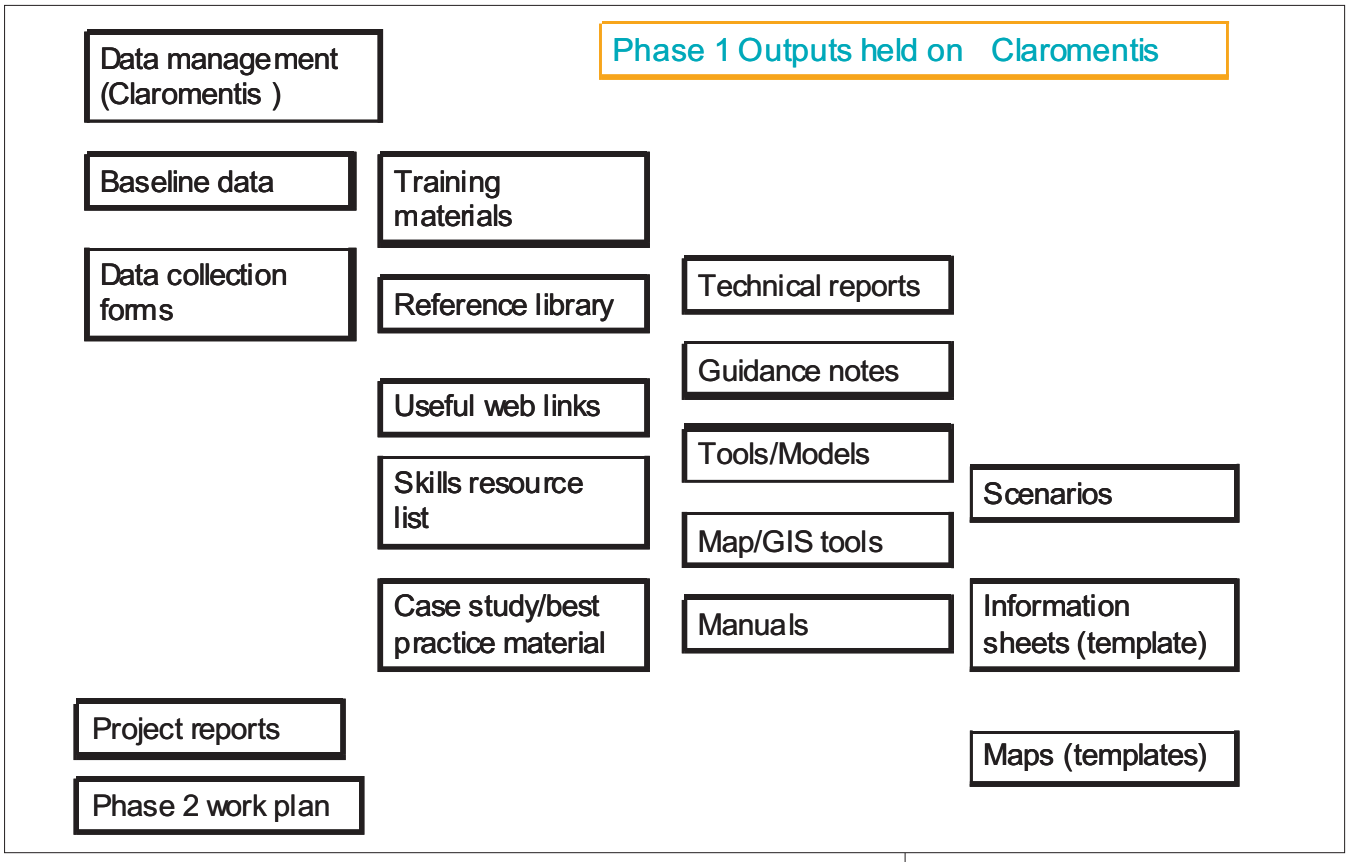
The use of spatial data, GIS, and mapping tools is very important in strategic planning and in the development of the SWLRI. The ministries will also actively use these tools in future master planning efforts, as well as in the important task of promoting the resulting plans and policies to others, including politicians, other ministries, and the general public. Many of the ministries have software and hardware for GIS, but have few or no trained staff. The goal of the ARDI training workshop was to teach basic GIS and remote sensing concepts and skills, and to train the participants in the use of ArcMap software. Some of the participating ministries already collect and use spatial data in different ways for varying functions. ArcMap is a comprehensive suite of applications that is used by many governments worldwide to manage spatial data. ArcMap will enable the ministries to coordinate data collection in the future and ensure that spatial data are collected in a structured, predefined manner.

A total of 32 staff members from ten ministries involved in the SWLRI were trained in GIS and GIS applications.

STREAM GAUGING AND HYDROLOGIC DATABASE CONSTRUCTION

The ability to measure stream flows and discharge rates of rivers and canals is essential for proper water management, and these data are important elements to inform the SWLRI and future master planning efforts. In 2005, the USAID-funded Iraqi Marshlands Restoration Program established a stream gauging station at a site in Sulaymaniyah. ARDI upgraded this station to include satellite telemetry, which enables the MoWR to have real-time access to the data collected at the station. ARDI also established an additional stream gauging station at the Tigris River in Faysh Khabour, and provided training for MoWR engineers in stream flow and discharge measurement in April 2006. The course, which was led by a five-person team of engineers and scientists from the US Geological Survey and the US Army Corps of Engineers, included training in the setup and operation of automated hydrologic monitoring equipment, telemetry devices, and acoustic Doppler current profilers (ADCPs). Members of the Italian-supported New Eden project, which provided the equipment for Faysh Khabour, joined the training so that the participants could learn to operate and maintain river gauging stations that the Italian government is supplying in southern Iraq.

The application of both fixed and mobile acoustic technology for measuring discharge proved to be of great interest. Students gained practical experience regarding the installation and configuration of modern data collection platforms, including pressure transducers for observing stage, and satellite telemetry modules. They also received training for the electronic retrieval and storage of the data. The database will be used to archive and manage the large quantities of electronic data that will be acquired as the MoWR's hydrologic monitoring network begins to take shape over the next few years.



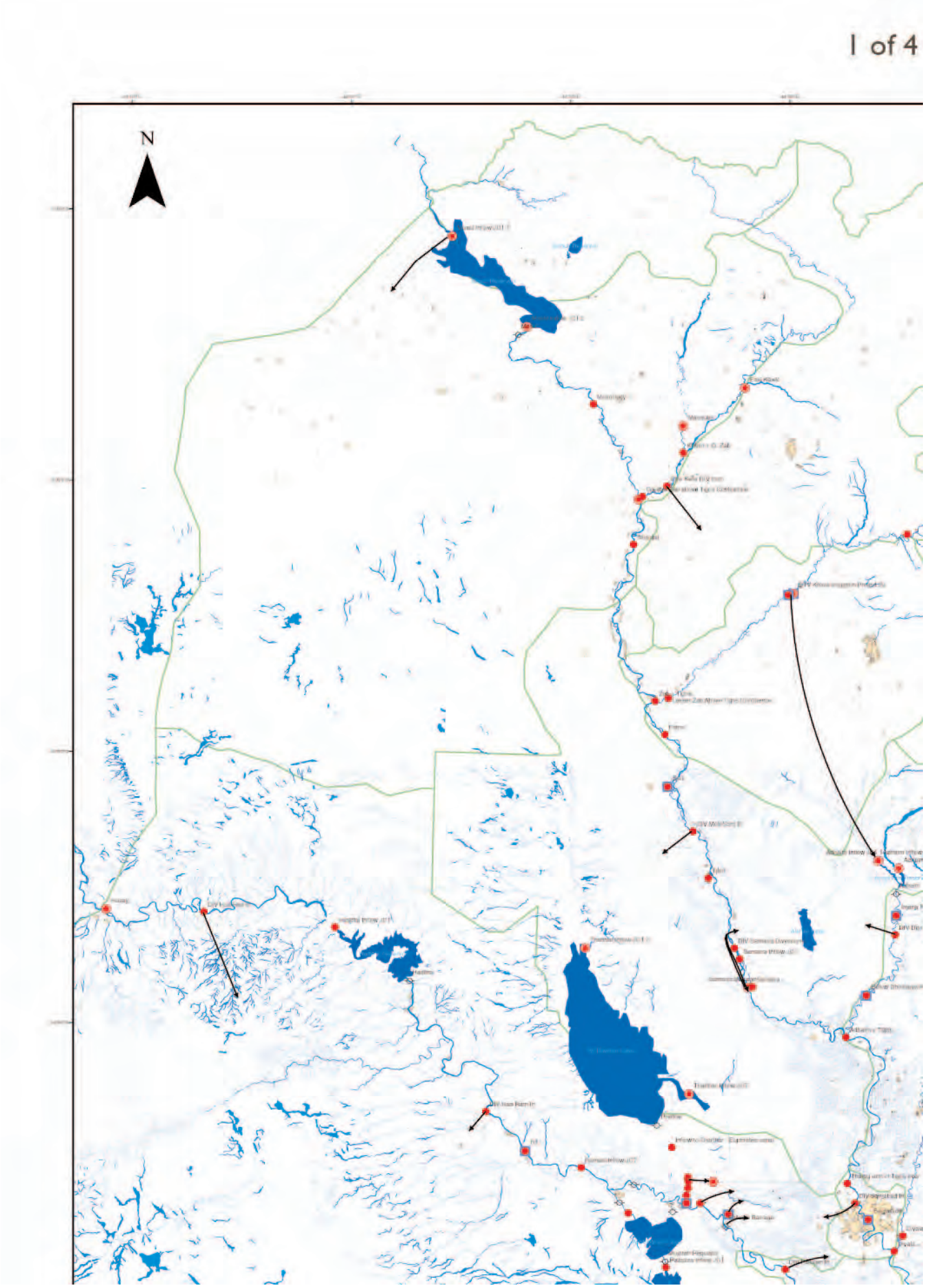
The MoWR is acquiring additional instruments that will be used to reestablish stage-discharge rating curves for many critical rivers and canals in Iraq. These ratings, combined with real-time data from the automated stream gauging stations, are needed to compute stream flows at these sites. The data will be useful in making decisions about storage and distribution of water for irrigation, industrial and domestic water use, flood control, and maintenance of water quality.

A total of 26 engineers from the MoWR were trained in stream gauging and hydrologic database construction.

(opposite, from top to bottom) Existing stream gauges will be replaced by newer technologies such as the "river boat" shown in the last photo. Other technologies utilizing telemetry for satellite transmission of data will also be incorporated into the new measurement system.

CLAROMENTIS TRAINING

A total of 49 staff from the ministries making up the SWLRI Steering Committee were trained in the use of, and administration of, the Claromentis repository and database management system. General training included system access, uses of document control, email, document uploading, and management and organization of documents. Administrator training was also provided to select staff from MoWR to administer the overall system and maintain levels of document security in accordance to established ministry policy.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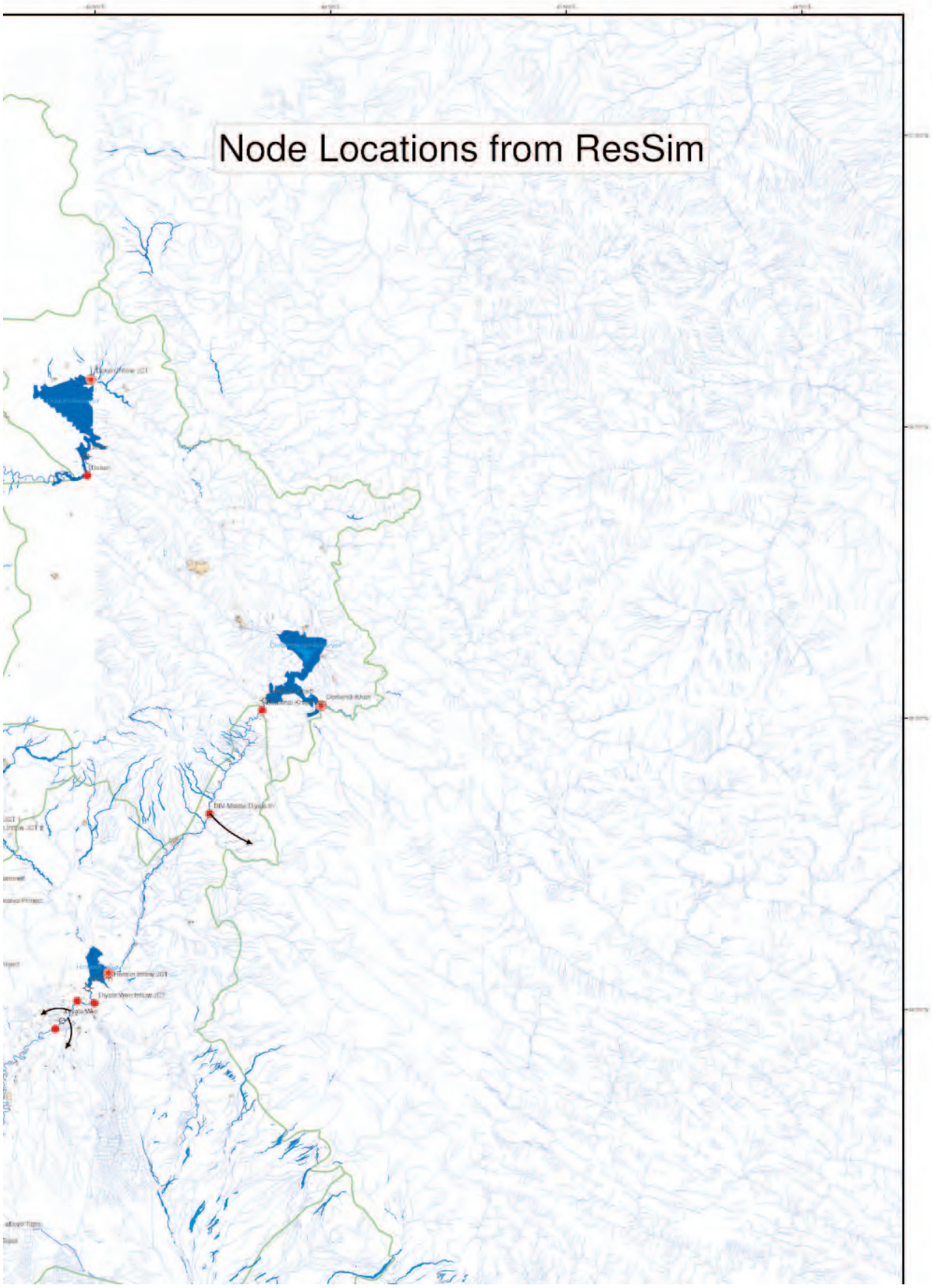

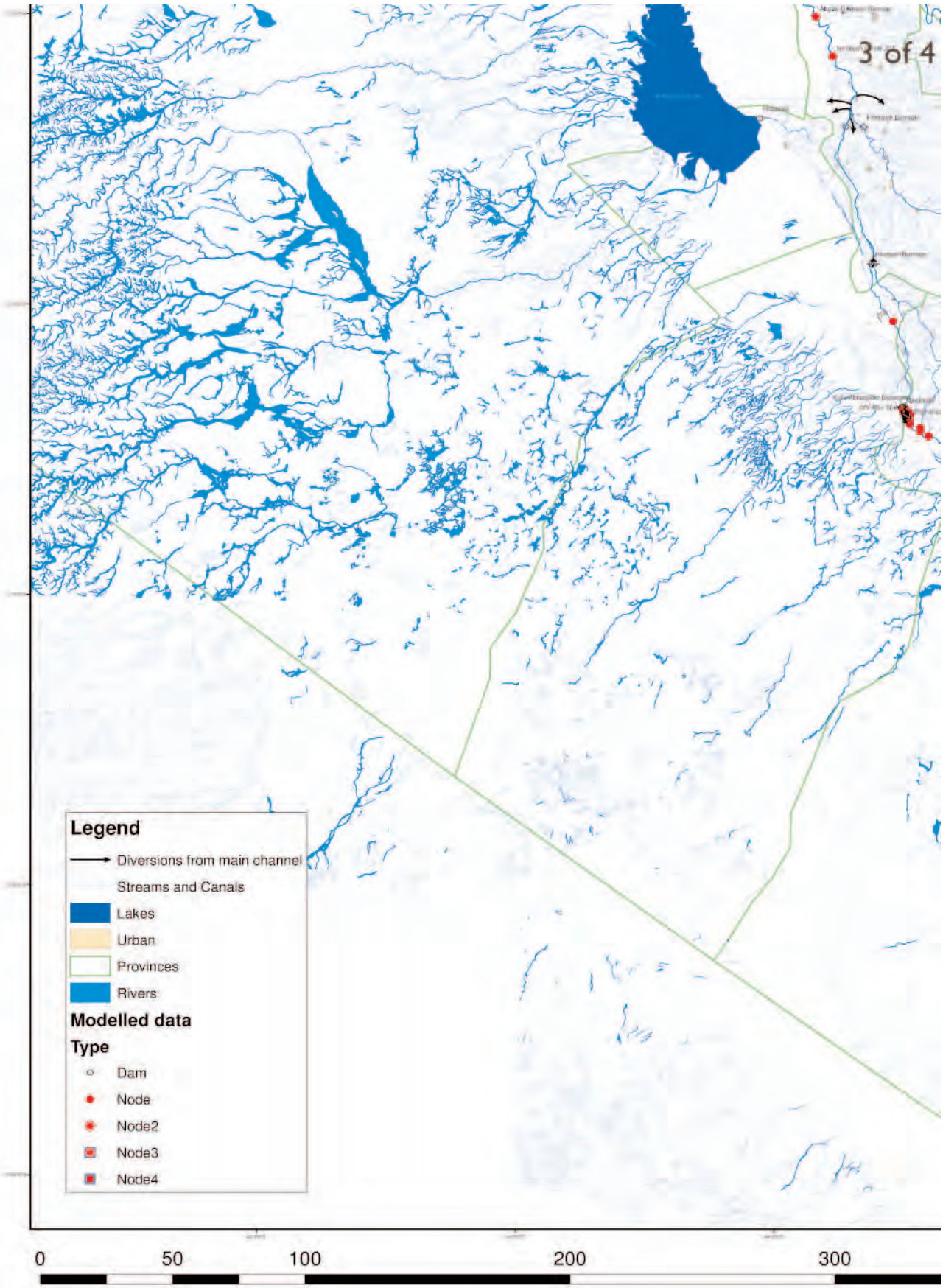
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Legend
Diversions from main channel
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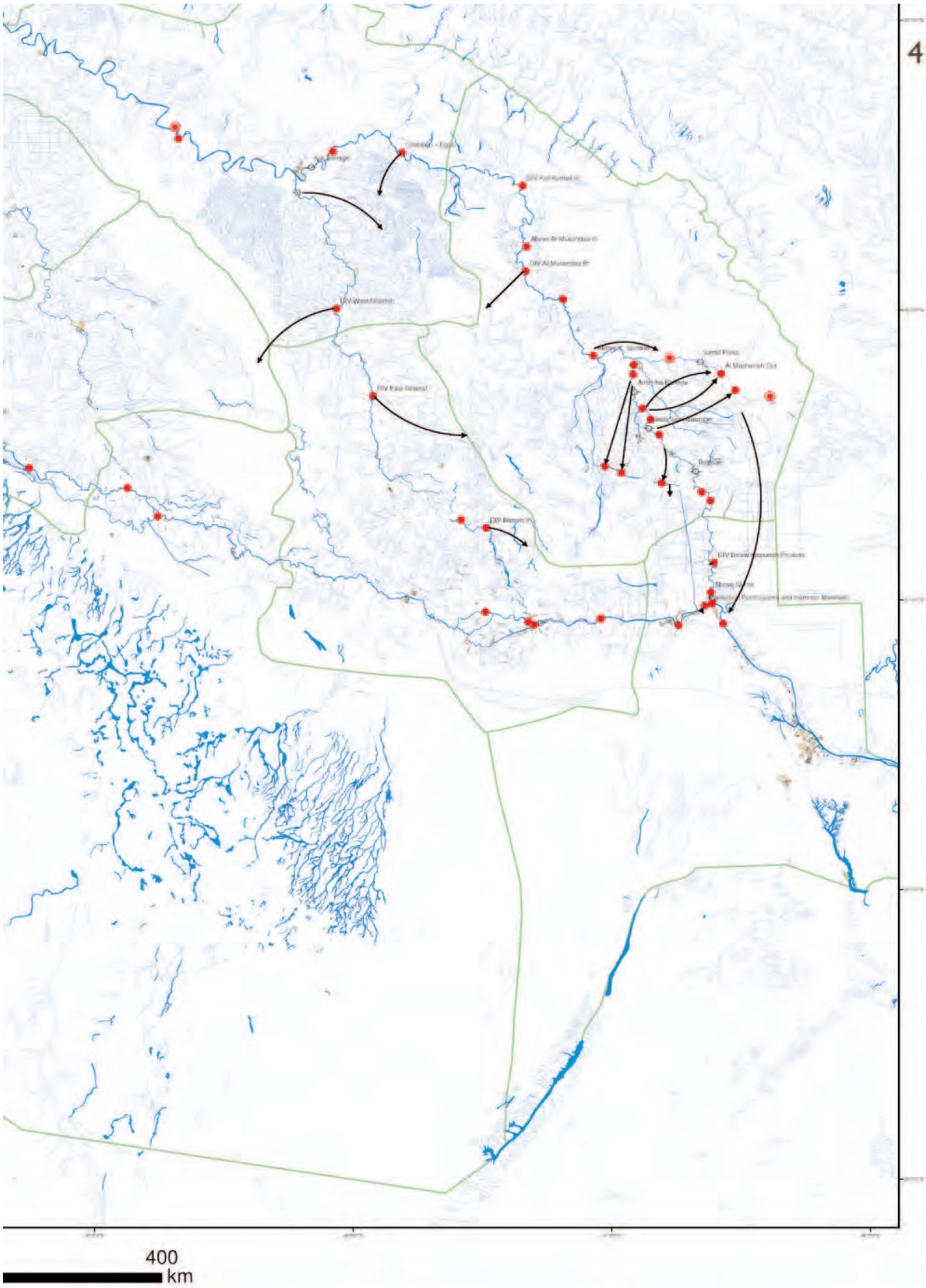
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PHASE 2 SCOPE OF WORK

ARDI, the Steering Committee, and the SWLRI Unit held a preliminary workshop (Part of the July SWLRI Steering Committee Meeting) on the nature and scope of Phase 2 in July 2006. ARDI consultants have taken these ideas and drafted a Phase 2 Scope of Work document. The document has been prepared as a proposal that the MoWR could modify, if necessary, and take forward into discussions with potential donors.

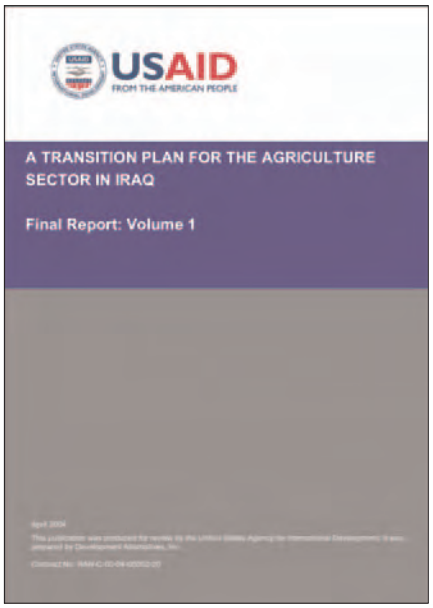
The proposal includes further strengthening of the fundamental building blocks for a successful strategy development process: data issues, modeling enhancements, more capacity building, greater collaboration between ministries, and the inclusion of other stakeholders. A government review of legal and institutional arrangements has also been identified as an essential precursor to achieving a fully fledged planning organization for the water sector.

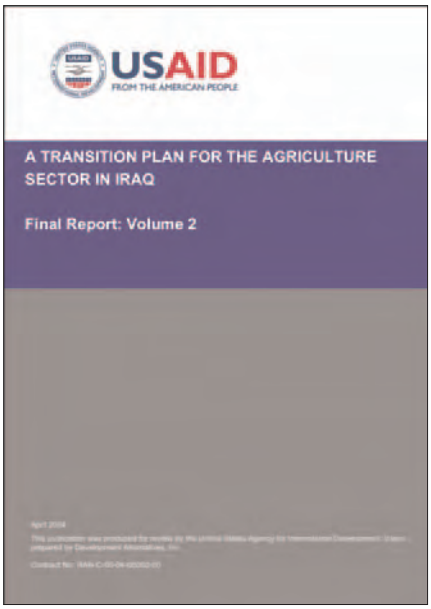
SUMMARY OF PHASE 1 OUTPUTS

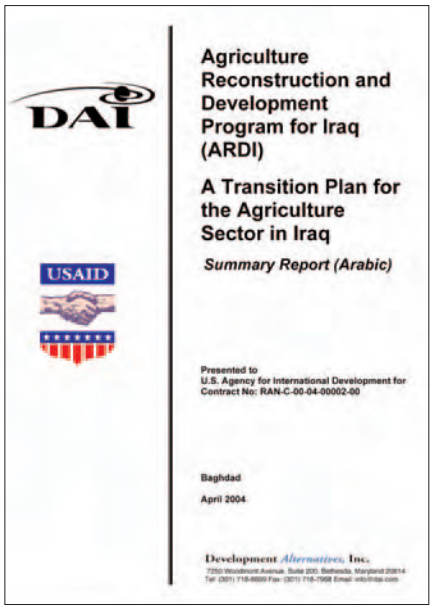
In addition to the contents of the SWLRI toolkit referred to above, training and study visit reports, a data management report, the Inception and Interim project reports, minutes of Steering Committee meetings, GIS Cluster meetings, and data collection meetings were all prepared as Phase 1 activities..

The Claromentis system hardware and software have been handed over to MoWR. This includes the data repository and the toolkit, together with the project reports, minutes, presentations, etc. associated with project meetings.

3.8 A TRANSITION PLAN FOR IRAQ'S AGRICULTURAL SECTOR







The agricultural and agribusiness sectors are Iraq's principal source of employment and their contribution to national income is second only to that of the oil industry. While Iraq has the natural and human resources, management capacity, and market opportunities to develop a modern and competitive agricultural sector, that can satisfy most of its food needs and export high-value products to the Middle East and beyond, the sector is marked by woefully low productivity and diminishing employment and income opportunities for the rural population.

The problems date from the 1960s, when the Iraqi government first formulated policies that affected the agricultural sector. National development policies generally neglected agriculture, relative to other sectors of the economy. In addition, their centrally planned approach determined which major crops would be grown, subsidized agricultural inputs, set official prices for what was produced, and established government-owned or controlled industries for processing products and distributing inputs.

Overall, such government controls have stifled private initiative. This problem has been most serious in the irrigated areas, which account for 70% of Iraq's total cultivated land and an even higher percentage of its total agricultural production. Decades of poor management and lack of irrigation and drainage canal maintenance have brought about a dilapidated infrastructure. Today, an estimated 50% of Iraq's irrigated land is either saline or waterlogged.

The *Transition Plan* included the entire agricultural sector in Iraq.

The state of the sector became considerably worse during the sanctions that followed the 1991 Gulf War. Initially, Iraq's food production rose in response to the complete ban on imports. However, production soon declined sharply because Iraq was also unable to purchase agricultural inputs and spare parts on world markets. At the same time, Iraqis' purchasing power dropped dramatically, resulting in a low effective demand for all products, including food crops.

In early 1997, the universal distribution of free food under the United Nations' Oil for Food program caused whatever was left of the domestic market to nearly disappear. This was compounded by the 2003 war, which destroyed key agricultural facilities (irrigation infrastructure, silos and warehouses, agroprocessing plants, and research and extension services) and severely disrupted input supplies to farmers.

Today, agricultural production remains at very low levels and rural poverty is widespread. In much of the country, 60 to 80% of the rural population is reported to be fully dependent on the Public Distribution System (PDS) to meet basic needs. In some areas it is closer to 100 percent.

ACTIVITIES

This transition plan was written in early 2004, a few months after the ARDI project began working in Iraq. It was prepared by USAID's contractor for ARDI, Development Alternatives, Inc., with inputs from Iraq's Ministry of Agriculture and the Coalition Provisional Authority.

At the time the plan was written, Iraq's agriculture sector was under the responsibility of the Coalition Provisional Authority. ARDI's plan was based on an assumption that responsibility for the Ministry of Agriculture would move from the Coalition Provisional Authority to the Minister of Agriculture. ARDI had two main goals:

- The goal for the immediate future (2004) was to help restore the conditions to move agricultural production to at least prewar levels, and create more jobs in the agriculture sector.
- The goal for the medium term (the next three to five years) was to move the sector from a command-and-control production and marketing system to one that is market-driven.

Wars, embargoes, and looting effectively reduced the information base in 15 of the country's 18 governorates to remembrances and estimates. In addition to the absence of hard data, the country's unsettled circumstances (and the consequent inability to move around freely) required that the transition plan be general. It was not a strategy that specified a programmed course of action; rather, it set out basic principles and recommendations for a revitalized and commercialized private agricultural sector.

Several sources of information informed this plan, including interviews and meetings with the staff of various government ministries (e.g., Agriculture at the national and governorate levels, Planning, Health), government publications, and documents from such sources as the World Bank and FAO. ARDI staff also facilitated roundtable discussions in Erbil, Sulaymaniyah, Baghdad, and Babylon governorates for private sector businessmen and women and farmers to discuss their ideas on the future of agriculture in Iraq.

THE COMPLETED TRANSITION PLAN HAD TWO PARTS:

Short-Term Stabilization Plan. This plan made recommendations for restoring agricultural production to at least where it was before the war and creating jobs in the short term (one year). This required the continued rehabilitation and reequipping of damaged and deteriorated infrastructure and facilities, and the immediate supply of critically needed inputs to farmers. The plan's elements, as stated at the time were:

- **Providing agricultural input supplies.** To get the sector moving immediately, fertilizer, good-quality seeds, proper pesticides, and other inputs (e.g., electricity and diesel for machinery) must be procured and provided to farmers.
- **Reestablishing the domestic market for wheat.** The Ministry of Trade and the private sector should begin an orderly transition to a wheat market characterized largely by market-based private sector participation, which will lead to farmers receiving international prices for wheat.
- **Reclaiming the natural resource base.** To halt the degradation of the resource base, drainage systems should be rehabilitated immediately and short-term improvements made to on-farm irrigation. The Ministry of Agriculture (MOA) should focus on rehabilitating on-farm canals and strengthening extension services.
- **Rehabilitating and reequipping MOA facilities.** Priority should be given to reconstructing veterinary clinics in the 15 southern governorates and repairing and reequipping research and extension facilities.
- **Establishing floor prices for maize and cotton.** To avoid sharp declines in the production of these two strategic crops, the government should establish floor prices that are below international prices but high enough to give farmers an incentive to produce.

Medium-Term Transition Plan. The plan made recommendations for the medium term (3-5 years, beginning in 2004) once the reconstruction effort was been launched. Then, the sector's main public and private sector participants were to effect a transition from a state-controlled, noncompetitive and declining agriculture sector to one that is market-oriented, economically efficient, productive, and employment generating:

- **Creating the appropriate policy environment.** To move agriculture forward, the government must cede control of production decisions and focus on regulation, supervision, and certification of private sector activities. A transition period is necessary in which some import subsidies must be phased out, while natural resources are protected (through, for example, government provision of animal vaccines). Export restrictions on major crops and animals must also be resolved.

  Reform of the Public Distribution System (PDS) for food is needed by eliminating the market disincentives associated with the current limited and price-controlled domestic purchases of food (especially wheat flour)

and by gradually reducing the scope of the PDS plan to make it needs-based.

- **Enabling public sector capacity to support a market-based agricultural economy.** The rules of engagement between the private and public sectors should be reconstructed to ensure that production, marketing and processing are safe for humans and the environment, and that farmers' rights are protected. This includes developing and implementing regulations, training government officials, and developing their capacity in policy and economic analysis. Technical and marketing knowledge should be made widely available through the Ministry of Agriculture.

- **Programs for the development of the sector.** The MoA needs to establish the capability to coordinate donor activities, so donors work and contribute to a common agenda. Other recommendations include:

  – Inject working capital to jumpstart the agricultural economy.

  – Test programs in wheat and sheep production and date palm restoration in two governorates and expand the successful ones nationally.

  – Develop pilot projects for the reclamation of saline soils and water resources to direct efforts to tertiary and on-farm irrigation improvements within improved land systems.

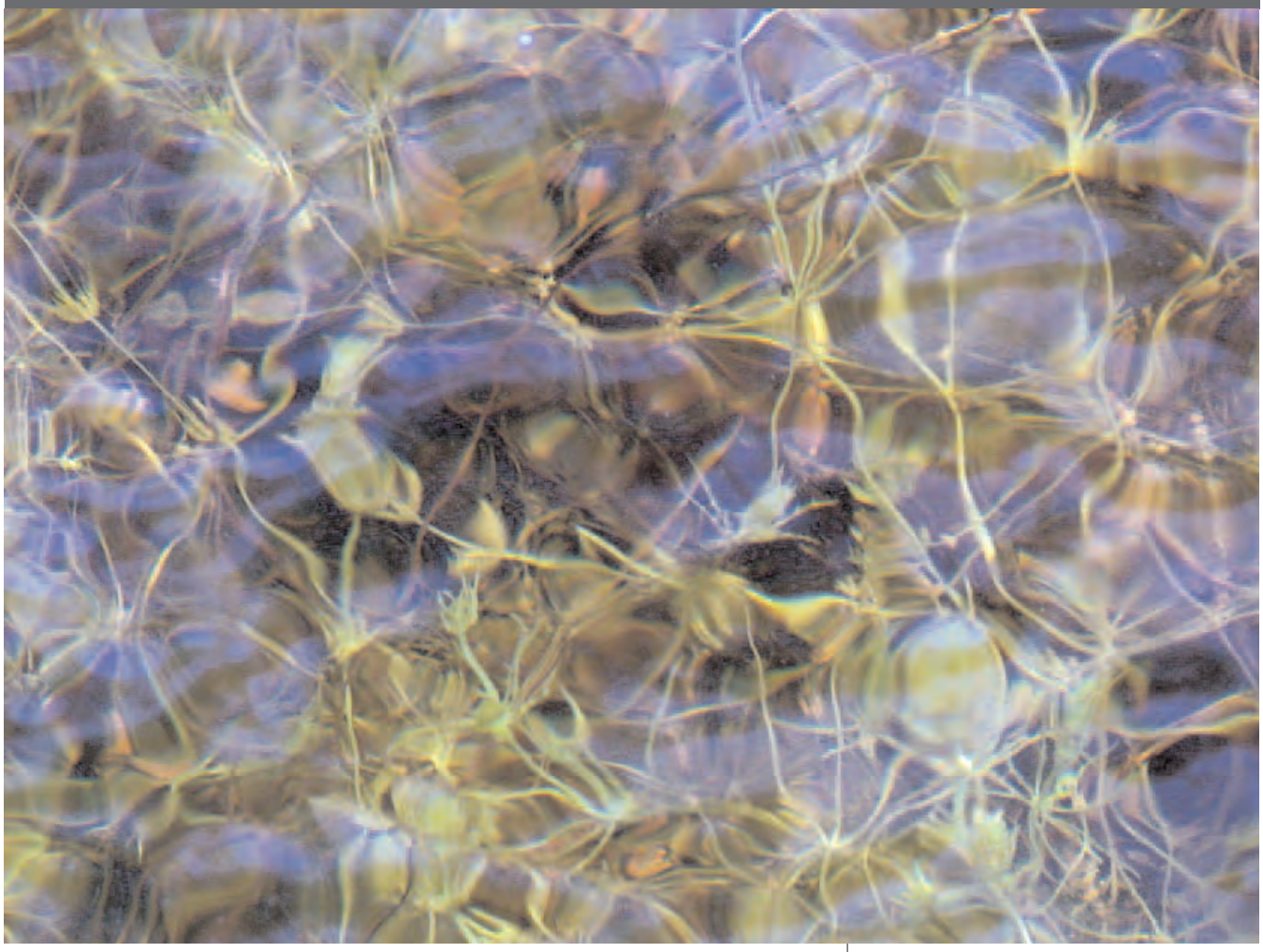
  – Work to understand how to initiate necessary changes in the land tenure system.

  – Protect vulnerable groups (displaced families, the very poor, subsistence farmers) by reaching rural communities to provide needed assistance.

RESULTS

This plan laid the groundwork and guidance for making the transition from government control to an agriculture sector based on markets and led by private initiative. Because ARDI was the US Government's only agricultural project in Iraq, this guidance also informed all of its subsequent activities. Over the next two and a half years, ARDI made important progress in realizing the goals of the short-term stabilization plan.

4.0 THE MARSHES OF IRAQ



Aquatic life in the marshes.

Iraq's Mesopotamian marshes were the "cradle of western civilization" according to many historians, and Muslims and Christians alike have referred to the area as the Garden of Eden. The word Mesopotamia means "between rivers", referring to the lands between the Tigris and the Euphrates. The marshes were once the largest wetlands in southwest Asia and covered over 15,000 square kilometers (km2), an area nearly twice the size of the original Everglades. However, by the year 2000 less than 10% of the area remained as functioning marshes due to a systematic plan by the Iraqi government to ditch, dike and drain the marshes.

The marshes were also famous for their biodiversity and cultural richness. They were the permanent habitat for millions of birds and a flyway for millions more migrating between Siberia and Africa. More than 80 bird species were found in the marshes in the last complete census in the 1970s. Populations of rare species like the marbled duck (*Marmaronetta marmarometta,* 40%-60% of the world

population) and the Basrah reed warbler (*Acrocephalus griseldis,* more than 90% of the world population) were thought to be close to extinction but were recently seen in a winter bird survey. Coastal fish populations in the Persian Gulf used the marshlands for spawning migrations, and the marshes also served as nursery grounds for penaeid shrimp (*Metapenaeus affinis*) and numerous marine fish species. The marshlands also once served as a natural filter for waste and other pollutants in the Tigris and Euphrates Rivers, protecting the Persian Gulf, which has now become noticeably degraded along the coast of Kuwait.

The Iraqi marshlands were also the ancestral home of the so-called "Marsh dwellers," better know in Iraq as the Ma'dan, an ethnic group unique in the Arab world for their cultural adaptation to the conditions of life in the flooded ecosystem. For five millennia, the Marsh dwellers have constructed a habitat on spotty dryland patches within the marshes, thriving on a combination of buffalo breeding, fishing, and cultivation of wetland-tolerant crops, most notably rice and dates. The Marsh dwellers used the tall reeds which cover the marshes as prime material for construction of their homes, their fishing boats, and mats for sale in urban centers. The Marsh dwellers, which numbered almost half a million people in the 1960s, saw both their ecosystemic and economic bases destroyed with the systematic draining of the marshes, mainly after 1991. Most of the inhabitants of the marshes migrated out, both to Iraqi cities as well as to refugee camps in Iran. At the present time there are only an estimated 20,000 to 30,000 Ma'dan living in the marshes, although others are returning with the destruction of dikes and the reflooding of much of the area.

(above and left) The *mudhif*, a barrel, vaulted, reed structure is indigenous to the marshlands of Iraq.

The Iraqi marshlands, once one of the world's largest wetlands ecosystems, have been undergoing extensive restoration since 2003. This process was implemented to remedy the damage done between 1991 and 2003, when the marshes were drained and reduced to a-tenth of its original size. Re-flooding efforts after 2003 have now restored the marshlands to one- third the original size, making the marshlands now the largest wetland area in the Middle East, covering an area of 8000 square kilometers (UNEP, 2005).

These marshlands are both regionally and globally significant for cultural, political and economical resources. Through restoration activities, these marshes are, once again, rich in aquatic productivity and provide a natural refuge for aquatic organisms especially fish and birds. This area plays a vital role in the maintenance of biodiversity in the Middle East due to its unique ecosystem characteristics and isolation from other comparable systems. The restoration of the marshlands will also revitalize their important function as a filter for degraded waters entering the system from the upstream Tigris and Euphrates, before that water is released into the Persian Gulf. Additionally, many refugee and internally displaced families of Marsh dwellers are returning to their marsh homes due to the return of the conditions which supported their livelihood.

INTERNATIONAL ASSISTANCE TO RESTORE THE MARSHLANDS

Perhaps the most serious problem for the marshlands' inhabitants today is the lack of safe drinking water. However, they are beset by other serious problems, including lack of basic services (e.g., health and education), the loss of income generating opportunities, and inadequate nutrition.

Donors from a broad spectrum of countries and institutions concluded that with appropriate development assistance, the marshlands could once again support rich biodiversity and offer its inhabitants new employment opportunities and the chance for a better life.

Since 2003, a number of donors have begun projects to restore the wetlands, and improve the health and livelihood of the population. USAID led an international effort for the sustainable management of the marshlands in close collaboration with the Ministry of Water Resources, other GOI ministries and other international donors. The projects were designed to balance economic and social development with hydrological and environmental monitoring and institutional capacity building.

TABLE 97 MAJOR PROJECTS TO RESTORE IRAQ'S MARSHLANDS

Donor	Focus
Canada	Biodiversity and wetland management
Italy	Water: marshlands, hydraulics, water assets Ecology: human impact management, ecosystem management Social-economy: land planning, infrastructure, culture and anthropology
UNEP/ Japan	Clean drinking water, sanitation and water quality management Marshlands information network and observation system
United Kingdom	Marshland restoration and management
USAID	IRMP: Livelihood improvements: (agricultural and agribusiness improvement, livestock and dairy production, date palm nurseries expansion, fish restocking) Environmental improvements: (hydrologic modeling, monitoring and data collection planning frameworks, capacity building) Equipping Ministry of Water Resources' Soil and Water Laboratory Extending primary health care facilities Design of community-constructed wetlands Donor strategy development
	ARDI: Strategic planning, veterinary clinic rehabilitation, crop production, livestock improvement, brucellosis vaccinations, irrigation, monitoring

MAJOR PROJECTS TO RESTORE IRAQ'S MARSHLANDS

ARDI ASSISTANCE TO THE MARSHLANDS

ARDI's work in the marshlands built on the USAID-sponsored Iraq Marshland Restoration Program (IMRP), which was implemented by Development Alternatives, Inc. From October, 2003 through September, 2006, IMRP sought to monitor the prime environmental indicators of marshlands restoration, expand economic opportunities and develop stakeholder and institutional capacities at the local, regional, and national levels. Its activities included:

MARSHLANDS ENVIRONMENTAL CONDITIONS IMPROVEMENT

- Hydrologic modeling
- Biological inventory, monitoring and data collection
- National and local frameworks for planning integrated marshland restoration efforts.
- Capacity building for stakeholders

LIVELIHOOD IMPROVEMENT

- Expansion of agriculture and agribusinesses to diversify production
- Livestock and dairy production improvement
- Expansion of date palm nurseries
- Fish restocking

ARDI's activities to restore Iraq's marshlands continued many of the activities initiated under IMRP, including the repopulation and restocking of fish, buffalo breeding, and wheat, sorghum, and barley cultivation. The program's main goals were to:

- Improve the productive capacity of the marsh dwellers (one of the poorest groups in Iraq) through improved technical practices and greater marketing opportunities
- Assist the Iraqi government in formulating policies and decisions to promote a sustainable water resources management strategy
- Build the capacity of Iraqis in natural resources management though an emphasis on advanced information systems and stakeholder involvement.

TABLE 98 ARDI MARSHLAND PROJECTS

Activity	Number of Projects	Projects Primary Beneficiaries
Planning	2	1 Strategy for water and land resources in Iraq 1 Marsh monitoring systems
Animal Health and Production	6	4 Rehabilitation of veterinary clinics 1 Improved nutrition for buffalo 1 Restock fisheries
Crop Production	4	1 Improve sorghum, alfalfa, sunflower, maize, and okra production 1 Establish government date palm nurseries 1 Establish government date palm mother orchards 1 Establish private date palm orchards
Irrigation	4	1 Distribute family drip irrigation kits and train farmers 3 Canal cleaning projects

PLANNING ACTIVITIES

STRATEGY FOR WATER AND LAND RESOURCES IN IRAQ

Although significant restoration activities have occurred, the future of the marshlands is not certain. First, much of the area was reflooded in an unplanned, haphazard way, by local residents who breached many of the dikes after the fall of the old regime. Second, the scale and degree of recovery is largely dependent on the amount and quality of water that is available for the area. This in turn depends on decisions made outside the region, upstream along the Tigris and Euphrates rivers. Iraq must make strategic decisions at a national level, and enforce them at regional and local levels, in order to ensure the health of the marshes as well as maximize the benefits from the available water resources.

In order to help the Ministry of Water Resources and other agencies of the government provide informed stewardship of Iraq's water resources, ARDI implemented the Strategic Water and Land Resource Initiative, discussed in Chapter 3.7. The data collection and water usage models developed during the first phase of the Water Strategy program will give policy-makers the tools they need to make informed, practical decisions about water usage and how to care for the needs of both the marshes and the marsh dwelling population.

MARSHLANDS MONITORING

Measuring aquatic productivity in Suq al Sha marsh

Monitoring team sampling at Huwayza marsh

ACTIVITIES

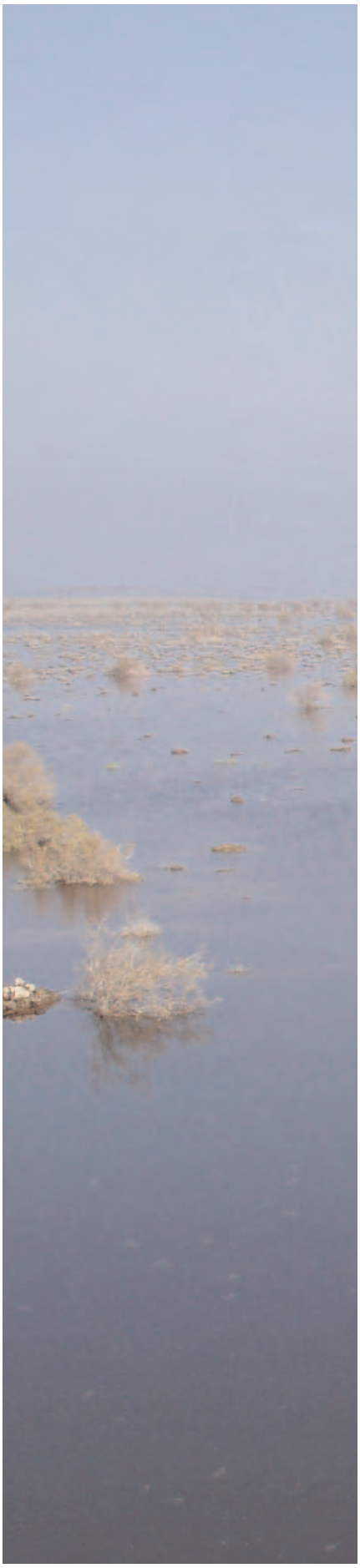
Monitoring teams from ARDI and a southern governorate university worked intensively within the marshlands to gain an accurate picture of the progress of wetlands restoration efforts and to establish baseline information on water, soil, wildlife, and socio-economic activities. Their activities included monitoring and data collection on:

- Water quality (e.g., temperature, depth, salinity, pH, velocity of flow)
- Ecological indicators of plant and algal productivity (e.g., sampling phytoplankton and zooplankton for analysis, sampling aquatic plants and cattails for chemical analysis)
- Populations of macro-invertebrates (insects, spiders, fish species, and shrimp)
- Populations of water birds (pygmy cormorant, little gereb, moorhen, storks), including observing any changes in bird health that could signal the presence of avian flu.
- Activities of marsh dwellers (number of settlers, amount of fishing, other economic activities, etc.).

After each monitoring expedition, the teams recorded the collected data in a Marsh Monitoring Database. This tool was developed under IMRP in 2003, and thus contains a record of information collected over a three-year period.

(opposite page) Testing salinity of the water by measuring its electrical conductivity.

The monitoring team on a collection and measurement mission.



RESULTS

Over a three-year period, the teams observed positive results with respect to the regeneration of flora and fauna in the marshlands. For example, increasing numbers of mature shrimp in the East Hammar marshes, larger catches of indigenous fish, and the greater observed number of water bird species all indicate that environmental restoration is underway. The monitors also had observed many positive economic indicators by mid-2006, including increased fishing activities, collection of reeds for cattle food, and canal cleaning for agriculture.

The data collected by the monitoring teams will help the Ministries of Agriculture and Water Resources to design interventions to help restore the marshlands and the marshland economy. A better knowledge of the current state of environmental and biological development that the database provides will inform the designs of programs to restore biodiversity, improve economic conditions for marsh dwellers, and ensure the sustainability of the marshlands' resources.

ECONOMIC DEVELOPMENT IN THE MARSHLANDS.

The culture of the marshlands is one of the oldest in the world. Though they were not wealthy relative to their dryland neighbors, the marsh dwellers were famously well-adapted to their environment, which differed radically from the surrounding region. Their communities were built around and lived off of the marshes, which provided food, clean water, fodder for animals, and construction materials.

The tragic story of the ruined marshes and persecuted and displaced marsh dwellers has been told many times during the Saddam regime and since its fall. Although the ecological basis for sustainable livelihood in the marshes had degenerated almost to the point of crisis, people are returning to the area and beginning to rebuild their lives.

Complete restoration of the marshes to their former size and biological diversity is unlikely. Even if it were possible, the marsh communities would not be able to completely recreate their traditional lifestyle. In fact, some people want desiccated areas that have become farmland to remain drained. The degree of marsh restoration, and the number of the tribal marsh dwellers who return will in part determine how much of the old marsh culture is preserved, and how local lifestyles will adapt to new social and economic conditions. Now that many people have been exposed to different standards of living in other parts of the country, as well as new technologies and ideas, economic and social change in the region is inevitable.

ARDI implemented several projects in the marshlands that were targeted at economic development in what has long been one of the poorest and most isolated regions in Iraq. Animal production, especially of water buffalo, was a familiar activity for marsh dwellers, but the traditional food sources for animals disappeared when the waters receded. ARDI helped farmers find new ways to raise healthier and more productive animals. Farming is a new frontier for many marsh dwellers. ARDI introduced simple improvements for common crops such as okra and alfalfa. ARDI also helped rebuild the irrigation infrastructure,

and introduced low-cost, water-saving irrigation equipment to farm families across the region.

ANIMAL HEALTH

REHABILITATING VETERINARY CLINICS

ACTIVITIES

Livestock production has historically been an important source of food, materials, and income for marsh dwellers. Water buffalo are especially important to their economy, providing dairy products, meat and hides.. Buffalo dung is is a major source of fuel for cooking. Although numbers of water buffalo are much smaller than sheep in the marshes, buffalo are particularly important animals in the marshlands culture. A single buffalo can be a marsh family's most important possession, and the animal's health critical to the family's ability to thrive.

ARDI rehabilitated four government-operated veterinary clinics in the marshlands that had fallen into disrepair. Such clinics are often the only source of veterinary care for breeders who cannot afford or do not have access to private clinics. In addition, these clinics coordinate national vaccination campaigns and provide treatment during disease outbreaks. The renovations were carried out by local construction companies that were selected through a competitive bidding process. Two of the clinics are located on the edges of the Basrah marshlands, and two are located in Thi-Qar.

RESULTS

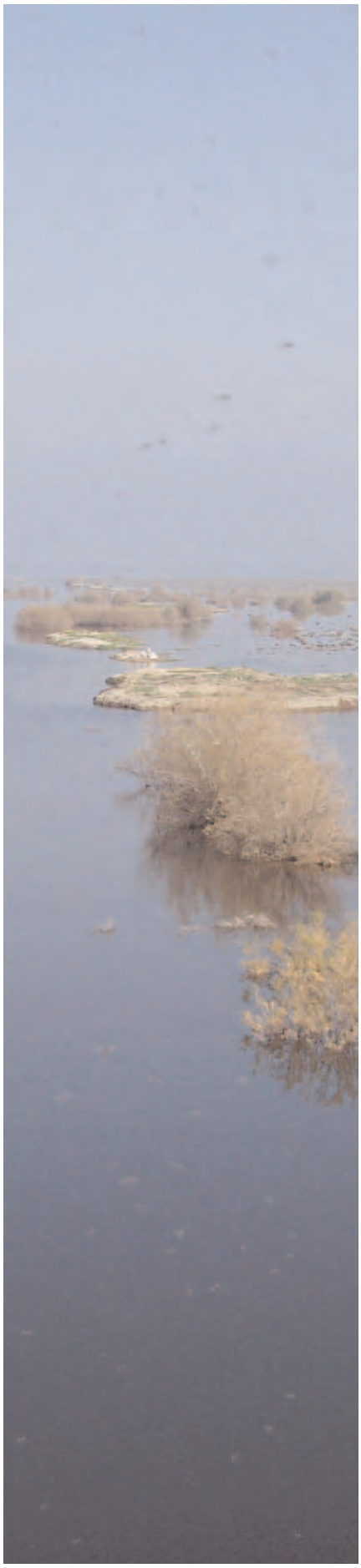
Rehabilitation of the Shatrah Veterinary Clinic in Thi-Qar and the Al-Qurnah Veterinary Clinic in Basrah were complete by October 2004. The Al Dair Clinic in Basrah and Thi-Qar Veterinary Hospital were completed in 2006. The clinics treat large numbers of sheep and cattle as well as water buffalo. ARDI surveys in the region showed the number of breeders served by the two clinics increased by 38 percent, and the number of animals treated by the clinics went up by 33 percent. The rehabilitation projects helped raise the profile of the clinics with breeders in the area, as well as improve the quality and kinds of of services provided by the clinics.

IMPROVING BUFFALO NUTRITION AND RATES OF REPRODUCTION

ACTIVITIES

In the marshlands, adult water buffalo are not usually slaughtered for their meat, but instead provide milk, butter , yogurt , cheese and other dairy products. Males are often used in agricultural activities and as draft animals. In the past, dairy products were sold outside the marshes and throughout the country. Today, water buffalo in the marshlands remain a primary source or protein for marsh dwellers, and as such are a major source of income for many families. The buffalo's value is largely dependent on the reproductive cycle of the animal, which determines calf and milk production.

Most buffalo owners nourish their animals on wheat bran and cotton seeds, and



in most cases on only small amounts of nutritious green roughages. This poor diet is one of the main causes of delays in puberty and long inter-calving period., This results in low calving rates and low milk production. Improvement of nutrition in female buffalo, both prior to mating and during the late gestation period, increases growth rates, ovulation rates (estrus) and calving.

ARDI's activities in this area focused on improving the health of female water buffalo to increase calf and milk production and reduce mortality rates, thereby increasing economic returns to breeders. ARDI selected some of the poorest breeders in the Basrah marshlands to participate in the program. These breeders fed their buffalo only low quality roughages and wheat bran, resulting in long inter-calving periods, delays in the onset of puberty, low calving rate, and general poor health.

Another intervention which ARDI demonstrated in the marshes used HGH (human growth hormone) to induce eustris and ovulation. Prolonged periods of high heat coupled with poor diet prevent the onset of ovulation without the HGH treatment. This lack of conception prevents pregnancy and lactation. With calving the female buffalo is not providing an income stream to the family through the sale of milk and milk products.

ARDI distributed a highly nutritious diet concentrate to the breeders to feed to their pre-mating and pregnant buffalo. One hundred pre-mating buffalo received the diet concentrate until mating, in order to stimulate ovarian activity and improve the chances of successful conception. One hundred pregnant buffalo received the diet during the last two months of gestation, in order to improve the birth-weight and health of the calves and increase their growth rate. ARDI technical staff monitored the progress of the activity.

RESULTS

Subsequent evaluation of the high-nutrition diet found that improved nutrition in pre-mating buffalo increased the percentage of buffalo that entered estrus and mated. The pregnant buffalo that received the concentrate diet also gave birth to heavier calves and are producing more milk than buffalo that did not participate in the program.

For an investment of $86 in nutritional supplements, there is an expected increase in income of $174 per calved buffalo, which includes increases in milk production and market weight of the calf. One hundred and five breeders participated in the buffalo nutrition program in the marshlands, and a number of field days extended the demonstration to other area breeders.

RESTOCKING FISHERIES

ACTIVITIES

Before the near-desiccation of the marshlands, fish was the primary source of food for the majority of marsh dwellers, and an essential part of their income. Daily fish catches are now only a fraction of earlier yields (3-8 kg vs. the pre-drainage average of 150-400 kg). Marsh families have been forced to seek other sources of income and food supply. This was a principal reason for migration out of the marshlands.

ARDI purchased nearly one million fish fingerlings from private hatcheries in Basrah and Babylon for release in the Basrah and Thi-Qar marshes. The first batch was released on July 3, 2006 to the Al-Hammar marsh in Basrah; it consisted of about 225,000 fingerlings of two major carp species, the common carp and the grass carp. Both are indigenous to the marshes and are in high demand by consumers. Four subsequent batches were released in July, including two additional indigenous species.

The bags of fingerlings were kept cool for the long journey to the release areas, where they were subsequently placed unopened in the water of the marshes to allow for a gradual adjustment to the warmer water temperature. The fingerlings were then released into shallow areas with protective aquatic vegetation supporting abundant food supplies. To avoid excess food competition and concentrated predation, the fingerlings were divided into small groups and distributed over a large area.

RESULTS

The releases were a success, with a high survival rate throughout both the transportation and distribution stages. As the restocking continued, ARDI conducted workshop and training activities for local populations to encourage proper management of the fish stocks. Increased awareness of harmful fishing methods will help ensure a stable future income for marshland fishermen. With this program, ARDI helped contribute to the return of marsh families who had been forced to migrate, in addition to helping improve their nutrition and income. An important part of the project was also to support private hatcheries, to encourage the production of cheap stocks of fish in the future.

CROP PRODUCTION

IMPROVING SORGHUM, ALFALFA, SUNFLOWER, MAIZE, AND OKRA PRODUCTION

ACTIVITIES

Historically, farming was not a major economic activity for most marsh dwellers. However, after their lands were drained, many marsh dwellers turned to agriculture in an attempt to earn a living. But there were few, if any, government extension services in the marshlands, resulting in a poor knowledge base for proper cultivation methods. In addition, agricultural productivity in these areas is poor, even where crops have been cultivated for a longer period of time. ARDI worked directly with farmers to introduce them to modern techniques for the proper cultivation of sorghum, alfalfa, okra, maize, and sunflowers, which are more commonly grown in the region and can be easily marketed during the summer months.

This project began with the collection and analysis of soil and water samples in the marshlands and using these data to select areas more suitable for production. ARDI then worked with farmers to establish 60 production plots (26 in Basrah, 16 in Thi-Qar and 18 in Missan) to demonstrate proper techniques of planting, cultivation, and harvesting to improve production both for income, as cash crops, and food supply as subsistence crops. For each of the five crops selected for demonstration, 12 one-acre plots were established. All of the

crops were planted during the spring, and throughout the growing season ARDI provided technical assistance on fertilization, weed control and harvesting.

Field days were held to demonstrate the effects of the improved cultivation techniques to other farmers in the marshlands. Area farmers observed the increased production obtained from improved practices, learned about the techniques to replicate those results, and became acquainted with agricultural specialists in the area with whom they can discuss the issues they face with crop production.

RESULTS

For all five crops, the introduced technology package demonstrated significant yield increases over traditional methods. Income increases, taking into account increased costs of production, ranged from 25% for maize to 80% for sorghum. The most promising results were seen with alfalfa. Alfalfa has proven to be a very economical crop in the marshland areas. It is possible to get 12 cuttings of alfalfa per year if the farmers are careful with plot leveling and the correct applications of fertilizers. Demonstration plots produced 12 cuttings a year as compared to only 6 cuttings taken with traditional methods. Each cutting produced in an average of 38 ton/hectare green fodder or 5.8 mt/ha dry fodder. The demonstrations plots produced average annual yields of alfalfa of 456 mt/ha green fodder or 69.6 mt/ha dry fodder.

The gross revenue of farmers participating in the alfalfa demos was $25,536 per hectare for green alfalfa and $22,272 per hectare for dry alfalfa. This can be compared to average revenues of $12,768 per hectare for green harvest and $11,136 for dry harvest under normal conditions. Participating farmers experienced more than a 100% increase in revenue. Marshland livestock breeders will also benefit greatly from the increased production of alfalfa, which will serve as a source of fodder to improve the health and production of their animals.

ESTABLISHING AND RESTORING MOA DATE PALM MOTHER ORCHARDS AND NURSERIES

ACTIVITIES

Date production is a key component of stabilizing future income and employment opportunities for marsh dwellers and internally displaced people who were returning to the marshlands. ARDI assisted the Ministry of Agriculture's date palm production program by establishing 22.5 hectares of mother orchards and 10 hectares of nurseries in the Basrah and Missan marshlands area in 2005. During the previous year, ARDI established an additional 17.5 hectares of mother orchards in the two governorates, for a total of 38 hectares.

Date palm production in the marshlands has declined by half over the past decade as trees have gone out of production due to the general neglect of the orchards due to sustained military conflicts, draining of the marshes and lack of new stock to replace dead and aging trees. Many farmers were forced to abandon their lands to pursue other employment and those who stayed to cultivate date palms experienced declining productivity and income as existing

(above) Traditional reed structures in the marshes.

(opposite page) Renewing the waterproofing on the longboat.

trees suffered damage from changing water regimes, or simply aged beyond their productive utility.

Beginning in 2004, ARDI contributed 83,000 offshoots to restock MOA mother orchards around the country. 16,000 of these offshoots went to mother orchards in the marshland region in the two governorates of Basrah and Missan. The MOA mother orchards will supply some offshoots directly to the farmers, though most will go to the nurseries for one year of further cultivation to increase their value and the likelihood of successful transplant. These will also be available to area farmers as they are moved out of the nurseries and replaced by new offshoots from mother orchards. The marshland mother orchards will have a capacity of approximately 48,000 offshoots per year, all of which will move to farmers fields either by direct transplant or through the nurseries.

To assure maximum productivity of the facilities, ARDI also rehabilitated the infrastructure of the mother orchards and nurseries, furnishing modern drip irrigation systems, pumps, pumphouses and water reservoirs.

Date palm offshoots awaiting planting in marshland areas.

RESULTS

ARDI's project to assist the Ministry of Agriculture to supply new date palm seedlings to farmers provides growers in the marshlands access to commercially desirable, high-value stock within a short distance of their groves. The productive capacity of Ministry mother orchards and nurseries will enable 2,400 date growers each year to replenish or increase their stock with 50 new trees.

REHABILITATING PRIVATE DATE PALM ORCHARDS

To promote date palm cultivation in the marshlands, ARDI worked with a local NGO to help 50 date palm farmers in Basrah replenish their existing orchards with high-quality, commercially desirable offshoots. The grant provided 40 offshoots to each farmer, which will enable each farmer to produce an additional 2,000 kg. of high-value fruit each year from the initial new stock. Technical specialists from the NGO worked with farmers to plant the offshoots using preferred methods, including the use of a rooting hormone to promote growth and fungicides to prevent disease. The NGO also held a workshop for farmers

to learn proper care for the offshoots, date palm orchard maintenance, and the benefit of interplanting other crops (particularly pomegranate) among date palm trees to further increase agricultural production and income.

This project was intended to complement ARDI's work with the Ministry of Agriculture to build up the government's stock of high-value date palm planting material in mother orchards and nurseries. With the government providing a reliable source for high-value offshoots, farmers can begin to reinvest in their orchards.

RESULTS

The improved production of date palms in the marshlands will benefit the participating farmers, who can expect each of their offshoots to produce an average of 3.5 additional offshoots in the second year, or 140 per orchard. The farmers can either replant these offshoots on their own lands, or sell them to neighboring farmers for an average price of $12 per offshoot. If the farmer has the available land, and replants the offshoots, each farmer would have 180 productive trees producing a minimum of 50 kg. of high-value fruit each year., Thus, in four years, each farmer could produce about 9,000 kg of dates per year, which would provide a gross annual income of $5,000 to $7,000. The farmer, of course, can continue to sell offshoots from mature trees, and provide neighboring farmers with new high-quality date palm varieties as well.

IRRIGATION

DISTRIBUTING FAMILY DRIP IRRIGATION KITS AND TRAINING FARMERS

ACTIVITIES

As with the rest of the country, efficient water use is one of the primary challenges facing farmers in the marshlands. To address this obstacle, ARDI introduced high efficiency family drip irrigation systems (FDIS). The systems work at very low pressure and can be gravity-operated, with no external power or electricity needed, making them ideal for rural and small-scale agricultural production. No specialized skill is needed to manage the low-tech FDIS, and they afford the farmer the same advantages as more sophisticated irrigation systems.

Thirty-three marshland farmers in Basrah, Missan and Thi-Qar received the systems and participated in the demonstration program. The farmers grow high-value horticultural crops such as okra and sunflower, which offer a larger return per hectare than typical dryland crops such as wheat. The drip system allows farmers to use the land for two cropping seasons in a year, which also increases their income.

RESULTS

With a modest investment for each FDIS system, which was equalled by the dramatic increases in production during the first year alone generates additional income for farm families. Growing interest in the FDIS generated by the initial demonstration projects motivated local entrepreneurs to produce their own systems at a lower cost of $100 to $120. These merchants also provide repair

services, helping ensure the long-term return from the farmer's investment. The distribution of these drip kits and the training of extension agents to provide irrigation scheduling assistance will significantly improve the productivity and income of small-scale farmers throughout the marshlands.

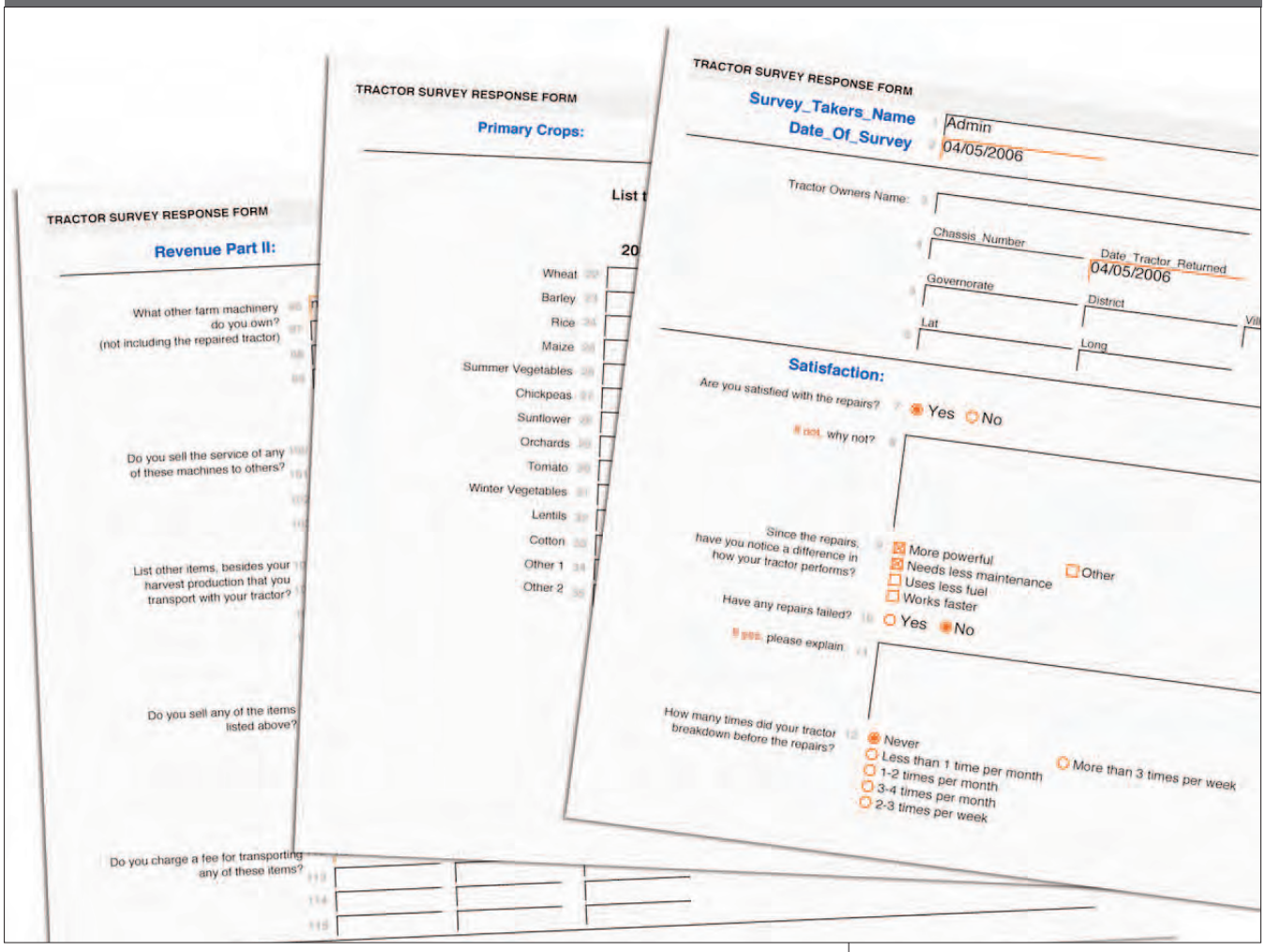
CLEANING CANALS

ACTIVITIES

Irrigation systems for adequate water supply and proper drainage are critical for farmers in the southern part of the country. Over the last fifteen year, government neglect has left many irrigation systems in advanced states of disrepair. Irrigation canals are often full of silt and weeds, which reduces or completely blocks the flow of water to the fields.

ARDI rehabilitated three tertiary canal systems blocked by silt and weeds, providing instant, tangible results to marshland farmers who cultivated lands fed by the network of canals. Two of the systems were in Basrah, and were meant to provide irrigation water to 3950 hectares and 1624 farmers. The third system was in Thi-Qar, and affected 1,688 hectares and 280 farmers. The farmers in these areas grow mainly high-value, but irrigation-dependent horticulture crops such as tomato, okra and sunflower. The rehabilitation of the irrigation systems enabled farmers to return lands to cultivation that had been left idle for lack of water.

5.0 MONITORING AND EVALUATION



ARDI designed and implemented a Monitoring and Evaluation system to inform managers of the success of project investments and to collect data that would satisfy contractual reporting requirements. Nine specific contract objectives (the C 5 Results) were tracked. Data was collected and analyzed, with the impacts reported in this chapter.

The Monitoring and Evaluation Team designed surveys to gather data that would add to the information collected during project implementation. Samples were distributed to the three regions—the Kurdistan Regional Government (KRG), Ninewa governorate, and the Central/South governorates, matching as closely as possible the distribution of project activities among those three areas. Sample sizes were set between the minimum number necessary for meaningful analysis and the maximum number considered manageable, given time and financial constraints. In most cases, the range of variability of the data was unknown at

the time of sample selection. Beneficiaries were selected at random. Project scope, sample sizes, and the number of surveys completed are listed in the following table.

TABLE 99 IMPACT SURVEYS IN MAJOR ARDI PROGRAMS

Program	Total Scope of Program	Target Sample Size	Surveys Completed	Percent Surveyed
Tractors	4600 tractors	600	300	6.50%
Irrigation	74 projects	10	7	9.50%
Seed Cleaning	7400 farmers	140	138	2%
"Neighbor" farmers	n/a	140	138	n/a
Vet Clinics	69 clinics	20	14	20%
Breeders	n/a	200	123	n/a
Honey Producers	368	50	35	9.50%
Mechanics	174	28	28	16%

Security concerns in Ninewa and the Central/South regions seriously hampered data collection, while surveys in the relatively secure KRG were completed almost in full. This uneven collection of data likely skews averages toward results recorded in the northern part of the country.

Given the security situation, it was necessary to assemble and train teams of enumerators with the necessary local knowledge to travel safely in each of the different areas of the country. ARDI issued contracts to NGOs in the KRG and Ninewa, and hired 9 independent enumerators to complete surveys in the Central/South areas of the country. Although enumerators were hired based on previous experience, they also received a three-day training course covering the projects to be surveyed, survey methodology, and data entry. Surveys in the north were taken from June through August of 2006, and surveys in the south were completed primarily in August, 2006.

Once data collection was completed, survey data were entered into a common database for analysis. Data entry was performed partially by the contracted survey enumerators and partially by ARDI staff. The ARDI Monitoring and Evaluation Team provided oversight to assure quality control for all data entry. Surveys were analyzed, cross-checked, and summarized by ARDI staff.

The nine C 5 Contract Results are reported below.

OBJECTIVE A:
$230 MILLION VALUE ADDED TO THE IRAQ AGRICULTURE ECONOMY DUE TO ARDI PROGRAMS.

The first C 5 objective calls for the monetization of ARDI project benefits as a contribution to Iraq's agricultural economy. Of the more than 100 ARDI initiatives, the four largest investments have been examined in depth: wheat seed (from wheat seed cleaners), tractor rehabilitation, veterinary clinic reconstruction, and irrigation and drainage infrastructure rehabilitation. Using conventional assumptions to monetize benefit streams, and discounting to obtain "present value," these four projects accounted for $400 million in value added to Iraq's agriculture economy, comfortably surpassing the contract requirement.

TABLE 100 MONETIZED PRESENT VALUE OF ARDI BENEFITS IN FOUR PROGRAMS

Program	First year Benefits	Project Total (Present Value)	Time Line
Seed Cleaners	$19,000,000	$66,000,000	5 Years
Tractor Rehabilitation	$16,000,000	$120,000,000	10 Years
Veterinary Clinic Reconstruction	$9,092,141	$61,000,000	10 Years
Irrigation and Drainage Infrastructure	$50,392,162	$153,000,000	5 Years
		Total $400,000,000	

MONETIZATION METHODOLOGY

The economic models that are used to monetize project benefits were developed prior to survey design or data collection. Each of the monetization models is specific to the project for which it was designed. There is, however, a common approach and methodology that forms the basis for all models. The elements of it are:

1. ARDI project benefits are calculated using a "with-project scenario" and a "without-project scenario." The "value introduced" is the with-project benefits minus the without-project benefits. Whenever possible the without-project scenario will be calculated for the same year as the with-project scenario. A comparison of year 1 to year 2 will be used as the alternative.

2. The future benefit stream from ARDI projects is converted to present value to take into account the time value of money. A dollar received today is worth more than a dollar received five years from now, because money in hand today can be invested and grow in value. The future benefits from ARDI projects are discounted at an annual rate of 10%.[1]

3. A ten-year benefit stream forecast is used for tractor rehabilitation and veterinary clinic reconstruction. The benefit stream from irrigation and drainage infrastructure rehabilitation and wheat seed cleaners is calculated for five years.

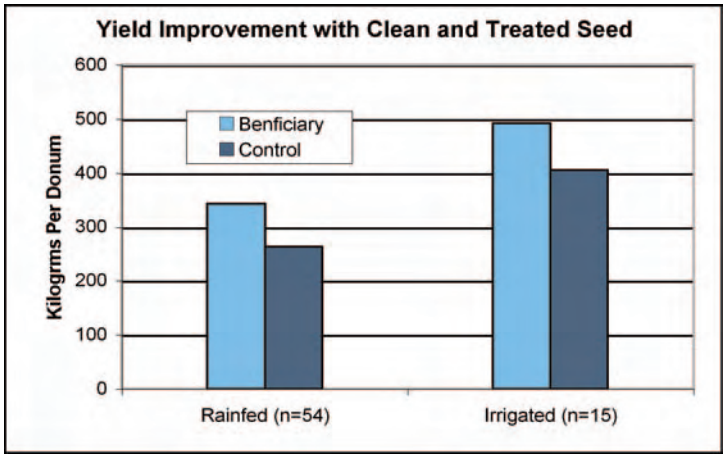
4. Monetization models are based on data from a number of sources, including prior field surveys, technical reports, or statistics gathered from public or private sources (e.g., FAO, UNWFP, Government of Iraq). ARDI conducted extensive surveys to evaluate the four targeted programs. Whenever the survey results were incomplete or inconclusive, due to security constraints on traveling or obtaining sufficient interviews, the assumptions used in developing the models are made explicit.

5. Monetized benefits can be calculated at various stages along the value chain. For example, the value added to the economy from newly introduced varieties of wheat could be valued at the farm-gate level, or that of the wholesale market, flourmill, or bakery. The monetized benefits in this report are calculated at the farm-gate or wholesale level.

[1] This rate may undervalue ARDI monetized benefits. There are few investments readily available to the general public that would yield such a return in Iraq. For domestic cost-benefit analysis the US Office of Management and Budget (OMB) currently mandates the use of a 2.8% real discount rate for 10-year forecasts.

CASE 1: WHEAT SEED CLEANERS

There has been no government-supported distribution of certified wheat seed grown in Iraq since 2002. In 2004, the MOA, ARDI and the US military combined to import 16,000 mt of certified wheat seed that satisfied a small portion of domestic demand. Most farmers rely on farmer-saved seed for planting the next season, seed that often contains a large percentage of foreign seeds, including mustard, barley, and other volunteers. In 2005, ARDI implemented a program to procure169 wheat seed cleaners for distribution throughout Iraq (see Section 2.1 for project details) to improve the quality of farmer-saved wheat seed. The result was higher wheat grain yield, with better quality as graded at the purchasing silo.[2] Cleaned seed commands a premium price on the open market. Seed cleaners add additional value by treating seed with a fungicide, which significantly reduces "smut," a major wheat disease.[3] Cleaned and treated seed can sell for 30% more than untreated wheat grain. However, the most significant benefits from clean and treated seed are realized with the subsequent year's harvest. Surveys showed that under rainfed conditions farmers who planted seed cleaned with ARDI machines harvested 30% more wheat than their neighbors, who did not use the machines. Under irrigation the increase in yield was over 20%.



The key variables of the monetization model include how the seed cleaner output is used, and the increased yield from cleaned seed. The increase in yield was determined by interviewing beneficiary farmers and the nearest neighbor who did not have cleaned seed. The survey also revealed that more than 75% of the wheat was treated with fungicide, which renders it unfit for human or animal consumption. Since this wheat seed has value, and the farmer has paid the cost of transportation to and from the seed cleaner location, we can safely assume that treated seed was saved for planting the next season, or sold to

[2] The Ministry of Trade grades wheat only on content of brokens, foreign matter, and smut. Thus a clean wheat field qualifies as Grade 1, receiving the highest price at the silo.

[3] The use of fungicide applied by the seed cleaners also contributed to the increased yields that were seen last year. However, the 2005/2006 growing season was not a year of a major smut infestation. Outbreaks of smut are generally contingent on meteorological and soil conditions, in addition to the extent of fungicide use. During a year when smut infestation is prevalent, much of the harvest not treated with fungicide in a given region will be affected with smut and will be unsuitable for human consumption. Consequently, farmers receive much lower prices for their harvest. Such an infestation of smut affected northern Iraq as recently as three years ago. The benefits from seed cleaners during such a year would be much greater than those seen in 2005/2006 and used in the monetization model.

someone else for planting.[4]

The monetization model is shown below. Seed cleaner records show that the cleaners input over 35 million kilograms of grain and delivered 31.76 million kilograms of clean seed. 57% of the wheat seed is assumed to be planted in rainfed land and 43% planted in irrigated land.[5] The sowing rate is the average value based on the estimated need for broadcast seeding. Yields under conditions "with" cleaning and treatment and "without" are captured by the beneficiary and neighbor surveys. The wheat silo prices for 2006 were used to calculate the monetization of seed cleaner benefits. Grade 1 wheat is purchased at 450 ID/kg, grade 2 at 375 ID/kg, and grade 3 at 250 ID/kg. These prices are established annually and paid by the Government of Iraq at Ministry of Trade silos.[6]

TABLE 101 ARDI SEED CLEANERS REVISED MONETIZED BENEFIT CALCULATION

Output Kgs wheat seed	31,764,633				
75% seed planted (Kgs)	23,823,475				
130 Kgs seed per ha					
		Yield with	Yield with total	Yield without	Yield without total
57% rainfed planted (ha)	104,457	1370 kgs per ha	143,105,780	1050 kgs per ha	109,679,613
43% irrigated planted (ha)	78,801	1966 kgs per ha	154,922,224	1619 kgs per ha	127,578,372
Next year's harvest	Grade 1		25.00%		0.00%
	Grade 2		75.00%		100.00%
Prices US$	Grade 1		$0.30		
Prices US$	Grade 2		$0.25		$0.25
Value with rainfed			$37,565,267		
Value with irrigated			$40,667,084		
Total			$78,232,351		
Value without rainfed					$27,419,903
Value without irrigated					$31,894,593
Total					**$59,314,496**
Net increase with Project (Year 1)			**$18,917,855**		

	Year 1	Year 2	Year 3	Year 4	Year 5
Survival Discount (10%)	$18,917,855	$17,026,069	$15,323,462	$13,791,116	$12,412,005
					$65,899,154

NPV @ 10% discount rate
=NPV(.1, benefit steam years 2,3,4,5)+benefit stream year 1

[4] The fungicide Raxil was to be provided by the government at seed cleaning sites and purchased by local farmers. In some locations the Raxil was not made available. In others, farmer associations or chambers of commerce purchased the Raxil and provided it at the sites. Thus, there is reason to believe that more cleaned seed will be planted each year than was treated by the seed cleaning machines.

[5] This assumption is based on Agro-Ecological Zone GIS analysis derived from remote sensing data.

[6] Wheat prices paid to farmers at the Ministry of Trade silos are administratively determined. Since 2003, the annual prices paid for Grade 1 wheat per metric ton have been $180, $200, $260, and $300. The 2006 figures (including Grades 2 and 3) most closely approximate the landed cost of wheat in Baghdad, estimated to be $275-$280 per mt.

CASE 2: TRACTOR REHABILITATION

As part of the Agriculture Mechanization Rehabilitation project (see Section 2.2), ARDI repaired 4,633 tractors across Iraq, approximately 9% of the national fleet, and provided training and basic tools to 216 mechanics, establishing the base for continued maintenance of the repaired tractors. The repairs ranged from engine and transmission overhauls to the replacement of starter motors and brakes. The program targeted tractors with the highest cost/benefit returns. Affordable costs were weighed against increasing tractor efficiency, and productive lifespan of the machine. Increased tractor efficiency and lifespan are particularly vital to Iraq's agricultural economy, given the age composition of the national fleet. FAO has reported that in 1995, 80% of the tractors in the center and south were more than 10 years old and 53% of total tractors were more than 15 years old. The "FAO Rural Socioeconomic Survey for 2002" reported that 97% of the tractors in the north were over 10 years old, 78.5% of the total were over 16 years old, and 35% of the total were over 21 years old.

Through the use of the monetization model described below, it is estimated that the present value added to the agriculture sector economy from tractor rehabilitation totals approximately $116,000,000 over a period of 10 years.

A year 1/year 2 approach is used to measure the change in tractor- related activity before and after the repairs. From approximately 300 sampled beneficiary tractor owners, 256 surveys contained responses considered valid for use in the monetization model.

The benefits from tractor rehabilitation are derived from the additional area brought into cultivation/kept in cultivation from more efficient and more reliable tractors; the additional revenue from tractor-related services; and the savings to farmer-owners from reduced purchase of imported tractor parts and equipment. The timing of tractor repairs eliminated most contract plowing and seeding for the 2006-2007 winter crops. Those benefits are estimated from the tractor's increased capacity after it has been repaired and returned. The timing of the tractor repairs, the agricultural season, and surveys did not allow a complete calculation of the value added to the agriculture economy from this project. More than anything else, benefits are contingent on the area plowed in the fall and early winter in preparation for the planting of wheat, barley, and other crops grown in the winter. For most of Iraq, plowing for the winter season begins around early October, is most intense during the month of December, and continues as late as January. Many of the tractors were undergoing repairs during this important period, as the table below shows. Surveying began in June and was completed in late August.

TABLE 102 DATE REPAIRED TRACTORS RETURNED TO THEIR OWNERS

Month Returned	Percent
November-05	22%
December-05	31%
January-06	34%
February-06	3%
After Feb-06	10%

The surveys did reveal strong positive results in additional area cultivated and revenue from tractor-related services, in spite of the limitations presented by the timing of the project and surveys. The average area cultivated per farmer is estimated by taking the area plowed for the two primary winter crops and applying a multiplier that accounts for the other crops grown.[8] These values are derived from survey data. During the 2004/2005 season (prior to tractor repairs) an average of 26.2 ha was cultivated by the farmers participating in the

[8] There are multiple ways to calculate area cultivated from the survey data. The multiplier was determined from previous data showing the average amount of land cultivated in grain crops against the amount of land cultivated in all crops.

tractor repair program. The area increased by 10% to 28.8 ha during the 2005/2006 season (after repairs). Tractor-related services captured by the surveys include the transportation of fodder, water, construction materials and, if the timing had included harvest, would have included the movement of the grain and straw from the fields to warehouses. The survey data showed that the revenue from tractor-related services (not including tractor custom plowing, seeding, and cultivation) increased by 24% after rehabilitation, to an annual total of $1,054 per tractor. This sizable increase points to the increase in tractor power, reliability, and efficiency.

The surveys included questions related to contracted agricultural services such as plowing, seeding, spreading fertilizer, and spraying for pests. According to the FAO, 96% of farmers in Iraq rely on renting a tractor or tractor services for all or part of their operations; clearly these services play an important role in agricultural production. Because of the timing of tractor repairs, the survey did not show an increase in the revenue from these services. However, with the average repaired tractor cultivating only 28 ha, there is sufficient capacity to undertake contract cultivation services in the next calendar year after repair. These benefits, calculated to approximate the 24% increase in noncultivation tractor rental services, have been included in the benefit stream.

The survey also obtained before and after tractor rehabilitation repair costs to the farmer-owners. This very substantial benefit was estimated by the repair facilities to consist of 50% cost of imported parts and equipment. This benefit to the agricultural economy has been captured in the monetization of benefits below.

THE MONETIZATION MODEL

The additional area cultivated and service revenue made possible from better power and reliability are calculated from survey data with extrapolations from the survey for custom tractor services. Estimates of future performance are based on efficiency and useful life, the two main contributing elements of future tractor performance used in the monetization model.

Efficiency is the amount of work that a fully operational tractor can perform. Repairs were intended to return tractors to new specification conditions. If repaired tractors delivered 75% of new efficiency, and estimating the prerepair status at 25% of new efficiency, the repaired tractors should show a 50% increase in performance. The increased area under production documented by the survey data provides the "with" and "without" efficiency factors for owner-cultivated land in year 1.The increase in nonfarm tractor leasing services provides a second efficiency measure, and the projection for a similar increase in farm-based custom tractor services completes the efficiency calculation.

The "survival rate" is defined as the percentage of the original set of tractors that is operational over time. Under the "with project" scenario, there is little likelihood of the repaired tractors failing for the first few years. The rehabilitation project focused on the repairs that would be most likely to ensure maximum tractor functionality (e.g. engine or transmission overhauls, or clutch repairs). Any necessary additional repairs over the short term would likely be minor, and could be completed at minimal cost to the farmer. A flat survival rate of 100% is used for the first 4 years after tractor repairs, followed by a decelerating

TABLE 103 ARDI TRACTOR REPAIR REVISED MONETIZED CALCULATION

Total number of tractors repaired	4633	
Average area in cultivation 2006 ha	28.5	
Average yield per ha wheat 2006 kgs/ha	1050	
Price of grade 2 wheat kg	$0.25	
MONETIZED BENEFIT: LAND UNDER CULTIVATION		
With Tractor Repair	**Year 1**	**Year 2**
Value of the wheat crop cultivated by tractors	$34,660,631	
Benefit stream:5% annual efficiency decline after 4 years	**$34,660,631**	**$34,660,631**
Without Tractor Repair		
Value of the wheat crop cultivated by tractors	$31,194,568	
Benefit stream with 5% efficiency decline each year	$31,194,568	$29,634,840
Net Benefits from tractor repair	**$3,466,063**	**$5,025,792**
Net Present Value discounted at 10% = **$41,395,028.85**		
MONETIZED BENEFITS: FARM TRACTOR SERVICES		
Annual income before repairs	$1,752.54	
Annual income after repairs	$2,173.15	
Net Benefit for all tractors	$1,948,684	
With Tractor Repair		
Benefit stream with 5% efficiency decline after 4 years	$10,068,202	$10,068,202
Without Tractor Repair		
Benefit stream with 5% efficiency decline each year	$8,119,518	$7,713,542
Net Benefits from tractor repair	**$1,948,684**	**$2,354,660**
Net Present Value discounted at 10% = **$17,337,004**		
MONETIZED BENEFITS: NON-FARM TRACTOR SERVICES		
Annual income before repairs	$849.94	
Annual income after repairs	$1,053.63	
Net Benefit for all tractors	$943,696	
With Tractor Repair		
Benefit stream with 5% efficiency decline after 4 years	$4,881,468	$4,881,468
Without Tractor Repair		
Benefit stream with 5% efficiency decline each year	$3,937,772	$3,740,883
Net Benefits from tractor repair	**$943,696**	**$1,140,584**
Net Present Value discounted at 10% = **$8,399,444**		
MONETIZED BENEFITS: REPAIR COSTS		
Annual costs before repair	$4,584.00	
Annual costs after repair	$564.00	
Percentage repairs cost of imported parts	$0.50	
Annual benefits to farmers of repairs in cost savings	$2,010.00	
Total benefits to tractor owners in repair cost savings	$9,312,330	
Benefit stream with 5% loss per year	**$9,312,330**	**$8,846,714**
Net Present Value discounted at 10% **$52,526,327.12**		
Total Net Present Value	**$119,657,804**	
Total first year	$15,670,773	

Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
$34,660,631	**$34,660,631**	**$32,927,600**	**$31,281,220**	**$29,717,159**	**$28,231,301**	**$26,819,736**	**$25,478,749**
$28,153,098	$26,745,443	$25,408,171	$24,137,762	$22,930,874	$21,784,330	$20,695,114	$19,660,358
$6,507,534	**$7,915,188**	**$7,519,429**	**$7,143,458**	**$6,786,285**	**$6,446,970**	**$6,124,622**	**$5,818,391**
$10,068,202	$10,068,202	$9,564,792	$9,086,552	$8,632,225	$8,200,614	$7,790,583	$7,401,054
$7,327,865	$6,961,472	$6,613,398	$6,282,728	$5,968,592	$5,670,162	$5,386,654	$5,117,321
$2,740,337	**$3,106,731**	**$2,951,394**	**$2,803,824**	**$2,663,633**	**$2,530,451**	**$2,403,929**	**$2,283,732**
$4,881,468	$4,881,468	$4,637,394	$4,405,525	$4,185,248	$3,975,986	$3,777,187	$3,588,327
$3,553,839	$3,376,147	$3,207,340	$3,046,973	$2,894,624	$2,749,893	$2,612,398	$2,481,778
$1,327,629	**$1,505,321**	**$1,430,054**	**$1,358,552**	**$1,290,624**	**$1,226,093**	**$1,164,788**	**$1,106,549**
$8,404,378	**$7,984,159**	**$7,584,951**	**$7,205,703**	**$6,845,418**	**$6,503,147**	**$6,177,990**	**$5,869,090**

survival rate similar to the calculated loss in efficiency by both repair and unrepaired tractors.

The value of the additional area in cultivation in measured in terms of wheat production. This crop is used both because wheat is the major crop grown by tractor owners, and also to ensure a simple monetization model that provides conservative estimates of project benefits. An average yield of 1050 kgs per hectare, and a silo price of $250 per metric ton (grade 2) complete the monetization of the additional area cultivated as a result of tractor rehabilitation. Taking the tractor rehabilitation project as a whole, the difference between the "with" and "without" project scenarios for the additional area cultivated in wheat totals over $41,000,000.

The net total value of benefits from nonfarm and farm tractor-related services, calculated over a ten-year period, exceed $25,000,000. Calculating the savings in imported parts and equipment repair costs increases the contribution of the tractor program by more than $52,000,000.

The total value in benefits from ARDI's tractor rehabilitation program, increasing tractor efficiency by 50%, is approximately $120,000,000 taken over the 10-year life of the tractor repairs.

CASE 3: VETERINARY CLINIC REHABILITATION

ARDI completed the rehabilitation of 68 Ministry of Agriculture (MOA) veterinary clinics in 17 governorates. According to Government of Iraq records, the rehabilitated clinics serve over 135,000 livestock breeders. The clinics suffered from years of neglect during the previous regime, and extensive looting after the 2003 invasion. MOA clinics provide a critical source of veterinary services for mass vaccination campaigns as well as for the small-scale breeders that can't afford private services. Since many diseases that most afflict animals can also be transferred to humans who live in close proximity with their animals, the clinics also serve an important role in public health. Iraqi breeders suffered increasing losses to herd numbers and household income as MOA clinic services declined, and cases of animal-transmitted diseases to humans, especially brucellosis, were at unacceptable levels in some governorates of the country. In terms of animal health alone, however, the estimated benefits from rehabilitation of the MOA veterinary clinics total more than $61,400,000 over a 10-year period.

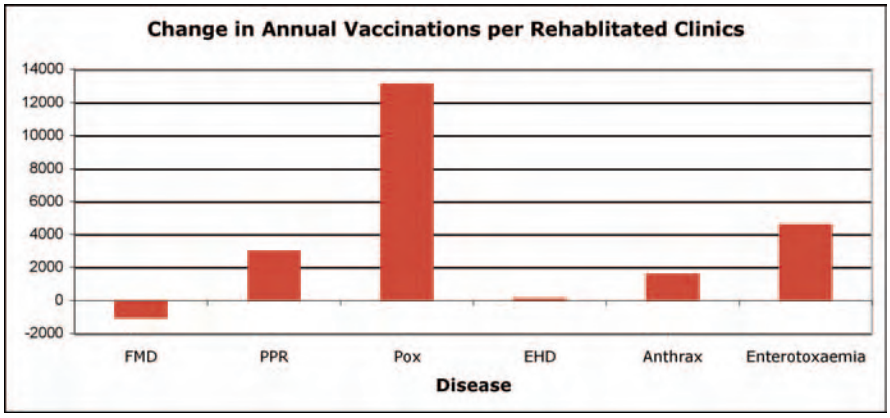
The value added to the agriculture economy is derived primarily from the animals saved through the rehabilitated veterinary clinics, either through treatments or vaccinations. Two separate studies were conducted in order to capture these benefits. First, a total of 14 rehabilitated clinics were chosen to compare services delivered both before and after rehabilitation. Second, a total of 73 valid surveys of livestock breeders who utilized the services of the clinics verified service delivery from the perspective of both service providers and users.

The surveys showed that, by far, the greatest benefits from the rehabilitated clinics were derived from significant increases in the number of vaccinations. This is an expected result, since the clinics serve as a vital component of the vaccination campaigns, and without a functioning clinic it is difficult to reach large numbers of animals. A functioning clinic is able to provide facilities for proper vaccine storage, as well as a satisfactory base of operations so that more staff

can reach more animals.

Perhaps surprisingly, the number of treatments for specific problems did not show a notable increase. This may be because farmers consult with the veterinarians about general problems during the course of on-farm visits for vaccination campaigns, while the long distance between farmer and clinic discourages consultations for treating a single animal, because of transportation difficulties for both veterinarian and farmer.

As government employees, clinic veterinarians keep complete records of all activities, including numbers of vaccinations for each disease. The clinic managers opened their records for ARDI surveyors, who noted figures for the years proceeding and following rehabilitation. The chart below shows the average change in number of vaccinations per clinic, after rehabilitation, for all of the vaccinations listed by the surveyed clinic managers. All of the vaccination types showed increases except for foot and mouth disease (FMD). Goat pox alone showed an average increase of around 13,000 vaccinated animals per clinic.



Expected morbidity and mortality rates of these diseases, both with and without vaccination, permit a determination of the monetized value of additional vaccinations. These variables are shown in the monetization model, below. Morbidity, mortality, and vaccine effectiveness values are provided by Iraqi State Veterinarians, the World Organization for Animal Health, or USDA-APHIS for every disease except peste des petits (PRR) and anthrax. Whenever possible, the values are specific to Iraq. Otherwise, the values are based on regional or global estimates. The epidemiology of PRR is somewhat similar to FMD; therefore FMD values are used for PRR. The anthrax estimate is based on values provided by the experience of local veterinarians.

The number of animals saved per year by each clinic is estimated by multiplying the number of additional vaccinations, morbidity, mortality, and vaccine effectiveness. It is assumed that the breeds of the animals saved are proportional to average herd composition determined by the breeder surveys (see the figure on the following pages). The value of each animal saved (whether adult or immature) is based on the average cost of the animal at market, as verified by the breeder surveys.

The percentage of adult animals by sex is captured by the breeder surveys. Local veterinarians estimate that on average 80% of the herd is over one year of age, or "adult." The total number of animals less than one year old is assumed

TABLE 104 MONETIZED BENEFITS - VACCINATION CAMPAIGNS

Vaccination Campaigns

Disease	**FMD**	**PPR**	**Pox**	**EHD**	
Vac/Year/Clinic Difference	-1094	3009	13138	136	
Morbidity X Mortality X Vac. Effectiveness	1.10%	5.40%	5.40%	2.30%	4.30%
Animals Saved/Clinic	-12	162	709	3	
Total Animals Saved/Year	1447				
Clinics Rehabilitated	68				
Sheep Saved per Year	78882				
Goats Saved per Year	17925				
Cattle Saved per Year	1154				
Buffalo Saved per Year	466				
Percent Female	58%				

Vaccination Campaigns

	Total	**Male**	**Female**
Percent Juvenile	20%	10%	10%
Percent Adult	80%	34%	46%

Average Price

	Female		**Male**	
	Price for Juvenile	**Price for Adult**	**Price for Juvenile**	**Price for Adult**
Sheep	$51	$77	$60	$120
Goats	$43	$74	$46	$78
Cattle	$224	$456	$371	$624
Buffalo	$133	$933	$425	$1,005

Vaccination Campaigns

	Sheep	**Goats**	**Cattle**	**Buffalo**
Male Juvenile	$474,741	$83,249	$42,799	$19,807
Female Juvenile	$401,792	$77,673	$25,812	$6,214
Adult Male	$3,201,820	$472,652	$242,537	$157,743
Adult Female	$2,828,318	$611,626	$243,913	$201,445
Vaccination				**$9,092,141**

Increased Vaccination Benefits Over Time

	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Annual Benefit of Increased Vaccination	$9,092,141	$9,092,141	$9,092,141	$9,092,141	$9,092,141
NPV Multiplier	1	0.91	0.83	0.75	
NPV Including Vaccination	**$9,092,141**	**$8,265,583**	**$7,514,166**	**$6,831,060**	

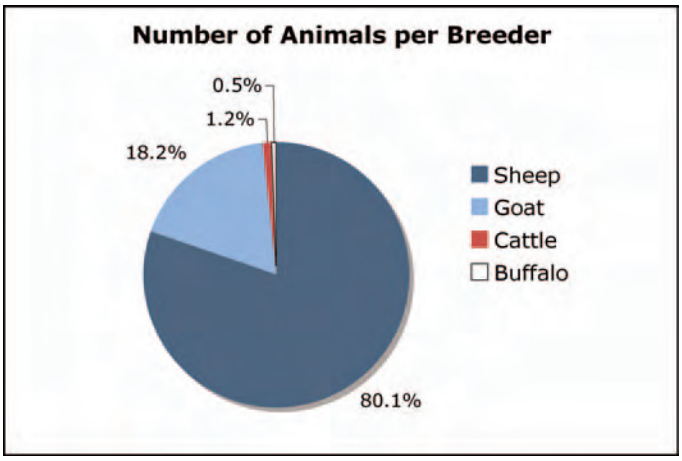
Total NPV Including Vaccination **$61,454,000**

	Anthrax	Enterotoxaemia
	1597	4591
2.30%	4.30%	11.30%
	68	516

Buffalo

$9,092,141

Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
$9,092,141	$9,092,141	$9,092,141	$9,092,141	$9,092,141	$9,092,141	$9,092,141
	0.68	0.62	0.56	0.51	0.47	0.42
	$6,210,055	**$5,645,504**	**$5,132,277**	**$4,665,706**	**$4,241,551**	**$3,855,955**



to be 50% male and 50% female, an approximation since the animals are culled by sex sometime between 6 months and one year. The annual benefits from increased vaccinations are monetized for both adult and immature animals, using value per animal based on market prices and verified by the breeder surveys. The annual benefits from increased vaccinations are estimated at $9,092,141 for all 68 rehabilitated clinics. At an annual discounted rate of 10%, the value in current dollars of the increased numbers of vaccinations totals $61,454,000 projected over a 10-year period.

CASE 4: IRRIGATION AND DRAINAGE IMPROVEMENT PROJECTS

In the center and southern areas of Iraq, all agriculture is dependent on irrigation. In the northern areas, irrigation systems supplement rainfall. The country has existing and extensive irrigation infrastructure, however, irrigation systems require regular maintenance and repair, and the Iraqi systems suffered from years of disrepair and neglect. ARDI determined that agricultural production could increase dramatically through the rehabilitation of existing irrigation systems, producing rapid results for relatively modest investments. Projects with the highest potential impact were identified and implemented, yielding impressive benefits for large numbers of farmers. The annual estimated benefits from irrigation and drainage infrastructure rehabilitation projects total over $50,000,000. The net present value over five years is more than $153,000,000.

For the purposes of data collection and monetization, the irrigation and drainage infrastructure projects are broken down into three categories. **Drainage** projects allow proper drainage (e.g. pumping stations), a critical function to maintain soil tilth and prevent salinization. **Regulator** projects are aimed at structures (e.g., head regulators, cross regulators, and gates) that permit efficient distribution and management of irrigation water. **Other irrigation infrastructure** projects both conserve water, and facilitate the regular flow of water to agricultural lands (e.g. canal cleaning, canal lining, pipe flumes).

For individual irrigation projects, surveys were conducted with randomly selected farmers at the beginning, middle, and "tail" of the irrigation system. This protects against unequal distribution of irrigation water between the time it leaves the main canal and arrives at the farmers' lands furthest from the headworks. Surveys were completed on one drainage project, two regulator projects, and three other irrigation infrastructure projects. These projects were selected to be representative in terms of scale and potential impact. Security considerations

affected the locations where surveys could and could not be conducted. Three projects in Muthanna were surveyed, along with one each from Wassit, Thi-Qar, and Sulaymaniyah.

TABLE 105 SURVEYED IRRIGATION AND DRAINAGE PROJECTS

Project	Governorate	Sample
Drainage		
Um Al-Agaf Pump Station	Muthana	15
Regulator		
Irrigation Regulator at Al Mhaddad Pumping Station	Muthana	21
Al-Bassrokiyah Cross Regulator	Wassit	15
Other Irrigation Infrastrcture		
Cleaning Canals in Sayed Dekhee	Thi-Qar	6
Cleaning Canals in Al-Warka'a	Muthana	24
Cleaning Khormal Irrigation Canal	Sulaymaniyah	20

The monetized benefits from irrigation infrastructure projects are determined by the increase in revenue of farm families as a result of ARDI-funded improvements in irrigation systems.[1] The additional area cultivated, crop selection, and increased yields from improved irrigation all contribute to the increase in revenue. Of the three kinds of projects evaluated, the average increase in farmer revenue from drainage projects was 27 percent. This increase is lower than found with regulator projects, which tend to produce immediate benefits as opposed to the longer-term benefits obtained from proper drainage systems. However, the repair of drainage systems will, over time, return large areas of agricultural lands affected by salinization back to full production. By far the highest short-term impact came from regulator projects, which increased farmer revenues by 196 percent. The average increase in revenue for other irrigation projects (mainly canal cleaning) was 21%. Overall there was an average farmer revenue increase of 54% from ARDI's irrigation and drainage infrastructure projects.

The commodity prices used to determine revenue are shown together with the monetization model below. Most commodity prices were derived from ARDI's Wholesale Market Price Monitoring Program. The irrigation survey farm-gate price is used when a product was not reported by the Price Monitoring Program. Prices are normalized to September 2006.

Surveys of irrigation and drainage projects provided data at the level of the farm family. Estimates are averaged, and multiplied by the total number of beneficiary families to determine the impact of each of ARDI's main types of irrigation improvement projects. The data for the area covered, and number of families for each project (the command area) are provided by Ministry of Water Resources.

The estimated annual benefits from irrigation and drainage projects total **$50,392,162.** The net present value over five years is **$153,074,668.** [2]

[1] One example of a particularly successful project was the Al-Warkaa canal cleaning project. None of the 24 farmers surveyed for the project was able to grow rice prior to the cleaning, because the canal was blocked with weeds and debris. After the project was completed, all farmers were able to grow rice; on average, each farmer cultivated 13.1 donums of rice and harvested 13 metric tons of rice in the "with" situation. However, the large increase in revenue from rice found in Al-Warkaa is not representative of production possibilities in most of irrigated Iraq, and thus not included in the monetization model.

[2] These substantial benefits should be examined with the knowledge that they are based on a small sample size. Five out of 76 projects were surveyed, but only 77 beneficiary families were surveyed out of 85,145 impacted. The high-return canal cleaning project that allowed rice production, Al Warkaa, is not included, as mentioned above.

TABLE 106 PROJECT SCALE AND COMMODITY PRICES

Type of Project	Hectares	Percent	Families	Percent
Drainage and Pumping	108,345	38%	47,435	56%
Regulators	85,473	30%	14,334	17%
Other Irrigation Infrastructure	88,596	31%	23,526	28%
Total	282,413	100%	85,295	100%

TABLE 107 COMMODITY PRICES

Prices				
	Price (IDN/kg)	Price (US$/kg)	Note	
Wheat	340	$0.23	Hard Grade One	
Barley	255	$0.17	Black Grade One	
Rice	1,000	$0.67	Anbar Grade One	
Maize	280	$0.19		
Sunflower	189	$0.13	From 2006 Irrigation Survey	
Tomato	300	$0.20		
Melon	325	$0.22		
Okra	625	$0.42		
Cucumber	350	$0.23		
Alfalfa	402	$0.27	From 2006 Irrigation Survey	
Eggplant	325	$0.22		
Black cumin	169	$0.11	From 2006 Irrigation Survey	
Broad - bean	600	$0.40	Anbar Wholesale Market	
Onion	260	$0.17	White Variety	
Sesame	185	$0.12	From 2006 Irrigation Survey	
Chickpea	1,063	$0.71	Erbil Wholesale Market	
Millet	340	$0.23	Wheat Price is Used as Sub.	
Water Melon	275	$0.18		
Cotton	231	$0.15	From 2006 Irrigation Survey	
Field Pistachio	162	$0.11	From 2006 Irrigation Survey	
Pomegranate	500	$0.33		
Fig	550	$0.37		
Apricot	500	$0.33	Diyala Wholesale Market	
Note: Unless noted, prices taken from Baghdad wholesale market first week in September.				

TABLE 108 ANNUAL BENEFITS FROM DRAINAGE AND PUMPING PROJECTS

Field Crops	2005 Harvest (kg)	2006 Harvest (kg)	Difference	Prices	Revenue
Wheat	525	689	164	$0.23	$37.27
Barley	2,020	2,720	700	$0.17	$119.00
Rice	833	933	100	$0.67	$66.67
Maize	468	479	11	$0.19	$2.00
Okra	167	200	33	$0.42	$13.89
Cucumber	407	693	287	$0.23	$66.89
Eggplant	0	200	200	$0.22	$43.33
Average Revenue Increase		**$349.05**			
Annual Project Benefits		**$16,557,153**			

TABLE 109 ANNUAL BENEFITS FROM REGULATOR PROJECTS

Field Crops	2005 Harvest (kg)	2006 Harvest (kg)	Difference	Prices	Revenue
Wheat	535	1,503	968	$0.23	$219.43
Barley	111	883	772	$0.17	$131.28
Melon	139	139	0	$0.42	$-
Cucumber	0	139	139	$0.27	$37.23
Apricot			0	$0.33	$-
Average Revenue Increase		**$387.93**			
Annual Project Benefits		**$5,560,598**			

TABLE 110 ANNUAL BENEFITS FROM OTHER IRRIGATION INFRASTRUCTURE PROJECTS

Field Crops	2005 Harvest (kg)	2006 Harvest (kg)	Difference	Prices	Revenue
Wheat	4,501	5,512	1,011	$0.23	$229.14
Barley	20,681	21,949	1,268	$0.17	$215.61
Rice	38	58	19	$0.67	$12.82
Maize	0	0	0	$0.19	$-
Sunflower	373	2,160	1,787	$0.13	$225.38
Tomato	277	483	206	$0.20	$41.15
Melon	198	654	456	$0.22	$98.75
Okra	46	19	-27	$0.42	($11.22)
Cucumber	269	304	35	$0.23	$8.08
Black cumin	813	754	-59	$0.11	($6.68)
Broad - bean	81	98	17	$0.40	$6.92
Onion	0	34	34	$0.17	$5.93
Sesame	226	171	-55	$0.12	($6.81)
Chickpea	317	256	-60	$0.71	($42.76)
Millet	178	88	-90	$0.23	($20.40)
Water Melon	81	190	109	$0.18	$20.04
Cotton	0	202	202	$0.15	$31.14
Field Pistachio	32	182	150	$0.11	$16.15
Pomegranate	19	231	212	$0.33	$70.51
Fig	1,217	2,075	858	$0.37	$314.49
Apricot	19	0	-19	$0.33	($6.41)
Average Revenue Increase		**$1,201.84**			
Annual Project Benefits		**$28,274,410**			

TABLE 111 SUMMARY

Annual Benefits from Drainage Projects		$16,557,153			
Annual Benefits from Regulator Projects		$5,560,598			
Annual Benefits from Irrigation Projects		$28,274,410			
Annual Water Project Benefits		**$50,392,162**			
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Project Benefits	$50,392,162	$50,392,162	$50,392,162	$50,392,162	$50,392,162
Failure Rate	1	0.85	0.7	0.55	0.4
NPV Multiplier	1	0.91	0.83	0.75	0.68
	$50,392,162	**$38,939,398**	**$29,152,491**	**$20,823,208**	**$13,767,410**
Total Benefits	**$153,074,668**				

IRRIGATION INFRASTRUCTURE MONETIZATION

SUMMARY: OBJECTIVE A

During three years of operation in Iraq, ARDI was involved in hundreds of individual projects aimed at the development of the agriculture sector, spread over six program areas. All contributed to the development of the agriculture sector, whether through education and training, organizational and business development, institutional renovation or infrastructure reconstruction. Many of the projects (such as training programs and organizational development) are extremely difficult to monetize because the benefits are realized over the long term, and may be diffuse in their effects. The material benefits of "production projects" are much easier to quantify, because their effects are more immediate and demonstrable. This report concentrates on only four project initiatives, which are explained in detail above. The results of this partial list of activities, totaling more than $400 million, demonstrate that ARDI surpassed the stated goal of this objective by a wide margin.

OBJECTIVE B:
CONDUCTED FIVE TARGETED ASSESSMENTS ON MAJOR COMMODITY SUBSECTORS TO GUIDE PROGRAM INVESTMENTS.

ARDI has far exceeded the number of studies required by this C 5 objective. The following is a list of the titles of 26 targeted assessments that played an integral part in guiding program activities and investments. These assessment reports have been delivered to USAID and are available from Clearinghouse.

TABLE 112 ASSESSMENT REPORTS PRODUCED BY ARDI

REPORT TITLE
Iraqi Date Industry - Marketing and Post-harvest Issues
Date Palm Restoration Program
Sheep Production Improvement Program
Beekeeping Input Final Report
Poultry Industry Study
Baghdad Poultry Farm Survey Summary Report, 2005
Poultry Survey Summary Report- Erbil, Dahuk and Sulaymaniyah, 2005
Seed Technology Study
Grape Benchmarking Study
Wheat Production Program
Mesopotamia Seed Company Report
Grain Silos Report
Rangelands Assessment- Preliminary Report
Erbil Winter Crop Survey 2004 – 2005
Dahuk Winter Crop Survey 2004 – 2005
2005 Livestock Inventory and Dairy Production Survey in Sulaymaniyah
2005 Summer Crop Production Survey in Sulaymaniyah
Major Issues in Markets for Farm Products and Agricultural Inputs
Market Research in Rural Areas- Basrah Region

Rural Liquidity for Agriculture and Agribusiness

Agriculture Credit Bank

Irrigation Water Management Assessment and Priorities for Iraq

Irrigation Fees Study in Iraq

Rehabilitation Of Irrigation And Drainage Infrastructures And Soil-Water On-Farm Management

Inception Report- Strategy for Water and Land Resources in Iraq

OBJECTIVE C:
PRODUCTION OF WHEAT, MAIZE, RICE, SORGHUM, AND TARGETED VEGETABLES IN PROGRAM-ASSISTED AREAS INCREASED BY 30% OVER THE LIFE OF THE PROGRAM.

ARDI's multiplication, production, and demonstration programs surpassed the target set for this objective. Production increased by an average of 70%, using weighted average (by area) of the selected crops. The specific production results for wheat, maize, rice, sorghum, and tomatoes are shown in the tables below.

In some instances, accurate production or baseline data (dating from the start of the ARDI project in 2003) did not exist. In these cases reasonable and conservative assumptions or substitutes are made, based on the best information available. Results from the appropriate ARDI Winter Crop Survey are used when a control production plot was not established to compare a project plot's improvement over traditional yields at a given location. The one exception is the 2005/2006 wheat demonstration in Qadissiya, Muthanna, Thi-Qar, and Baghdad. In that case, there was no productive agriculture on the land to allow comparison, so the results have been shown in the table below as a 200% increase in yield. Complete results are not available for the 2004/2005 wheat production program in Ninewa. The 2005/2006 results for the same variety (Cham 5) are used as a substitute. Complete results were also not available for the 2005 maize production program in Kirkuk, Babylon, Wassit, Diyala, Qadissiya, Missan, and Kerbala. Only results from Missan are complete, so those figures are used for all governorates.

TABLE 112 WHEAT - SEED MULTIPLICATION PROGRAMS

Season	Governorate	Participating Farmers	Impacted Area (Hectares)	Improved Yield (kg/ha)	Traditional Yield (kg/ha)*	% Increase Production
2004-2005	Dahuk	5	200	1,700	752	126%
2005-2006	Dahuk, Erbil (Cham 5)	55	3,959	1,888	1,196	58%
2005-2006	Dahuk, Erbil (Acsad-65)	69	5,821	1,808	1,196	51%
2005-2006	Qadissiya, Muthanna, Thi-Qar, Baghdad	17	100	2,100	1050	200%

TABLE 113 WHEAT - PRODUCTION PROGRAMS

Season	Governorate	Participating Farmers	Impacted Area (Hectares)	Improved Yield (kg/ha)	Traditional Yield (kg/ha)*	% Increase Production
2004-2005	Ninewa	*no data*	30,770	1,888	1,196	58%
2005-2006	Sulaymaniyah	10	594	1,290	1,139	13%

TABLE 114 MAIZE - PRODUCTION PROGRAMS

Season	Governorate	Participating Farmers	Impacted Area (ha)	Improved Yield (kg/ha)	Traditional Yield (kg/ha)	% Increase Production
2005	Kirkuk, Babylon, Wassit, Diyala, Qadissiya, Missan, Kerbala	1,844	1,743	4,700	1,250	276%
2006	Anbar	100	1,250	8,500	2950	188%

TABLE 115 MAIZE - DEMONSTRATION PROGRAMS

Season	Governorate	Farmers Attending Field Days	Demonstration Area-- Improved and Traditional (ha)	Improved Yield (kg/ha)	Traditional Yield (kg/ha)*	% Increase Production
2006	Missan, Thi-Qar, Basrah (Marshlands)	n/a	12	4800	2950	63%

TABLE 116 RICE - DEMONSTRATION PROGRAMS

Season	Governorate	Farmers Attending Field Days	Demonstration Area-- Improved and Traditional (ha)	Improved Yield (kg/ha)	Traditional Yield (kg/ha)*	% Increase Production
2004	Najaf, Qadissiya, Diyala	344	13	5,160	3,753	37%
2005	Najaf, Qadissiya, Muthanna, Wassit, Diyala, Babylon, Erbil	1,450	40	3,613	2,767	31%

TABLE 117 SORGHUM - DEMONSTRATION PROGRAMS

Season	Governorate	Farmers Attending Field Days	Demonstration Area-- Improved and Traditional (ha)	Improved Yield (kg/ha)	Traditional Yield (kg/ha)*	% Increase Production
2005	Baghdad, Babylon, Kirkuk, Thi-Qar, Sulaymaniyah, Basrah, Muthanna, Qadissiya, Wassit	n/a	1	5,191	4,754	9%
2006	Missan, Basrah, Thi-Qar	n/a	12	2,590	1,000	159%

TABLE 118 TOMATOES - DEMONSTRATION PROGRAMS

Season	Governorate	Farmers Attending Field Days	Demonstration Area-- Improved and Traditional (ha)	Improved Yield (kg/ha)	Traditional Yield (kg/ha)*	% Increase Production
2005	Muthanna, Kerbala, Najaf, Basrah	235	40	50,700	4,000	1168%
2006	Dahuk					

* Traditional yield taken from the Winter Crop Surveys

TABLE 119 SUMMARY

	Total Area (Hectares)	Average Yield*	% Increase in Production*
Wheat	41,444	1,868	56%
Maize	3,005	6281	239%
Rice	53	3,992	32%
Sorghum	13	2790	147%
Tomatoes	40	50,700	1168%
Total	**44,555**	**-**	**70%**

* Weighted averages, based on area cultivated

OBJECTIVE D:
ESTABLISH INFRASTRUCTURE TO SUPPLY 410,000 DATE PALM SEEDLINGS, OR OTHER HIGH-VALUE CROP TRANSPLANTS PER YEAR.

ARDI established infrastructure to increase supplies of improved varieties of date palm seedlings, grape seedlings, and ornamentals. The combined annual output from this infrastructure will total over 1,000,000 plants per year.

In collaboration with the MOA, ARDI established 21 date palm mother orchards in 13 governorates of Iraq where dates are an economically important crop. In addition to supplying over 80,000 mother trees of commercially desirable varieties, ARDI made considerable improvements to orchard infrastructure, including efficient drip irrigation systems, water reservoirs, generators, and pump houses. These orchards will produce a minimum of 240,000 new date offshoots (seedlings) per year, to replenish aging orchards and establish new orchards. This figure allows for an average of 3 offshoots per year per mother tree, although experts in date nursery production state that more than 8 offshoots per year of some varieties are possible under the conditions provided by these improved mother orchards. The offshoots from the mother orchards also feed a network of 16 date palm nurseries that ARDI established in the same 13 governorates. The date offshoots remain in the nurseries for one year in order to grow to a size ideal for transplanting, although offshoots can also be planted directly from the mother orchards to the farmers' lands, with a high survival rate. Nursery production will total 170,000 date palms per year. Within three years, total annual production of young date palms will peak at around 240,000 plants, including the 170,000 transplants from nurseries and 70,000 additional offshoots for direct planting from mother orchards. This number of new palm trees is valued at nearly $2,500,000 per year, and will replenish 6% of Iraq's aging and nonproductive trees each year. The increase in date production as a result of the new stock will equal approximately 15,288 tons per year, for a total of $8,179,000 in added income to date farmers each year.

Grapes are a major fruit crop, and have a high potential for profit for small to medium farmers, especially in northern Iraq, although varieties of grapes can be grown throughout the country. The vines are also one of the few crops that can be grown on the steep and rocky hillsides in the northern part of the country, where vineyards offer erosion control and convert otherwise fallow land to profitable use. ARDI provided farmers with the opportunity to greatly increase their benefits from grape production through the establishment of three privately owned and operated nurseries. These nurseries will provide farmers with new vine stock of the most commercially desirable varieties, and guarantee

the provenance of genetic lines. The privately owned nurseries offer the seedlings at a low price, and sales of stock will enable the nurseries to continue replacing seedlings from approved "mother plants." In return for matching funds from nursery operators, ARDI provided each nursery with drip-irrigation facilities and an initial stock of 400,000 grape cuttings taken from the best vines found in the country. Each of the nurseries produced approximately 300,000 new plants of commercial quality during the first year. The nursery owners will have access to the same registered "mother stocks" to replenish their nurseries, although they will also establish their own "mother blocks" which will allow them to become completely self-sufficient within four years. Maintaining the current rates of production, the three nurseries will be able to furnish at least 750,000 new plants each year, with a gross retail value exceeding $200,000. The grape growers, especially in the northern region, will be able to replenish or expand their vineyards with proven stock of high commercial value.

TABLE 120 PRIMARY SOURCES - MOA DATE MOTHER ORCHARDS

Governorate	Mother Orchards	Mother Plants	Offshoots per Year
Baghdad	3	8,000	24,000
Anbar	1	4,000	12,000
Salah al-Din	1	4,000	12,000
Diyala	1	4,000	12,000
Wassit	1	6,000	18,000
Missan	1	6,000	18,000
Basrah	4	12,000	36,000
Thi-Qar	1	6,000	18,000
Muthana	1	6,000	18,000
Qadissiya	3	6,000	18,000
Najaf	1	6,000	18,000
Karbala	2	6,000	18,000
Babylon	1	6,000	18,000
Total	**21**	**80,000**	**240,000**
Offshoots moved to nurseries			**170**
Offshoots for direct transplant			**70,000**

Supported by:

LOA-033: National Program for the Improvement and Propagation of Date Palms - Mother Orchard Infrastructure Support

Notes:

Assuming 3.0 offshoots per plant per year

TABLE 121 PRIMARY SOURCES - MOA DATE NURSERIES

Governorate	Plants per Year
Anbar	15,000
Babil	10,000
Baghdad	12,000
Baghdad	2,000
Basrah	5,000
Basrah	10,000
Basrah	10,000
Qadissiya	11,000
Diyala	10,000
Karbala	12,000
Missan	10,000
Muthanna	18,000
Najaf	10,000
Salah al Din	10,000
Thi Qar	15,000
Wassit	10,000
Total	**170,000**

Supported by:

- LOA-004: Establishment of Date Palms Mother Orchards (2004)

- LOA-026: Establishment of date palms mother orchards Phase II

- LOA-028: National Program for the Improvement and Propagation of Date Palms - Nursery Infrastructure Support

- LOA-033: National Program for the Improvement and Propagation of Date Palms - Mother Orchard Infrastructure Support

Notes: Date offshoots remain in the nurseries for 1 year before they are distributed

TABLE 122 PRIMARY SOURCES GRAPE NURSERIES

Governorate	Grant #	Plants produced per Year
Dahuk	G-3834-001-0221	250,000
Sulaymaniyah	G-3834-001-0223	250,000
Erbil	G-3834-001-0224	250,000
Total		**750,000**

TABLE 123 SUMMARY

Type	Plants per Year
Date Nurseries	170,000
Date Mother Orchards	70,000
Grape Nurseries	750,000
Total	**990,000**

OBJECTIVE E:
AVERAGE PRODUCTIVITY OF APPROXIMATELY 250,000 FARM FAMILIES INCREASED BY 20% IN PROGRAM-ASSISTED AREAS THROUGH THE USE OF ONE OR MORE OF THE FOLLOWING: IMPROVED TECHNOLOGY AND BEST PRACTICES, IMPROVED INFRASTRUCTURE, AND ACCESS TO PROFITABLE MARKETS.

The data presented in this and other sections strongly indicate that this objective was met, with nearly 300,000 farm families receiving increases in productivity of greater than 30%. For the purposes of this analysis, productivity is measured in terms of either increased harvest or income from agriculture.

A. Irrigation and drainage infrastructure rehabilitation projects have increased the productivity of 85,295 farm families by an average of 54%. These results are based on the data from the irrigation surveys and have been previously discussed.

B. The rehabilitation of veterinary clinics significantly increased the productivity of many breeders across Iraq. This is especially true in the center and south of the country, where the clinics and related infrastructure suffered most from disrepair, neglect, and destructive looting in 2003. The gain in value through vaccination services was calculated at $61 million. Given improved security conditions, the majority of breeders in the south will realize productivity increases greater than 20% from an efficient public veterinary service. However, for the purposes of this objective, we used the more conservative assumption that half the breeders (approximately 68,000) served by the clinics will increase their productivity by 20% over the course of the animal breeding cycle.

C. ARDI's projects related to wheat production have clearer results regarding productivity gains. An estimated 48,828 farmers or farm families increased their productivity by 27% through ARDI's seed cleaner program. The productivity increase is from survey results, and the number of farmers is based on an assumed seeding rate of 130/kg/hectare, 5 hectares per farmer. Precise results for productivity increases are not available for the 4,000 metric tons of certified seed supplied by ARDI. However, approximately 71,000 families increased their yield by at least 20%, if the certified grade 1 imported (and treated) seed performed at expected minimum levels. Finally, the Certified+1 wheat multiplication program managed by ARDI will increase the productivity of 25,000 farmers by 20%.

TABLE 124 PROGRAM SPECIFIC RESULTS IRRIGATION REHABILITATION

	Farm Families	% Increase
Drainage Projects	47,435	27%
Regulator Projects	14,334	196%
Other Irrigation Projects	23,526	21%
Average Productivity Increase	85,295	54%

TABLE 124 PROGRAM SPECIFIC RESULTS VET CLINIC REHABILITATION

	Clinics	Families (2000/clinic)	Productivity Increase
Project Scope	68	136,000	-
Estimated Impact	68	68,000	20%

TABLE 125 PROGRAM SPECIFIC RESULTS - SEED CLEANING

	Farmers Participating	Clean Seed (mt)	Farmers Benefiting	Productivity Increase
Rainfed (65%)	4,800	20,630	31,738	30%
Irrigated (35%)	2,600	11,108	17,090	21%
Total	7,400	31,738	48,828	27%

TABLE 126 PROGRAM SPECIFIC RESULTS PROCUREMENT OF CERTIFIED SEED

Year 1	
Certified Cham 6 Imported by ARDI (MT)	4,000
Area Planted (Ha) @ 130 Kg/MT	30,769
Number of Families Benefiting (5 ha per farmer)	6,152
Year 2	
Resulting Harvest (Kg) @ 1,500 Kg/Ha	46,153,846
Area Planted with Certified+1 (Ha)	355,030
Number of Families Benefiting (5 ha per farmer)	71,006

TABLE 127 PROGRAM SPECIFIC RESULTS SUMMARY

Seed Procured	Farmers Benefiting	Productivity Increase*
4,000 mt	77,158	> 20%

Multiplication of Certified+1 seed

TABLE 128 PROGRAM SPECIFIC RESULTS - CERTIFIED SEED

Season	Variety	Participating Farmers	% Increase Production	Total Harvest (mt)	Farmers Benefiting
2004-2005	Cham 6	5	126%	305	470
2005-2006	Cham 5	55	58%	1,118	1,720
2005-2006	Acsad-65	69	51%	1,816	2,794
2005-2006	Salt-tolerant varieties	17	200%	97	150
Total		146	74%	3,336	25,662

TABLE 129 PROGRAM SPECIFIC RESULTS

Projects	Number of Farm Families	Productivity Increase (%)
Irrigation and Drainage Infrastructure	85,295	54%
Vet Clinic Rehabilitation	68,000	20%
Seed Cleaning	48,828	27%
Certified Wheat Seed	71,158	20%
Certified+1	25,662	20%
Total	**298,943**	**31%**

OBJECTIVE F:
50% INCREASE IN REVENUE FOR APPROXIMATELY 6,000 AGRIBUSINESSES IMPACTED BY ARDI PROGRAMS

When ARDI was conceived, direct support to agribusinesses was an important objective. The agricultural sector in 2003 had been nearly destroyed, and the project made major contributions in rebuilding the capital and infrastructure. Only in the later part of 2004 did attention turn again to agribusiness development.

In the context of Iraq, we have accepted as an agribusiness all enterprises or individuals not producing primary agricultural products—farmers in their usual role growing wheat are not agribusinesses. However, tractor owners who sell tractor services to others are agribusinesses, as are honey producers, private veterinarians, wheat seed multipliers, nurseries, etc. Using these definitions, targeted ARDI programs have produced at least a 50% increase in income for a minimum of 3,000 agribusinesses, reaching half the objective.

Honey Producers: Beekeepers represent a well-documented instance of the success of an ARDI-assisted agribusiness program. The project helped honey producers increase their revenue directly through honey production programs, and indirectly through the formation of honey producers associations. The honey production programs established new honey producing businesses and introduced modern technologies to those that were already established. As indicated in the figure below, the results are striking. ARDI honey production programs assisted 368 honey producers to far exceed the 50% revenue increase target of this objective.

ARDI trained leaders and representatives from the Erbil, Dahuk, Sulaymaniyah, Kirkuk, and Ninewa beekeepers associations, and was directly responsible for the formation of the Dahuk and Kirkuk beekeeper associations. These interventions led to an increase in the productivity of beekeepers involved with these organizations. One of the most significant changes has been in marketing practices. Profits can climb 50% from changing the packaging of honey products to compare in consumer appeal with foreign imported products. A survey of association presidents from Erbil, Dahuk, Kirkuk, and Ninewa was taken to determine the number of beekeepers who have changed their packaging as a result of ARDI interventions. The survey showed that 1,930 beekeepers increased their income in honey sales by more than 50% through improved marketing and packaging practices.

TABLE 130 PRIMARY SOURCES
HONEY PRODUCTION - DIRECT

Honey Producers	Income Increase	Grant #
32	1,400%	28
50	1,400%	29
183	1,400%	131
51	1,400%	161
52	1,400%	242
Agribusiness that qualify under Honey Production Grants = 368		

Income increase is taken from the honey production survey.

TABLE 131 PRIMARY SOURCES HONEY PRODUCTION - INDIRECT

Association	Percent Of Members w/ Improved Marketing	Number of Members
Baghdad	0%	700
Diyala	0%	300
Dahuk	60%	711
Erbil	65%	870
Sulaymaniyah	55%	1,705
Total	**28%**	**6,940**
Total Associated Members Qualifying = 1930		

TABLE 132 PRIMARY SOURCES - FEEDLOTS

Feedlot Business	Grant #	Governorate	Business Owners
1	276	Ninewa	31
1	238	Ninewa	35
1	237	Tameem	35
Agribusiness that qualify under Feedlot Grants = 3			

Note: Feedlots were not operating before ARDI intervention.

TABLE 133 PRIMARY SOURCES - NURSERIES

Nursery	Type of Nursery	Grant #	Location
1	Tomato	205	Dahuk
1	Flower	117	Dahuk
1	Grape	221	Dahuk
1	Grape	224	Erbil
1	Grape	223	Sulaymaniyah
Agribusiness that qualify under Nursery Grants = 5			

Nurseries were not operating before ARDI intervention

TABLE 134 PRIMARY SOURCES - CARPENTERS

Businesses	Grant #	Governorate	Business Owners
9	127	Dahuk, Erbil, Sulaymaniyah, Ninewa, Tameem	13
Agribusiness that qualify under Carpenter Grants = 9			

Carpenters were not producing bee hives previous to ARDI intervention.

TABLE 135 PRIMARY SOURCES - AGRICULTURAL MACHINERY MECHANICS AND TECHNICIANS

Businesses	Income Increase	Grant #	Governorate
13	56%	230	Sulaymaniyah
23	56%	232	Dahuk
29	56%	248	Tameem
8	56%	231	Sulaymaniyah
14	56%	135	Erbil
Agribusiness that qualify under Grants = 87			

Income increase established through the survey results.

TABLE 136 PRIMARY SOURCES - PESTICIDE DEALERS

Businesses	Income Increase	Governorate
119	24%	Nationwide
Agribusiness that qualify under Pesticide Dealer Training Grants = 0		

Income increase established through the survey results.

TABLE 137 PRIMARY SOURCES WHEAT SEED PRODUCERS

	Businesses
2005	5
2006	141

Total of farmers participating in Certified+1 seed production

TABLE 138 PRIMARY SOURCES CONTRACT TRACTOR SERVICES

Tractor owners selling farm contract services:17% of survey sample	787 tractor owners

TABLE 139 SUMMARY

Type	Agribusinesses	# Who Qualify
Honey Production - Direct	368	368
Honey Production - Indirect	3,516	1930
Feedlots	3	2
Nurseries	5	5
Carpenters	9	9
Mechanics	87	87
Pesticide Dealers	119	0
Tractor Owners	787	787
Total	**4,894**	**3,188**

OBJECTIVE I:
30% OF MARSH DWELLERS WILL INCREASE FAMILY INCOME BY 50% FROM PROJECT INTERVENTIONS

Security restrictions on staff movement, and the lack of baseline data, made the measurement of ARDI's progress against this objective difficult. ARDI's activities in the Marshlands represent investments that will result in increased family income of a significant portion of the marsh dweller population. The potential impact of marshland projects can be demonstrated by examining several key projects. The analysis below focuses on the potential impact of fish restocking and the rehabilitation of irrigation infrastructure. Other projects are briefly discussed. A full description of ARDI's marshland activities can be found in Section 4.

ARDI's programs that directly affect the marsh dweller population include wheat seed cleaners, crop demonstrations, family drip irrigation kits, tractor rehabilitation, date palm mother orchards, date palm nurseries, buffalo nutrition, irrigation infrastructure, marshland monitoring, fish restocking, and veterinary clinic rehabilitation. The existence of ARDI's Basrah and Samawa offices made these projects possible. Those offices bordered the marshlands and played a vital role in the implementation of ARDI projects there. Some initiatives, such as date palm mother orchards, and fish restocking, have longer-term impact, with the benefits increasing over time. Other projects, such as family drip irrigation and crop demonstrations, have a strong "replicator effect" with a high potential for persuading neighboring farmers to adopt the new technologies.

The figure below shows baseline data and the details of the fish restocking program and irrigation infrastructure projects in and around the marshlands. For the purposes of this analysis the marsh dweller population is set at 85,000, a figure which was established by the USAID-funded Iraq Marshland Restoration Project (IMRP). This figure includes the indigenous marsh dwelling population, as well as other Iraqis who have settled in the area. A median household size of 8.2 in marshland districts was estimated by the United Nations World Food Program. These numbers provided an estimate of 10,366 households in marshland areas.

TABLE 140 MARSHLAND BASELINE

Marsh dwellers population (IMRP/USAID)	85,000
Median regional (selected districts) household size (WFP)	8.2
Marsh Dweller Households	**10,366**

TABLE 141 SAMPLE PROJECTS MARSHLAND FISH RESTOCKING

Total 2000 Iraq employment in fish production (FAO)	20,000
Total 2000 Employment in fish marketing (FAO)	4,500
Fisheries Employment Multiplier	**1.23**
Square km of water May 14, 2006 (UNEP)	1,379
Fishermen per square km (IMRP)	2.3
Current Marshlands Fisherman	**3,172**
Marsh Dwellers Fisheries Employment	**3,885**
Estimated current catch weight/predrainage catch weight (IMRP)	10%

TABLE 142 SAMPLE PROJECTS IRRIGATION

Project ID	Donums	Farmers	Employees
G-3834-001-0219	7,800	260	161
G-3834-001-0266	8,000	200	163
G-3834-001-0240	11,500	550	68

Percentage of Families	10%

In 2006, ARDI's fish restocking program successfully released nearly 1,000,000 indigenous fingerlings into the marshlands at four locations. These fish will replenish the breeding stock and will also, upon maturity, provide income for fishing families. ARDI focused on raising and releasing indigenous species that are significant both in terms of commercial value and of their importance to ecosystem restoration. The restocking has special importance, given the central role that fishing plays in marsh family income and nutrition.

While fish are an integral part of the diet of all marsh families, the number who depend on fishing as a primary source of income is less clear. According to the UNEP, as of May 14, 2006 there were 1,379 square kilometers of water in the marshlands. Using a fisherman density of 2.3 fishermen per square kilometer, there are currently 3,172 fishermen in the marshlands. This equates to 3,885 marsh dweller families that depend on the fishing industry, assuming .23 related jobs for every fishermen. Therefore, ARDI's restocking activities directly impact 38% of marshland families who rely on fishing (or related employment) as a primary source of income.

It is too soon to determine the extent to which ARDI's restocking program will increase catch rates in the shorter term. Monitoring of the fingerling survival rate was under way at the time of ARDI's closedown, but more time is necessary to assess the success of this project intervention. According to the local fishing hatchery operators, the restocking efforts have a high probability of increasing the catch by more than 50% for many fishermen, as the marshlands ecosystem recovers and the newly introduced fingerlings reproduce.

In contrast to the restocking program, the irrigation projects in and around the marshlands have a clearer and more immediate impact on family income. There are three irrigation projects that benefit a large number of marshland families:

- Irrigation Canal Cleaning of Hamdan and Muhagran, Basra
- Irrigation Canal Cleaning in Sayed Dekheel, Nassriya, Thi-Qar
- Irrigation Canal Cleaning in Abu Al-Khaseeb, Basrah.

The irrigation surveys conducted as part of the overall M&E effort show that the average income of families benefiting from irrigation projects increase by more than 50%. A total of 1,010 families, or maximum of 10% of the marshland families, benefited from ARDI's irrigation projects, and are expected to increase their income from agriculture by an average of 50 percent.

OBJECTIVE G:
REHABILITATE, INTENSIFY, OR EXPAND 250,000 HECTARES OF EXISTING IRRIGATED AREA.

ARDI awarded a total of 68 grants and 5 direct subcontracts to rehabilitate irrigation systems in Iraq. As explained elsewhere, these projects ranged from repair or complete renovation of damaged infrastructure (drains, gates, regulators, flumes, etc.), to upgrading existing water resources (community water storage facilities), to reclaiming inefficient existing resources (canal cleaning projects). The following table is a list of all the projects completed by ARDI devoted to renovation of irrigation and drainage systems. ARDI surpassed the objective set for these activities, with total land area restored of 282,038 hectares.

TABLE 143 IRRIGATION AND DRAINAGE PROJECTS

Name of Project	Grant/LOA	Governorate	Hectares	Families
Drainage Projects				
Constructing Al Bashiyah Pipe Culvert on Al Salamiyah Drain	G-3834-001-0222	Kerbala	750	200
Raising the Canal Banks for transporting Drainage Water	ARDIBAG-FP-0048	Kerbala	17,500	10,000
Re-construction of the Al Thail Regulator	G-3834-001-0191	Muthanna	750	1,500
Cleaning and Rehabilitation of drainage canal in Al Hindia District	G-3834-001-0196	Kerbala	413	480
Al Kufa Drain Rehabilitation	ARDIBAG-FP-0051	Najaf	7,500	5,000
Improving the Drainage Conditions of a waterlogged area in Al-Muthanna	G-3834-001-0241	Muthanna	520	55
Main Baquba Drain Cleaning	G-3834-001-0251	Diyala	9,961	12,000
Shomaly Pumping Station Emergency Regulator	ARDIBAG-FP-0053	Babylon	60,000	16,000
Irrigation Projects				
Cleaning Balula Irrigation Canal	G-3834-001-0098	Diyala	1,250	200
Rehabilitation of Tertiary Canal System in Al Nasiriyah Reclamation Project	G-3834-001-0118	Babylon	2,500	1,700
Rehabilitation of Al Haminiyah Culvert	G-3834-001-0168	Babylon	625	150
Rehabilitation of Al Tajyah Culvert	G-3834-001-0169	Babylon	625	100
Rehabilitation of Tertiary Canal System AT Hillah-Kifil Reclamation Project Phase 1	G-3834-001-0121	Babylon	0	0
Rehabilitation of Tertiary Canal System AT Hillah-Kifil Reclamation Project Phase 2	G-3834-001-0122	Babylon	1,250	850
Rehabilitation of the Moka Irrigation Project	G-3834-001-0136	Erbil	28	100
Reconstruction of Al Mhaddad Regulator	G-3834-001-0192	Muthanna	15,000	1,500
Al Behta Pipe Flume	G-3834-001-0173	Kerbala	75	30
Al E'aywig Pipe flume Grant	G-3834-001-0174	Kerbala	750	400
Rehabilitation of Baskadere Irrigation Project	G-3834-001-0159	Dahuk	40	80
Reconstruction of Al Bassrokiyah Discharge Regulator	G-3834-001-0187	Wassit	5,000	500
Reconstruction of Al Khashaniyah Head Regulator	G-3834-001-0172	Qadissiya	1,000	500
Rehabilitation of Zamaqy Sarw Kareze	G-3834-001-0153	Sulaymaniyah	39	26
Repairing the Um Al Agaf Pumping Station	G-3834-001-0190	Muthanna	7,500	1,000
Re-construction of A'al Awad A'al Majid Head Regulators	G-3834-001-0185	Najaf	275	180
Reconstruction of Al Ghallal-Al Gowah Head Regulators	G-3834-001-0170	Najaf	325	240
Reconstruction of Al Ghazali-A'al Habib Head Regulators	G-3834-001-0184	Najaf	275	180
Rehabilitation of Abu Gressah-Al Kothary Head Regulators	G-3834-001-0183	Najaf	500	500
Rehabilitation of Abu Jagi Head Regulator	G-3834-001-0186	Najaf	250	100
Cleaning Irrigation Canals in Bewre	G-3834-001-0143	Sulaymaniyah	210	322

TABLE 143 IRRIGATION AND DRAINAGE PROJECTS - CONTINUED

Name of Project	Grant/LOA	Governorate	Hectares	Families
Drainage Projects				
Irrigation Canal Cleaning. Eastern Drainage Canals	G-3834-001-0150	Muthanna	1,706	800
Irrigation Canal Cleaning, Al Dokhan Village Project	G-3834-001-0151	Muthanna	1,219	700
Irrigation Canal Cleaning, Small Irrigation Canals Project	G-3834-001-0152	Muthanna	1,950	500
Cleaning Bnkura Irrigation Canal	G-3834-001-0129	Diyala	2,750	716
Cleaning Irrigation Canals in Fayda-Ninewa	G-3834-001-0128	Ninewa	644	97
Cleaning Irrigation Canals in Dasnee, Bechoporshik, Zheen and Zhoyhel Villages	G-3834-001-0124	Erbil	625	200
Cleaning Irrigation Canals in Mjesar, Shiwan, Kazhad, Qalatan	G-3834-001-0147	Erbil	738	395
Cleaning canals in 6 Villages of Rawandooz	G-3834-001-0145	Erbil	1,675	251
Cleaning Canals in 4 Villages in Salahadin Subdistrict	G-3834-001-0149	Erbil	1,000	600
Cleaning Khormal Irrigation Canal in Sulaymaniyah	G-3834-001-0160	Sulaymaniyah	6,175	1,938
Irrigation Canals Cleaning in Al Warka'a District	G-3834-001-0182	Muthanna	4,003	491
Installation of Center Pivot Irrigation Systems in Tameem Governorate	G-3834-001-0197	Tameem	450	360
Installation of Center Pivot Irrigation Systems in Tameem Governorate, Phase II	G-3834-001-0247	Tameem	180	15
Irrigation Canals Cleaning in Al Mahnawiyah Sub-District	G-3834-001-0229	Qadissiya	2,000	750
Irrigation Canal Cleaning in Abu Alkhaseeb	G-3834-001-0219	Basrah	1,950	260
Cleaning Al - Dujeel Irrigation Canals	G-3834-001-0216	Salah al-Din	1,838	600
Cleaning Jalwla Irrigation Canal	G-3834-001-0253	Diyala	1,383	545
Cleaning Shekhan Irrigation Canal	G-3834-001-0215	Ninewa	2,277	250
Rehabilitation of Retaining Walls and Pipe Flume in Al-Adja'a River	G-3834-001-0213	Kerbala	1,150	1,000
Construction of a Head Regulator and Retaining Walls for Eshan Graed Canal	G-3834-001-0260	Babylon	1,373	1,800
Reconstruction of Al Mishkab Head Regulator	G-3834-001-0245	Najaf	12,500	2,000
Reconstruction of the Munaither Pumping Station between Hillah-Kifil Canal and the Euphrates River (Monaither)	ARDIBAG-FP-0058	Babylon	3,451	1,200
Irrigation canals cleaning in Sayed Dekheel, Nasseriyah.	G-3834-001-0240	Thi Qar	1,688	280
Gordara Irrigation Canal Cleaning in Taza District	G-3834-001-0209	Tameem	1,250	700
Rehabilitation of Shleet Regulator in Abu-Zaraá Canal	G-3834-001-0255	Kerbala	2,350	900
Reconstruction of Hanoon Cross Regulator	LOA-X17	Wassit	45,000	3,000
Renovation of Sidakan Irrigation Channel	G-3834-001-0125	Erbil	1,125	200
Irrigation Canal Cleaning Project in Al Hilal	G-3834-001-0261	Muthanna	5,713	2,434
Construction of Abu Kohuf Regulator	G-3834-001-0250	Muthanna	1,250	2,134
Construction of Al Khdirawy canal regulator	G-3834-001-0252	Muthanna	375	800
Irrigation Canal Cleaning in 45 villages in Dinarta	G-3834-001-0249	Ninewa	4,091	2,500
Irrigation Canal Cleaning in 15 Villages in Sidakan Subdistrict	G-3834-001-0258	Erbil	2,963	200
Irrigation Canal Cleaning in 15 Villages in Soran district	G-3834-001-0259	Erbil	3,125	210
Rejuvenate and Expand Water Spring and Cleaning an Irrigation Canal	G-3834-001-0267	Erbil	5,500	600
Irrigation Canals Cleaning of Hamdan and Muhagran	G-3834-001-0266	Basrah	2,000	200

TABLE 143 IRRIGATION AND DRAINAGE PROJECTS - CONTINUED

Name of Project	Grant/LOA	Governorate	Hectares	Families
Drainage Projects				
Irrigation/Drainage Projects				
Cleaning Canals and Drains in Al Buhwaichma and surrounded villages	G-3834-001-0181	Muthanna	5,330	450
Village Water Supply Projects				
Village Water Storage Facilities	G-3834-001-0104	Dahuk	55	81
Village Water Storage Facilities in Akre District	G-3834-001-0141	Ninewa	39	61
Village Water Storage Facilities Shekhan District	G-3834-001-0142	Ninewa	46	77
Water Storage Facilities in Qadesh Village	G-3834-001-0158	Dahuk	38	100
Water Storage Facilities at 5 villages in Rawanduz Subdistrict	G-3834-001-0178	Erbil	113	190
		Total	**282,038**	**85,145**

Summary

Type of Project	Area		Families	
	Hectares	**Percent**	**Families**	**Percent**
Drainage	97,394	35%	45,235	53%
Irrigation	184,645	65%	39,910	47%
Total	**282,038**	**100%**	**85,145**	**100%**

OBJECTIVE H:
PROVIDE THE GOI WITH THE TOOLS NEEDED FOR MORE ACCURATE DETERMINATION OF THE VOLUME OF WATER, OVER TIME THAT COULD BE ALLOCATED TO THE MARSHLANDS AND AGRICULTURE USES

The program and activities for a water strategy for Iraq, to meet the requirements stated in this objective, are found in Annex 1 – *Strategy for Water and Land Resources in Iraq Final Report*.

In close coordination with GOI ministries (in particular, the Ministry of Water Resources – MOWR), ARDI developed the Strategy for Water and Land Resources in Iraq, which would occur in two phases. Phase 1 was completed over a 14-month timeframe, and equipped GOI with the resources necessary to continue to work independently on a constantly evolving plan to determine water resources and distribution strategies. The collaboration between ARDI and the participating ministries, including the MOWR and SWLRI Steering Committee, focused on collecting relevant data from all ministries and creating a framework for management and development of Iraq's water and land resources over the next few decades. Activities completed under Phase 1 included:

- Data collection across all ministries to compile data sets of current information, needs in the water sector, and future opportunities (project and program development);
- Development of models and tools to inform the planning process, with a schedule to demonstrate the planning process by running all the models;
- Training and capacity building within the Government to ensure that staff have the necessary capability to proceed with implementation of the SWLRI in Phase 2.

Phase 2 of the SWLRI project will be led by the MOWR and will involve selection of appropriate interventions and identification of priorities in the water and land sectors, using the data sets, tools, and models developed during Phase 1. This phase will also initiate the development of a "rolling" master plan that can updated periodically upon receipt of new data and/or policy changes.

To facilitate its leadership role in the development of the SWLRI, the MOWR established a special SLWRI unit with dedicated staffing resources, including two senior chief engineers, an expert agronomist, two irrigation engineers, and two IT engineers. ARDI provided funds for the establishment of the unit, including equipment for the offices and filled some of the initial staff positions.

Type	Activity ID#	Activity Title	Governorate (s)	Start Date	End Date
Agronomic Crop Production					
General Production					
Direct National	LOA-001	MOA Winter Crop Demonstrations, 2003-2004	Baghdad, Missan, Ninewa, Qadissiya, Wassit, Dahuk	December-03	September-04
Direct National	LOA-008	Winter Crop R&E Swiss Chard, Radish, 2004	Erbil	August-04	October-04
Direct National	LOA-010	Winter Crop Technology Demonstrations, Erbil, 2004 - 2005	Erbil, Dahuk	November-04	August-05
Direct National	LOA-011	Winter Crop Technology Demonstrations, Sulaymaniyah, 2004 - 2005	Sulaymaniyah	November-04	August-05
Direct National Programs	LOA-020	Winter Crop Technology Demonstrations, 2004 - 2005	Baghdad, Babylon, Dahuk, Erbil, Najaf, Ninewa, Qadissiya, Sulaymaniyah, Tameem, Wassit	December-04	August-05
Seed Cleaning					
Direct National Programs	LOA-051	Wheat Seed Cleaning, 2005-2006	Baghdad, Anbar, Babylon, Basrah, Diyala, Kerbala, Missan, Muthanna, Najaf, Ninewa, Qadissiya, Salah al-Din, Tameem, Thi-Qar, Wassit	August-05	January-06
Grant	G-3834-001-0130	Provision of Seed Cleaner to Al Naqa Association in Ninewa	Ninewa	July-05	August-05
Grant	G-3834-001-0133	Provision of Seed Cleaner to Al-Rafiddain Association in Haweeja	Tameem	July-05	August-05
Grant	G-3834-001-0134	Provision of Seed Cleaner to Mar Odda Agriculture Cooperative in Erbil	Erbil	July-05	August-05
Grant	G-3834-001-0144	Provision of Seed Cleaner to Dinarta Agriculture Cooperative in Akre	Ninewa	August-05	September-05
Direct	AAP-015	Seed Cleaning Training and Distribution, 2006	National	August-06	December-06
Wheat Production					
Direct National	LOA-X11	Wheat Seed Procurement, National, 2004	National	September-05	November-04
Direct National	LOA-XX8	Wheat Production Program, Sulaymaniyah, 2005-2006	Sulaymaniyah	December-05	June-06
Direct National	LOA-XX9	Small Village Wheat Production Program, Dahuk, 2005-2006	Dahuk	December-05	June-06
Wheat Multiplication					
Direct National	LOA-X27	Wheat Seed Multiplication, Dahuk, 2004-2005	Dahuk	December-04	August-05
Direct National	LOA-XX7	Multiplication of High Quality Wheat Seed, Northern Iraq, 2005-2006	Erbil, Dahuk	September-05	June-06
Direct National	LOA-056	Multiplication of Salt Tolerant Wheat Seed, Central and Southern Iraq, 2005-2006	Muthanna, Qadissiya, Thi-Qar	December-05	July 2006
Direct	LOA-X31	Multiplication of Salt-Tolerant Seed, 2006 (IRI)	Muthanna	September-06	September-06
Pest Management					
Grant	G-3834-001-0093	Rodent Control Program in Kirkuk	Tameem	March-05	May-05
Grant	G-3834-001-0132	Sunn Pest Control in Sulaymaniyah	Sulaymaniyah	July-05	August-05
Grant	G-3834-001-0140	Sunn Pest Control in Sulaymaniyah Phase II	Sulaymaniyah	August-05	September-05
Direct National	AAP-006	Sunn Pest Susceptibility Trials, 2006	Erbil, Dahuk, Sulaymaniyah	January-06	July-06
Direct National	LOA-X10	Durum Wheat & Barley Variety Testing, Northern Iraq, 2005-2006	Dahuk	December-05	June-06
Hybrid Maize					
Direct National	LOA-007	Inbred Maize Trials 2004	Baghdad	July-04	October-04
Direct National	LOA-029	Inbred Maize Trials, 2005	Baghdad	March-05	July-05
Direct National	LOA-044	On-Farm Hybrid Maize Trials, 2005	Babylon, Wassit, Kerbala, Qadissiya, Missan, Tameem	July-05	December-05

Type	Activity ID#	Activity Title	Governorate (s)	Start Date	End Date
Grant	G-3834-001-0200	Procurement of Seed for Maize Multiplication Project, Ninewa Governorate	Ninewa	February-06	March-06
Grant	G-3834-001-0201	Procurement of Seed for Maize Multiplication Project, Central Governorates	Anbar	February-06	March-06
Direct	AAP-014	Inbred Maize Trials, 2006	Erbil	June-06	September-06
Direct	LOA-X30	Production of High-Quality Maize Seed, 2006 (Golden Spike)	Erbil	September-06	September-06
Sorghum					
Direct National Programs	LOA-043	Summer Sorghum Demonstrations, National, 2005	Baghdad, Babylon, Basrah, Missan, Muthanna, Qadissiya, Sulaymaniyah, Tameem, Thi-Qar, Wassit	July-05	December-05
Rice					
Direct National	LOA-039	Summer Rice Demonstrations	Erbil, Sulaymaniyah, Babylon, Diyala, Muthanna, Najaf, Qadissiya, Wassit	June-05	January-06
Training	LOA-TRN07	Farm & Financial Management Training, National, 2006	National	January-06	February-06
Organizational Development					
Training	LOA-TRN08	Senior Policy Round Table, National, 2006	National	January-06	January-06
Crop - Soil - Water Management					
Agro-Ecological Zoning					
Direct National	LOA-038	National Program for the Preparation of Agro-ecological Zones (AEZ) Maps, 2005-	National	January-05	September-06
Grant	G-3834-001-0056	Infrastructure for National Program for the Preparation of Agro-ecological Zone (AEZ)	Baghdad	January-05	March-05
Grant	G-3834-001-0057	Infrastructure for National Program for the Preparation of Agro-ecological Zone (AEZ)	Baghdad	January-05	March-05
Agro-Meteorological Network					
Direct National Programs	LOA-035	Agro-Meteorological Stations, 2006	Baghdad, Babylon, Basrah, Diyala, Erbil, Kerbala, Missan, Muthanna, Najaf, Ninewa, Qadissiya, Salaha al-Din, Tameem, Thi-Qar, Wassit	April-05	June-06
Family Drip Irrigation Systems					
Grant	G-3834-001-0011	Family Drip Irrigation Kit Demonstrations in Diwaniya	Qadissiya	May-04	June-04
Grant	G-3834-001-0097	Family Drip Irrigation Kit Demonstrations in South and Central Iraq	Baghdad	June-05	November-05
Direct National	AAP-002	Demonstrative Areas for Family Drip Irrigation Systems, Southern Iraq, 2006	Babylon, Basrah, Kerbala, Missan, Muthanna, Najaf, Thi Qar and Wassit	February-06	August-06
Irrigation Infrastructure Rehabilitation					
Grant	G-3834-001-0191	Reconstruction of the Al Thail Regulator for the Al Thail Drain	Muthanna	January-05	March-06
Grant	G-3834-001-0192	Construction of Irrigation Regulator at Al Mhaddad Pumping Station	Muthanna	January-05	April-06
Grant	G-3834-001-0098	Cleaning Irrigation Canal, Diyala, 2005	Diyala	April-05	May-05
Grant	G-3834-001-0104	Water Storage Facilities, Dahuk, 2005	Dahuk	April-05	June-05
Grant	G-3834-001-0121	Rehabilitation of Tertiary Canal System, Babylon Reclamation Project Phase I, 2005	Babylon	June-05	September-05
Grant	G-3834-001-0122	Rehabilitation of Tertiary Canal System, Babylon Reclamation Project Phase II, 2005	Babylon	June-05	September-05
Grant	G-3834-001-0118	Rehabilitation of Tertiary Canal System, Babylon, 2005	Babylon	June-05	September-05
Grant	G-3834-001-0124	Cleaning Irrigation Canals in Erbil, 2005	Erbil, Erbil	June-05	August-05
Grant	G-3834-001-0128	Cleaning Irrigation Canals in Ninewa, 2005	Ninewa	July-05	August-05
Grant	G-3834-001-0125	Renovation of Irrigation Canal, Erbil, 2005	Erbil	July-05	October-05

Type	Activity ID#	Activity Title	Governorate (s)	Start Date	End Date
Grant	G-3834-001-0129	Cleaning Irrigation Canal, Diyala, 2005	Diyala	July-05	September-05
Grant	G-3834-001-0141	Village Water Storage Facilities in Ninewa Governorate	Ninewa	August-05	November-05
Grant	G-3834-001-0142	Village Water Storage Facilities in Shekhan District - Ninewa	Ninewa	August-05	November-05
Grant	G-3834-001-0143	Cleaning Irrigation Canals in Sulaymaniyah, 2005	Sulaymaniyah	August-05	October-05
Grant	G-3834-001-0145	Cleaning Irrigation Canals in Erbil, 2005	Erbil	September-05	October-05
Grant	G-3834-001-0136	Rehabilitation of Irrigation System in Erbil, 2005	Erbil	September-05	November-05
Grant	G-3834-001-0147	Cleaning Irrigation Canals in Erbil, 2005	Erbil	September-05	October-05
Grant	G-3834-001-0149	Cleaning Irrigation Canals in 4 Villages in Salah el-Din Sub-District (Kore, Almawani	Erbil	September-05	October-05
Grant	G-3834-001-0150	Irrigation Canal Cleaning, Eastern Drainage Canals Project (Al Muthanna Governorate)	Muthanna	October-05	October-05
Grant	G-3834-001-0153	Rehabilitation of Zamaqy Sarw Kareze, Halabja District.	Sulaymaniyah	October-05	January-06
Grant	G-3834-001-0158	Water Storage Facilities in Qadesh Village - Dahuk	Dahuk	October-05	December-05
Grant	G-3834-001-0160	Cleaning Irrigation Canal, Sulaymaniya, 2005	Sulaymaniyah	October-05	December-05
Grant	G-3834-001-0159	Rehabilitation of the Irrigation Project, Dahuk, 2005	Dahuk	November-05	February-06
Grant	G-3834-001-0151	Irrigation Canal Cleaning, Al Dokhan Village Project (Al Muthanna Governorate)	Muthanna	November-05	November-05
Grant	G-3834-001-0168	Rehabilitation of Culvert, Babylon, 2006	Babylon	November-05	January-06
Grant	G-3834-001-0169	Rehabilitation of Al Tajyah Culvert, Babylon Governorate	Babylon	November-05	January-06
Grant	G-3834-001-0170	Al Gowah and Al Ghallal Irrigation Head Regulators Reconstruction, Najaf	Najaf	November-05	January-06
Grant	G-3834-001-0152	Irrigation Canal Cleaning, Small Irrigation Canals Project (Al Muthanna Governorate)	Muthanna	November-05	December-05
Grant	G-3834-001-0174	Re Construction of Al E'aywig Canal Pipe Flume	Kerbala	November-05	February-06
Grant	G-3834-001-0173	Re Construction of Al Behta Canal Pipe Flume	Kerbala	November-05	February-06
Grant	G-3834-001-0172	Reconstruct Al Khashaniyah Head Regulator in Al-Qadisiayh Governorate	Qadissiya	December-05	March-06
Grant	G-3834-001-0139	Install Pumping Station for Irrigation System, Muthanna, 2005 – 2006	Muthanna	December-05	January-05
Grant	G-3834-001-0178	Water Storage Facilities at 5 Villages (Bardgrka, Gochar, Dargala, Kawlokan and	Erbil	December-05	March-06
Grant	G-3834-001-0187	Reconstruction of Al-Bassrokiyah Cross Regulator in Wasit Governorate	Wassit	January-06	March-06
Grant	G-3834-001-0185	A'al Majid and A'al Awad Irrigation Head Regulators Reconstruction, Najaf	Najaf	January-06	February-06
Grant	G-3834-001-0186	Abu Jagi Head Regulator Reconstruction, Najaf Governorate	Najaf	January-06	February-06
Grant	G-3834-001-0182	Irrigation Canals Cleaning in Al-Warka'a District - Muthanna Governorate	Muthanna	January-06	January-06
Grant	G-3834-001-0183	Irrigation Regulators Reconstruction for Jannabiyat Al Mishkhab Canal, Najaf	Najaf	January-06	February-06
Grant	G-3834-001-0184	Al Ghazali and A'al Habib Irrigation Head Regulators Reconstruction, Najaf	Najaf	January-06	February-06
Grant	G-3834-001-0190	Rehabilitation of the Um Al-Agaf Pump Station	Muthanna	January-06	March-06
Grant	G-3834-001-0181	Cleaning of Irrigation and Drainage Canals in Al-Buhwaichma and surrounded villages -	Muthanna	February-06	February-06
Subcontract	LOA-X13	Raising Canal Banks, Kerbala, 2006	Kerbala	February-06	May 2006
Grant	G-3834-001-0197	Installation of Center Pivot Irrigation Systems in Tameem Governorate	Tameem	February-06	June-06
Grant	G-3834-001-0196	Cleaning and Rehabilitation of drainage canal in Al Hindia District, Karbla Governorate	Kerbala	March-06	April-06
Grant	G-3834-001-0215	Cleaning Shekhan Irrigation Canal - Ninewa	Ninewa	March-06	May-06

Type	Activity ID#	Activity Title	Governorate (s)	Start Date	End Date
Grant	G-3834-001-0209	Gordara Irrigation Canal Cleaning in Taza District of Tammem Governorate	Tameem	March-06	April-06
Grant	G-3834-001-0213	Rehabilitation of retaining wall and pipe flume in Al-Ajda'a River	Babylon	March-06	March-06
Grant	G-3834-001-0216	Cleaning Al-Dujeel Irrigation Canals - Samarra	Salah al-Din	March-06	April-06
Grant	G-3834-001-0219	Irrigation Canals Cleaning in Abu alkhaseeb-Basrah	Basrah	March-06	April-06
Grant	G-3834-001-0222	Constructing Al Bashiyah pipe culvert on Al Salamiyah main drain	Kerbala	March-06	May-06
Grant	G-3834-001-0225	Civil and Engineering Works for Canal at Al-Bidairy Irrigation System	Muthanna	March-06	May-06
Grant	G-3834-001-0229	Irrigation Canals Cleaning in Al-Mhannawiyah Sub-District in Al-Qadisia	Najaf	March-06	April-06
Grant	G-3834-001-241	Improving the Drainage Conditions of a Waterlogged Affected Area in Al-Muthannah	Muthanna	April-06	May-06
Grant	G-3834-001-240	Irrigation canals cleaning in Sayed Dekheel--Nassriya /Thi-Qar governorate	Thi-Qar	April-06	May-06
Grant	G-3834-001-245	Reconstruction of Al Mishkhab Cross Regulator, Al Najaf Governorate	Najaf	May-06	September-06
Subcontract	LOA-X14	Kufa Drain Rehabilitation, Najaf, 2006	Najaf	May-06	August-06
Subcontract	LOA-X15	Shomaly Pumping Station Emergency Regulator, Babylon, 2006	Babylon	May-06	August-06
Subcontract	LOA-X16	Monaither Pumping Station, Babylon, 2006	Babylon	May-06	August-06
Subcontract	LOA-X17	Hanoon Cross Regulator, Wassit, 2006	Wassit	May-06	August-06
Grant	G-3834-001-247	Installation of Center Pivot Irrigation Systems in Tameem Governorate, Phase II	Tameem	June-06	August-06
Grant	G-3834-001-249	Irrigation Canal Cleaning in 45 villages in Dinarta Sub-District of Ninewa	Ninewa	June-06	September-06
Grant	G-3834-001-250	Construction of Abu-Kohuf regulator in Ar-Rumaitha District -Al-Muthanna	Muthanna	June-06	July-06
Grant	G-3834-001-251	Main Baquba Drain Cleaning Project	Diyala	June-06	August-06
Grant	G-3834-001-252	Construction of Al-Khdirawy Canal regulator in Al-Warka'a Sub-District-Al-	Muthanna	June-06	July-06
Grant	G-3834-001-253	Cleaning Jalwla Irrigation Canal	Diyala	June-06	July-06
Grant	G-3834-001-255	Reconstruction of Shleet regulator in Karbala'a Governorate	Kerbala	June-06	July-06
Grant	G-3834-001-258	Irrigation Canal Cleaning in 15 villages in Sidakan Subdistrict of Soran District of Erbil	Erbil	June-06	July-06
Grant	G-3834-001-259	Irrigation Canal Cleaning in 15 villages in Soran District of Erbil Governorate	Erbil	June-06	July-06
Grant	G-3834-001-260	Construction of head regulator and retaining walls for Eshan Graed Canal.	Babylon	June-06	June-06
Grant	G-3834-001-261	Irrigation canals cleaning project in Al-Hilal Sub-District/ Al-Muthanna Governorate.	Muthanna, Muthanna	June-06	July-06
Grant	G-3834-001-266	Irrigation canals cleaning of Hamdan and Muhagran/ Basrah	Basrah	July-06	August-06
Grant	G-3834-001-267	Rejuvenate and Expand Water Spring, Cleanin Irrigation Canal in Khala Bazyan	Tameem	July-06	August-06
Grant	G-3834-001-268	Irrigation Canal Cleaning in Daquq District of Kerkuk Governorate	Tameem	July-06	August-06
Grant	G-3834-001-271	Irrigation Canal Cleaning in Choman Sub-District of Erbil Governorate	Erbil	July-06	August-06
Water and Land Resource Strategy Development					
Direct National	LOA-X25	Develop Strategy for Water and Land Reources in Iraq, National, 2005-2006	National	June-05	September-06
Government Strengthening					
Training	LOA-TRN02	Amman Water Management Training, International, 2005	National	February-05	March-05
Direct National Programs	LOA-036	Irrigation Efficiencies, 2005-2006	Baghdad, Babylon, Erbil, Basrah, Diyala, Kerbala, Muthanna, Najaf, Ninewa, Qadisiya, Suleymaniyah, Tameem,	April-05	June-06
Direct National	LOA-037	Drainage & Salinity Pilot Areas, 2005-2006	Baghdad, Muthanna, Qadisiya, Babylon	April-05	June-06

Type	Activity ID#	Activity Title	Governorate (s)	Start Date	End Date
Direct National	LOA-X12	Design of Hydraulic Structures Training, National, 2005	Baghdad	November-05	December-05
Other Programs					
Grant	G-3834-001-0095	Reforestation Program in Erbil	Erbil	March-05	April-05
Grant	G-3834-001-0094	Reforestation Program in Dahuk	Dahuk	April-05	April-05
Government Transition for Market Economy					
Cadastral Mapping Reform					
Direct	AAP-013	National Cadastral Mapping and Lands Administration Project	National	August-04	September-06
Agricultural Surveys (Development of MOA Statistical Unit)					
Direct National	LOA-042	Survey of Winter Crops, Erbil, 2005	Erbil	July-05	August-05
Direct National	LOA-049	Survey of Winter Crops, Dahuk, 2005	Dohuk	July-05	September-05
Direct National	LOA-024	Survey of Winter Crops, Sulaymaniya, 2005	Suleymaniyah	April-05	June-05
Direct National	AAP-008	Winter Crops Survey, Northern Iraq, 2006	Erbil, Suleymaniyah, Dohuk	April-06	August-06
Direct National	AAP-010	Area Frame Sampling (AFS), Northern Iraq, 2006	Dohuk, Erbil, Suleimaniyah	May-06	August-06
Direct National	LOA-054	Summer Crop Production Survey, Sulaymaniya, 2005-2006	Suleymaniyah	October-05	February-06
Direct National	LOA-012	Poultry Production Surveys, Erbil/Dahuk, 2004	Erbil, Dohuk	December-04	February-05
Direct National	LOA-013	Poultry Production Survey, Sulaymaniya, 2004-2005	Suleymaniyah	December-04	February-05
Direct National	LOA-032	Poultry Production Surveys, Baghdad, 2005	Baghdad	April-05	July-05
Direct National	LOA-009	Ag Production Surveys, Diyala/Babylon, 2004	Babylon, Diyala	July-04	October-04
Direct National	LOA-031	Ag Production Surveys, Diyala/Babylon, 2005	Diyala/Babyl	April-05	July-05
Direct National	LOA-XX2	Wholesale Prices Monitoring	National	April-05	September-06
Direct National	LOA-041	Sunna Pest Surveys, Erbil, 2005	Erbil	July-05	October-05
Direct National	LOA-052	Sunna Pest Survey & Control Program, Dahuk, 2005	Dohuk	October-05	October-05
Direct National	LOA-045	Livestock Inventory and Dairy Production Survey, Sulaymaniya, 2005-2006	Suleymaniyah	July-05	April-06
Direct National	LOA-050	Beekeepers Survey, Diyala 2005	Dyala	September-05	August-06
Training and Workshops					
Training	LOA-TRN01	Cairo Donor Coordination Trainning, International, 2004-2005	National	October-04	January-05
Training	LOA-TRN04	Cairo Training -Dr.Saad, International, 2004	National	April-05	July-05
Training	LOA-TRN11	National Ag Survey Workshop, National, 2006	National	February-06	February-06
Training	LOA-TRN13	Workshop of Ag Market Price Surveyors, National, 2006	National	February-06	February-06
Training	LOA-TRN28	Price Monitoring Workshop, National, 2006	National	February-06	July-06
Training	LOA-TRN23	Irrigation Scheduling Workshop, National, 2006	National	June-06	July-06
Training	LOA-TRN25	Farm & Financial Management Training of Trainers, National, 2006	National	June-06	June-06
Training	LOA-TRN29	GPS Training, National, 2006	National	July-06	August-06
Improving Communication and Research Capabilities					

Type	Activity ID#	Activity Title	Governorate (s)	Start Date	End Date
Grant	G-3834-001-0004	University of Baghdad, College of Veterinary Medicine, Internet Center	Baghdad	January-04	January-04
Grant	G-3834-001-0006	State Board of Agricultural Research, Internet Support	Baghdad	March-04	March-04
Grant	G-3834-001-0021	Equipping Media Center at the GD Research & Extension in Erbil	Erbil	July-04	August-04
Grant	G-3834-001-0020	U of Baghdad, College of Veterinary Medecine - Media Center	Baghdad	July-04	August-04
Grant	G-3834-001-0022	Equipping Agriculture Extension Center in Salahaddin Sub-District	Erbil	August-04	September-04
Grant	G-3834-001-0023	Equipping Agriculture Extension Center in Shaqlawa District	Erbil	August-04	September-04
Grant	G-3834-001-0024	Equipping Agriculture Extension Center in Barzan Sub-District	Erbil	August-04	September-04
Grant	G-3834-001-0027	State Board for Lands Internet Center	Baghdad	August-04	September-04
Grant	G-3834-001-0071	Land Registration System for the State Board for Agricultural Lands - Phase I	Baghdad	January-05	May-05
Grant	G-3834-001-0072	Land Registration System for the State Board for Agricultural Lands - Phase II	Baghdad	January-05	May-05
Grant	G-3834-001-0076	Equipping Media Center at The General Directorate of Agriculture Research and	Sulaymaniyah	February-05	April-05
Grant	G-3834-001-0078	Equipping Khabat Agriculture Extension Center	Erbil	February-05	April-05
Grant	G-3834-001-0077	Equipping the Computer Training Hall at the General Directorate of Agriculture Research	Erbil	February-05	April-05
Grant	G-3834-001-0100	Rehabilitating Ministry of Agriculture Building in Baghdad - Phase I	Baghdad	March-05	April-05
Grant	G-3834-001-0101	Rehabilitating Ministry of Agriculture Building in Baghdad - Phase II	Baghdad	March-05	April-05
Grant	G-3834-001-0102	Rehabilitating Ministry of Agriculture Building in Baghdad - Phase III	Baghdad	March-05	April-05
Grant	G-3834-001-0111	Equipping Agriculture Training and Development Center in Mosul	Ninewa	April-05	May-05
Grant	G-3834-001-0105	Equipping Agriculture Training Hall in Ainkawa	Erbil	May-05	June-05
Grant	G-3834-001-0167	Renovation of Qushtapa Agriculture Research and Extension Center	Erbil	November-05	March-05
Grant	G-3834-001-0171	Computer and Internet Support, State Board for Agricultural Extension, 2005	Baghdad	November-05	December-05
High Value Agricultural Production					
Honey Production					
Grant	G-3834-001-0028	Basharat Upper Beekeping Project	Sulaymaniyah	September-04	October-04
Grant	G-3834-001-0029	Tappai-Safa Lower Beekeeping Project	Sulaymaniyah	September-04	October-04
Direct National	LOA-Various POs	Honey Production Program, Sulaymaniya, 2006	Suleymaniyah	September-04	April-05
Grant	G-3834-001-0034	Beekeeping Training School	Sulaymaniyah	December-04	February-05
Direct National	ARDI-ERB-FP-0011	Establishment of Beekeeping Association Dahuk, 2004	Dohuk	December-04	December-04
Direct National	ARDI-ERB-FP-0010	Establishment of Beekeeping Association Kirkuk, Tameem, 2004	Kirkuk	December-04	December-04
Grant	G-3834-001-0099	Karbala Queen Bee Rearing Apiary and Research Facility	Kerbala	April-05	August-05
Grant	G-3834-001-0103	Beekeeping Library and Research and Extension Facilities in Rashdia	Baghdad	May-05	August-05
Grant	G-3834-001-0127	Carpenters Training Workshop on Beehive Manufacturing	Dahuk, Erbil, Tameem, Sulaymaniyah, Ninewa	July-05	August-05
Grant	G-3834-001-0131	Beekeeping Project for Vulnerable Groups in (Kirkuk, Sulaymaniyha and Diyala)	Tameem, Sulaymaniyah	July-05	February-06
Direct National	ARDI-ERB-FP-0142	National Trading Fair for Iraqi Beekeepers & Honey Producers, 2005	Suleymaniyah	September-05	September-05
Grant	G-3834-001-0161	Beekeeping Project for Vulnerable Groups in Al-Guba Village - Ninewa Governorate	Ninewa	October-05	March-06

Type	Activity ID#	Activity Title	Governorate (s)	Start Date	End Date
Grant	G-3834-001-242	Honey production project for vulnerable communities in Erbil	Erbil	May-06	June-06
Dates					
Direct National Programs	LOA-004	Establishment of Date Palms Mother Orchads (2004)	Baghdad, Anbar, Babylon, Basrah, Diyala, Kerbala, Missan, Muthanna, Najaf, Qadissiya, Salahadin, Thi-Qar,	February-04	October-04
Direct National Programs	LOA-026	Establishment of date palms mother orchards Phase II, 2005-2006	Baghdad, Anbar, Babylon, Basrah, Diyala, Kerbala, Missan, Muthanna, Najaf, Qadissiya, Salahadin, Thi-Qar,	April-05	May-06
Direct National Programs	LOA-027	Establishment of date palm nurseries Phase I, 2005-2006	Baghdad, Anbar, Babylon, Basrah, Diyala, Kerbala, Missan, Muthanna, Najaf, Qadisiya, Salahaldin, Thi-Qar ,	April-05	May-06
Direct National Programs	LOA-028	National Program for the Improvement and Propagation of Date Palms - Nursery Infrastructure Support, 2005-2006	Baghdad, Anbar, Babylon, Basrah, Diyala, Kerbala, Missan, Muthanna, Najaf, Qadissiya, Salahadin, Thi-Qar,	April-05	May-06
Direct National Programs	LOA-033	National Program for the Improvement and Propagation of Date Palms - Mother Orchard Infrastructure Support, 2005-2006	Baghdad, Babylon, Basrah, Diyala, Kerbala, Missan, Muthana, Najaf, Qadissiya, Salah Al-Din, Thi-Qar, Wassit, Anbar	April-05	May-06
Training	LOA-TRN17	Date Palm Conference in Abu Dhabi, International, 2006	National	February-06	February-06
Grant	G-3834-001-0233	Restoration 20 Orchards of palm trees in Al-Muthanna	Muthanna	March-06	May-06
Grant	G-3834-001-243	Restoration of of date palm orchards at marsh lands	Basrah	May-06	May-06
Grant	G-3834-001-0220	Restoration of Date Palm Orchards in Basra	Basrah	March-06	May-06
Extension					
Direct National	LOA-X19	Participatory Extension Training, National, 2005-2006	National	October-05	August-06
Training	LOA-TRN19	Field Extension Training, National, 2006	Erbil	May-06	May-06
Grapes					
Grant	G-3834-001-0148	Benchmarking Selected Varieties of Vine Stock for Propagation	Erbil	September-05	November-05
Grant	G-3834-001-0195	Collecting Grape Cuttings (Select Varieties) for Nursery Stock	Erbil	January-06	March-06
Grant	G-3834-001-0224	Establish Private Sector Grape Nursery, Erbil	Erbil	March-06	May-06
Grant	G-3834-001-0221	Establish Private Sector Grape Nursery, Dohuk	Dahuk	March-06	May-06
Grant	G-3834-001-0223	Establish Private Sector Grape Nursery, Suleimaniya	Sulaymaniyah	March-06	May-06
Grant	G-3834-001-263	Production Vineyards with Trellising and Irrigation Systems	Erbil, Sulaymaniyah, Dahuk	June-06	September-06
Land Rehabili					
Grant	G-3834-001-0030	Cleaning and Weeding of Bazyan Orchard Station	Sulaymaniyah	September-04	November-04
Grant	G-3834-001-0032	Stone Clearing in Qasrok Sub-district	Ninewa	December-04	March-05
Grant	G-3834-001-0073	Stone Clearing in Qasrok Sub-district Phase II	Ninewa	February-05	March-05
IPM					
Training	LOA-TRN06	Integrated Pest Management Workshop, National, 2006	National	January-06	February-06
Subcontract	LOA-X23	PERSUAP, National, 2006	National	January-06	September-06
Training	LOA-TRN21	Pesticide Dealer Association Workshop & Training	National	May-06	May-06
Grant	G-3834-001-262	Proper and safe usage of Pesticide	Sulaymaniyah	June-06	September-06
Training	LOA-TRN05	Pesticide Dealer Association Workshop & Training, National, 2006	National	January-06	April-06
Mechanization					

Type	Activity ID#	Activity Title	Governorate (s)	Start Date	End Date
Direct National Programs	LOA-014	Case New Holland Mechanization Program (CNH) 2005 - 2006	Baghdad, Anbar, Babylon, Dahuk, Diyala, Erbil, Kerbala, Missan, Najaf, Ninewa, Qadissiya, Salah Al-Din, Suleymaniyah, Tameem, Thi-qar, Wassit	December-04	September-06
Direct National	LOA-022	Massey Ferguson Mechanization (MF) Zozik, 2005 - 2006	Erbil, Ninawa, Suleymaniyah	March-05	September-06
Direct National	LOA-025	Khorayef Mechanization Rehabilitation Program, 2005-2006	Anbar, Baghdad, Diyala, Sallahedin	August-05	September-06
Training	LOA-TRN10	CNH Mechanic Training, Turkey, 2006	National	January-06	August-06
Grant	G-3834-001-0239	Tractor and Combine Repair Project, Dahuk, 2006	Dahuk	April-06	June-06
Nurseries					
Grant	G-3834-001-0117	Establishment of Flower Nursery	Dahuk	June-05	December-05
Grant	G-3834-001-0180	Rehabilitation of Kirkuk Nursery	Tameem	January-06	March-06
Olives					
Direct National	LOA-023	Establishment of High-Oil Olive Orchards, 2005-2006	Wassit	April-05	May 2006
Grant	G-3834-001-0080	Establishment of Olive Orchards - Dahuk	Dahuk	March-05	April-05
Fruit Orchards					
Grant	G-3834-001-0079	Improvement of Apple Orchards in Duhok Governorate	Dahuk	March-05	November-05
Grant	G-3834-001-0081	Improvement of Peach Orchards in Ninewa.	Ninewa	March-05	November-05
Grant	G-3834-001-0206	Development of Fruit Trees Orchards in Basra	Basrah	March-06	March-06
Grant	G-3834-001-0234	Improvement of Apple, Peach and Plum Production in Erbil Governorate	Erbil	March-06	August-06
Grant	G-3834-001-0214	Commercial Orchard Production Improvement in Sulaimaniyha Governorate	Sulaymaniyah	March-06	August-06
Grant	G-3834-001-0217	Improvement of Production Peach Orchards in Ninewa Governorate	Ninewa	March-06	August-06
Grant	G-3834-001-0218	Improvement of Production Apple Orchards in Dahuk Governorate	Dahuk	March-06	August-06
Grant	G-3834-001-0162	Apple Orchards Survey in Dahuk-Ninewa Governorate	Dahuk, Ninewa	November-05	May-06
Tomatoes					
Direct National	LOA-040	Expanding Hybrid Variety Tomato Production, Central/Southern Iraq, 2005-	Basrah, Karbala, Muthanna, Najaf	June-05	May-06
Grant	G-3834-001-0205	Improvement of Tomato Production in Zakho - Dahuk Governorate	Dahuk	March-06	June-06
Horticulture					
Training	LOA-TRN03	Cairo Global Horticultural Initiative Conference, International, 2005	National	April-05	April-05
Training	LOA-TRN30	Horticulture Workshop, National, 2006	National	July-06	July-06
Direct National	LOA-006	MOA Summer Crop Technology Demonstrations (2004)	Babylon, Basrah, Diyala, Kerbala, Najaf, Qadissiya, Tameem, Wassit	June-04	October-04
Livestock Production					
Avian Flu and Zoonotic Disease Awareness					
Training	LOA-TRN12	6th International Imposium on Avian Influenza, International, 2006	Cambridge, Englad	February-06	February-06
Training	LOA-TRN15	Avian Influenza Conference, National, 2006	Erbil	April-06	May-06
Grant	G-3834-001-272	Avian Influenza and Zoonotic Diseases Extension and Awareness Program in	Sulaymaniyah	July-06	September-06
Grant	G-3834-001-273	Avian Influenza and Zoonotic Diseases Extension and Awareness Program in	Sulaymaniyah	July-06	September-06

Type	Activity ID#	Activity Title	Governorate (s)	Start Date	End Date
Grant	G-3834-001-0123	Zoonetic Diseases Extension and Awareness Program	Ninewa	June-05	August-05
Grant	G-3834-001-0176	Animal Health and Zoonotic Diseases Extension and Awareness Program in Dahuk	Dahuk	December-05	March-06
Grant	G-3834-001-0177	Animal Health and Zoonotic Diseases Extension and Awareness Program in	Sulaymaniyah	December-05	March-06
Grant	G-3834-001-0194	Animal Health and Zoonotic Diseases Awareness and Extension Program in	Erbil	January-06	March-06
Grant	G-3834-001-0198	Animal Health and Zoonotic Diseases Awareness and Extension Program in Diyala	Diyala	February-06	April-06
Grant	G-3834-001-0199	Animal Health and Zoonotic Diseases Awareness and Extension Program in Kirkuk	Tameem, Sulaymaniyah	February-06	April-06
MOA Veterinary Clinic Rehabilitation					
Grant	G-3834-001-0001	Taza and Rashad (Kirkuk) Veterinary Clinic Rehabilitation	Tameem	January-04	March-04
Grant	G-3834-001-0002	Kirkuk Veterinary Hospital Renovation	Tameem	January-04	March-04
Grant	G-3834-001-0005	Al Karmah Veterinary Clinic	Anbar	March-04	June-04
Grant	G-3834-001-0008	Daquq (Kirkuk) Veterinary Clinic Rehabilitation	Tameem	March-04	June-04
Grant	G-3834-001-0010	Al Riyadh (Kirkuk) Veterinary Clinic Renovation	Tameem	May-04	July-04
Grant	G-3834-001-0014	Al Hafriya Veterinary Clinic Rehabilitation	Wassit	July-04	November-04
Grant	G-3834-001-0015	Yusufiya Veterinary Clinic Rehabilitation	Baghdad	July-04	November-04
Grant	G-3834-001-0016	Al Qurnah Veterinary Clinic Rehabilitation	Basrah	July-04	November-04
Grant	G-3834-001-0017	As Saqlawiyah Veterinary Clinic Rehabilitation	Anbar	July-04	December-04
Grant	G-3834-001-0019	Renovation of the Khalifan Veterinary Clinic	Erbil	July-04	December-04
Grant	G-3834-001-0018	Shatrah Veterinary Clinic Rehabilitation	Thi-Qar	July-04	September-04
Grant	G-3834-001-0026	Al Abbasiyah Veterinary Clinic Rehabilitation	Najaf	August-04	November-04
Grant	G-3834-001-0025	Al Hurr Veterinary Clinic Rehabilitation	Kerbala	August-04	October-04
Grant	G-3834-001-0036	Touz Hourmato Veterinary Clinic Rehabilitation	Salah al-Din	December-04	March-05
Grant	G-3834-001-0037	Amirli Veterinary Clinic Rehabilitation - Phase I	Salah al-Din	December-04	March-05
Grant	G-3834-001-0038	Khazwan Veterinary Clinic Rehabilitation Phase I	Anbar	December-04	March-05
Grant	G-3834-001-0039	Al Qa'im Veterinary Clinic Rehabilitation Phase I	Anbar	December-04	March-05
Grant	G-3834-001-0040	Al Rumana Veterinary Clinic Rehabilitation	Anbar	December-04	March-05
Grant	G-3834-001-0041	Al-Thahab Al-Abyath Veterinary Clinic Rehabilitation - Phase I	Baghdad	December-04	March-05
Grant	G-3834-001-0042	Abu Gharaib Veterinary Clinic Rehabilitation - Phase I	Baghdad	December-04	March-05
Grant	G-3834-001-0043	Amirli Veterinary Clinic Rehabilitation - Phase II	Salah al-Din	December-04	March-05
Grant	G-3834-001-0044	Al-Thahab Al-Abyath Veterinary Clinic Rehabilitation - Phase II	Baghdad	December-04	March-05
Grant	G-3834-001-0045	Abu Gharaib Veterinary Clinic Rehabilitation - Phase II	Baghdad	December-04	March-05
Grant	G-3834-001-0046	Khazwan Veterinary Clinic Renovation - Phase II	Anbar	December-04	March-05
Grant	G-3834-001-0035	Makmoor Veterinary Clinic Rehabilitation	Erbil	December-04	March-05
Grant	G-3834-001-0048	Fayda Veterinary Clinic Rehabilitation	Ninewa	December-04	March-05
Grant	G-3834-001-0049	Gwer Veterinary Clinic Rehabilitation	Ninewa	December-04	March-05
Grant	G-3834-001-0050	Al Fallujah Veterinary Clinic Rehabilitation Phase I	Anbar	December-04	March-05

Type	Activity ID#	Activity Title	Governorate (s)	Start Date	End Date
Grant	G-3834-001-0051	Al `Ubaydi Veterinary Clinic Rehabilitation	Anbar	December-04	March-05
Grant	G-3834-001-0052	Altun Kupri Veterinary Clinic Rehabilitation Phase I	Tameem	December-04	March-05
Grant	G-3834-001-0053	Equipping Khalifan Veterinary Clinic	Erbil	December-04	April-05
Grant	G-3834-001-0054	Altun Kupri Veterinary Clinic Rehabilitation Phase II	Tameem	December-04	March-05
Grant	G-3834-001-0009	Imam Qasm (Kirkuk) Veterinary Clinic Renovation	Tameem	December-04	August-05
Grant	G-3834-001-0058	Shomeli Veterinary Clinic Rehabilitation Phase I	Babylon	January-05	July-05
Grant	G-3834-001-0059	Al Fallah Veterinary Clinic Rehabilitation Phase I	Wassit	January-05	July-05
Grant	G-3834-001-0060	As Suwayrha Veterinary Clinic Rehabilitation Phase I	Wassit	January-05	July-05
Grant	G-3834-001-0061	Al Wehda Veterinary Clinic Rehabilitation Phase I	Baghdad	January-05	July-05
Grant	G-3834-001-0062	Al Yusufiya Veterinary Clinic Rehabilitation Phase I	Baghdad	January-05	July-05
Grant	G-3834-001-0063	Al-Baquba Veterinary Clinic Rehabilitation Phase I	Diyala	January-05	July-05
Grant	G-3834-001-0064	Al-Abassia Veterinary Clinic Rehabilitation	Tameem	January-05	July-05
Grant	G-3834-001-0065	Shomeli Veterinary Clinic Rehabilitation Phase II	Babylon	January-05	July-05
Grant	G-3834-001-0066	Al Fallah Veterinary Clinic Rehabilitation Phase II	Wassit	January-05	July-05
Grant	G-3834-001-0067	As Suwayrha Veterinary Clinic Rehabilitation Phase II	Wassit	January-05	July-05
Grant	G-3834-001-0068	Al Wehda Veterinary Clinic Rehabilitation Phase II	Baghdad	January-05	July-05
Grant	G-3834-001-0069	Al Yusufiya Veterinary Clinic Rehabilitation Phase II	Baghdad	January-05	July-05
Grant	G-3834-001-0070	Al-Baquba Veterinary Clinic Rehabilitation Phase II	Diyala	January-05	July-05
Grant	G-3834-001-0074	Jurf as Sakhr Veterinary Clinic Rehabilitation Phase I	Babylon	February-05	July-05
Grant	G-3834-001-0075	Jurf as Sakhr Veterinary Clinic Rehabilitation Phase II	Babylon	February-05	July-05
Grant	G-3834-001-0082	Renovation of Batel Veterinary Clinic Phase I	Dahuk	March-05	July-05
Grant	G-3834-001-0083	Renovation of Sheladize Veterinary Clinic Phase I	Dahuk	March-05	July-05
Grant	G-3834-001-0084	Renovation of Amedi Veterinary Clinic Phase I	Dahuk	March-05	July-05
Grant	G-3834-001-0085	Rehabilitation of Bardarash Veterinary Clinic Phase I	Ninewa	March-05	July-05
Grant	G-3834-001-0086	Rehabilitation of Qasrok Veterinary Clinic Phase I	Ninewa	March-05	July-05
Grant	G-3834-001-0087	Rehabilitation of Zawita Veterinary Clinic	Dahuk	March-05	July-05
Grant	G-3834-001-0088	Renovation of Amedi Veterinary Clinic Phase II	Dahuk	March-05	July-05
Grant	G-3834-001-0089	Rehabilitation of Bardarash Veterinary Clinic Phase II	Ninewa	March-05	July-05
Grant	G-3834-001-0090	Renovation of Batel Veterinary Clinic Phase II	Dahuk	March-05	July-05
Grant	G-3834-001-0091	Rehabilitation of Qasrok Veterinary Clinic Phase II	Ninewa	March-05	July-05
Grant	G-3834-001-0092	Renovation of Sheladize Veterinary Clinic Phase II	Dahuk	March-05	July-05
Grant	G-3834-001-0096	Namrud Veterinary Clinic Rehabilitation	Ninewa	March-05	July-05
Grant	G-3834-001-0106	Salah el-Din Veterinary Clinic Renovation	Erbil	April-05	September-05
Grant	G-3834-001-0107	Darawa Veterinary Clinic Renovation	Erbil	April-05	September-05
Grant	G-3834-001-0108	Brayati Veterinary Clinic Renovation	Erbil	April-05	September-05

Type	Activity ID#	Activity Title	Governorate (s)	Start Date	End Date
Grant	G-3834-001-0109	Bnaslawa Veterinary Clinic Renovation	Erbil	April-05	September-05
Grant	G-3834-001-0110	Mergasur Veterinary Clinic Renovation	Erbil	April-05	September-05
Grant	G-3834-001-0116	Soran Veterinary Clinic Renovation	Erbil	April-05	September-05
Grant	G-3834-001-0112	Barzan Veterinary Clinic Renovation Phase I	Erbil	June-05	October-05
Grant	G-3834-001-0113	Barzan Veterinary Clinic Renovation Phase II	Erbil	June-05	October-05
Grant	G-3834-001-0114	Shaqlawa Veterinary Clinic Renovation Phase I	Erbil	June-05	October-05
Grant	G-3834-001-0115	Renovation of Shaqlawa Veterinary Clinic Phase II	Erbil	June-05	October-05
Grant	G-3834-001-0154	Sangaw Veterinary Clinic Renovation	Sulaymaniyah	October-05	January-05
Grant	G-3834-001-0155	Qara Anjir Veterinary Clinic Renovation	Sulaymaniyah	October-05	January-06
Grant	G-3834-001-0157	Koysinjaq Veterinary Clinic Renovation	Erbil	October-05	January-06
Grant	G-3834-001-0156	Chwarta Veterinary Clinic Renovation	Sulaymaniyah	October-05	February-06
Grant	G-3834-001-0163	Renovation of Al-Haweeja Veterinary Clinic	Tameem	November-05	January-06
Grant	G-3834-001-0164	Renovation of Lailan Veterinary Clinic	Tameem	November-05	January-06
Grant	G-3834-001-0165	Renovation of Al-Zaab Veterinary Clinic	Tameem	November-05	January-06
Grant	G-3834-001-0166	Renovation of Barznja Veterinary Clinic	Sulaymaniyah	November-05	January-06
Grant	G-3834-001-0175	Taq Taq Veterinary Clinic Renovation	Erbil	December-05	February-06
Grant	G-3834-001-0179	Renovation of Al-Rashdia Veterinary Clinic	Baghdad	January-06	March-06
Grant	G-3834-001-0204	Ronovation of Al-Dair Veterinary Clinic	Basrah	March-06	May-06
Grant	G-3834-001-0207	Renovation of Rawa Veterinary Clinic in Al-Anbar Governorate	Anbar	March-06	June-06
Grant	G-3834-001-0208	Renovation of Daghara Veterinary Clinic in Qadissiya Governorate	Qadissiya	March-06	May-06
Grant	G-3834-001-0212	Renovation of Samarra'a Veterinary Clinic in Salah el-Din Governorate	Salah al-Din	March-06	May-06
Grant	G-3834-001-0211	Renovation of Diwaniya Veterinary Hospital in Al-Qadissiya Governorate	Qadissiya	March-06	May-06
Grant	G-3834-001-0226	Renovation of Al-Kufa Veterinary Clinic in Al-Najaf Governorate	Najaf	March-06	June-06
Grant	G-3834-001-0228	Renovation of Buhriz Veterinary Clinic	Diyala	March-06	June-06
Grant	G-3834-001-244	Renovation of Al-Warka Veterinary Clinic	Muthanna	May-06	June-06
Grant	G-3834-001-256	Renovation of Thi-Qar Veterinary Hospital	Thi-Qar	June-06	July-06
Grant	G-3834-001-269	Renovation of Al Haditha Veterinay Clinic in Al-Anbar Governorate	Anbar	July-06	November-06
Grant	G-3834-001-270	Renovation of As Sinniyah Veterinay Clinic in Al-Qadissyah Governorate	Qadissiya	July-06	November-06
Other Infrastructure Rehabilitation					
Grant	G-3834-001-0007	Sheep Dipping Tanks in Zakho	Dahuk	March-04	April-04
Grant	G-3834-001-0013	Veterinary Clinic in a Box	Baghdad	July-04	October-04
Grant	G-3834-001-0031	Sheep Dip Tanks - Suleimania	Sulaymaniyah	September-04	January-05
Buffalo Production					
Direct National	LOA-XX4	Improving Buffalo Calving Rate through Hormone Treatment Demonstration, 2005-	Baghdad, Muthanna, Thi-Qar, Basrah	July-05	March-06
Direct National	LOA-XX5	Improving Buffalo Calving Rate through Improved Nutritional Regime	Baghdad, Muthanna, Thi-Qar, Basrah	July-05	March-06

Type	Activity ID#	Activity Title	Governorate (s)	Start Date	End Date
Sheep Production					
Direct National	LOA-XX3	Improving Sheep Production East of the Tigris, 2005-2006	Wassit	August-05	May-06
Direct National	LOA-055	Brucellosis Vaccination Campaign, Southern Iraq, 2005-2006	Southern Iraq	November-05	February-06
Direct National	LOA-XX6	Improving Nutritional Regimes of Lambed Ewes, 2005-2006	Najaf, Wassit, Muthanna, Diwaniyah	November-05	March-06
Direct	AAP-004	Improving Nutritional Regimes of Suckling Lambs	Najaf, Wassit	January-06	September-06
Direct National	AAP-009	Improving the Nutritional Regime of Ewes Pre-Mating, Kerbala/Missan/Wassit, 2006	Kerbala, Missan, Wassit	May-06	August-06
Training	LOA-TRN18	Rangeland Workshop, National, 2006	Erbil	May-06	May-06
Direct	AAP-016	Improving Nutrition in Pregnant Ewes, 2006	Najaf	August-06	August-06
Marshlands					
Direct National	AAP-001	Crop Demos, Marshlands, 2006	Basrah, Missan, Thiqar	February-06	August-06
Direct National	AAP-005	Marshlands Monitoring	Basrah, Missan, Thi-Qar	November-05	September-06
Direct	AAP-011	Fish Restocking in Southern Marshlands, 2006	Basrah, Missan, Thi-Qar	May-06	August-06
Training	LOA-TRN14	Marshlands Symposium, National, 2006	Erbil	April-06	April-06
Private Sector Development					
Infrastructure Rehabilitation					
Grant	G-3834-001-0146	Reconstruction of Canal Bridge for Market Access	Babylon	September-05	December-05
Grant	G-3834-001-0126	Renovation of Kurdistan Agronomist Syndicate	Erbil	June-05	December-05
Grant	G-3834-001-0210	Support the Agriculture Training Center at the Kurdistan Agronomist Syndicate	Erbil	March-06	April-06
Livestock Cooperatives					
Grant	G-3834-001-0237	Feedlot Cooperative Project in Taza District, Kirkuk	Tameem	April-06	August-06
Grant	G-3834-001-0238	Feedlot Cooperative Project in Gogjaly Village, Mosul	Ninewa	April-06	August-06
Grant	G-3834-001-254	Establish Sheep Raising Cooperative in Kirkuk Governorate, Al-Rashad Subdistrict		June-06	July-06
Grant	G-3834-001-276	Establish Sheep Raising Cooperative in Ninewa, Shallalat subdistrict	Ninewa	September-06	October-06
Organizational Development					
Grant	G-3834-001-0033	PAPID II	Sulaymaniyah	December-04	February-05
Training	LOA-TRN24	Agri Business Startup Workshop, National, 2006	National	June-06	June-06
Private Veterinary Service Providers (PSP)					
Grant	G-3834-001-0188	Establish Veterinary Private Services Providers in Ninewa Governorate	Ninewa	January-06	March-05
Grant	G-3834-001-0189	Establish Veterinary Private Service Providers in Tameem Governorate	Tameem	January-06	March-06
Grant	G-3834-001-0236	Establish Ten Veterinarian Private Service Providers (PSPs) in Dahuk Governorate	Dahuk	April-06	June-06
Grant	G-3834-001-265	Establish Ten Veterinarian Private Service Providers (PSPs) in Salah al-Din	Salah al-Din	July-06	October-06
Seed Cleaning					
Training	LOA-TRN26	Business Management Workshop for NGOs, National, 2005-2006	National	May-05	July-06

Type	Activity ID#	Activity Title	Governorate (s)	Start Date	End Date
Grant	G-3834-001-0135	Support to Private Sector through Vocational Training on (Agricultural	Erbil	July-05	September-05
Training	LOA-TRN16	Pesticide Regulatory Training, Morocco	National	September-05	September-05
Grant	G-3834-001-0230	Support to Private Sector through Vocational Training in Agricultural Mechanics	Sulaymaniyah	March-06	May-06
Grant	G-3834-001-0231	Support to Private Sector through Vocational Training in Agricultural Mechanics	Sulaymaniyah	March-06	May-06
Grant	G-3834-001-0232	Support to Private Sector through Vocational Training in Agricultural Mechanics	Dahuk	March-06	May-06
Training	LOA-TRN27	Business Management Workshop for Honey Producers, National, 2006	National	April-06	April-06
Grant	G-3834-001-248	Provision of Vocational Training, Support, and Equipment to Private Sector Agricultural	Tameem	June-06	August-06
Project Management					
Direct	AAP-017	M&E Analysis (includes surveys: FP-0054 - FP-0057, and EI support)	National	January-06	September-06
Training	LOA-TRN20	M&E Survey Enumerator Training	National	May-06	May-06

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FINAL REPORT: APPENDIX C
MARSHLANDS MONITORING ACTIVITIES

AGRICULTURE RECONSTRUCTION AND DEVELOPMENT PROGRAM FOR IRAQ
ARDI

December 2006

This publication was produced for review by the United States Agency for International Development. It was prepared by Development Alternatives, Inc.

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1.0 Introduction & Background

Iraq's Mesopotamian marshes are considered by many to be the "cradle of western civilization" and have often been referred to as the Garden of Eden. The word Mesopotamia means "between rivers" and refers to the location between the Tigris and the Euphrates. The marshes were once the largest wetlands in southwest Asia and covered more than 15,000 square kilometers (km^2), an area nearly twice the size of the original Everglades. However, by the year 2000 less than 10% of the area remained as functioning marshes due to a systematic plan by the Iraqi government to ditch, dike, and drain the marshes (Richardson and Hussain 2006).

The marshes were also once famous for their biodiversity and cultural richness. They were the permanent habitat for millions of birds and a flyway for millions more migrating between Siberia and Africa. More than 80 bird species were found in the marshes in the last complete census in the 1970s. Populations of rare species like the marbled duck (*Marmaronetta marmarometta*, 40%-60% of the world population) and the Basrah reed warbler (*Acrocephalus griseldis*, more than 90% of the world population) were thought to be close to extinction but have recently been seen in a winter bird survey. Coastal fish populations in the Persian Gulf used the marshlands for spawning migrations, and the marshes also served as nursery grounds for penaeid shrimp (*Metapenaeus affinis*) and numerous marine fish species. The marshlands also once served as a natural filter for waste and other pollutants in the Tigris and Euphrates Rivers, protecting the Persian Gulf, which has now become noticeably degraded along the coast of Kuwait (Richardson et al. 2005).

The Iraqi marshlands, once one of the world's largest wetlands ecosystems, have been undergoing extensive restoration. This process was implemented to remedy the damage done between 1991 and 2003, when the marshes were drained and reduced to a tenth of their original size. Reflooding efforts after 2003 have now restored the marshlands to one-third their original

size, making them now the largest wetland area in the Middle East, covering 8000 square kilometers (UNEP 2005).

These marshlands are both regionally and globally significant as cultural, political, and economic resources. Through restoration activities, they are, once again, rich in aquatic productivity and provide a natural refuge for aquatic organisms, especially fish and birds. They play a vital role in the maintenance of biodiversity in the Middle East, due to their unique ecosystem characteristics and isolation from other comparable systems. Additionally, many refugee and internally displaced families of Marsh Dwellers are returning to their homes in response to increased economic opportunities.

1.1 Goals of the Project

In support of the marshlands restoration, the Agriculture Reconstruction and Development Program for Iraq (ARDI) established monitoring teams to assess the success of wetlands restoration efforts and to collect data that will guide the Iraqi government's policies and decisions regarding the area. ARDI's monitoring activities provided an assessment of where the inundation occurred, how it shifted over time, and what responses occurred in the ecology of water, soil, vegetation, and wildlife—and in the society and economy of the region—as a result of the newly increased flows. USAID, through ARDI's marshlands component, assisted the restoration process.

1.2 The key objectives of the monitoring program were to:

- Gain an accurate understanding of the present restoration status of the marshlands;
- Develop protocols for monitoring marsh restoration that can be institutionalized by the Ministry of Water Resources, Ministry of Environment, and Ministry of Agriculture;

- Assist the Ministry of Water Resources and Ministry of Environment in determining the best areas for inundating and restoration in the future;
- Establish baseline information about the reflooded marshes;
- Characterize the immediate and long-term effects of inundation on water, soil, and biotic resources through:
    - Assessment of the changes in biodiversity, ecosystem structure, functioning, and human use;
    - Quantification, to the extent possible, of long-term restoration sustainability;
    - Development of a long-term database;
    - Characterization and definition of the properties of a sustainable marshland ecosystem;
    - Provision of future working protocols for the local and scientific media;
    - Preparation of guidelines for future restoration efforts and suggestions for future plans concerning the development of agriculture and fisheries;
    - Recognition of the effect of restoration on the livelihoods of Marsh Dwellers.

Another goal of the monitoring program was to measure the marshland ecosystem functions, according to guidelines by Richardson and Nunnery (1998). These can be summarized as: hydrological flux and water storage, plant productivity, biogeochemical cycles and nutrient storage, organic matter decomposition, and community biodiversity. Other program goals were to examine species community structure (species composition), to recognize monthly changes in essential ecological indices (diversity, richness; evenness), and to develop a similarity index between restored wetlands and the remaining natural parts of the Al-Hawizeh marsh.

Specifically, this report includes comparison of data collected in 2005 and 2006 and an analysis of:

- Water quality characteristics;
- Phytoplankton productivity as indexed by chlorophyll-a concentration and species identification;
- Zooplankton biomass and species identification;
- Aquatic macrophyte densities, cover percentage, frequency, seasonal and annual biomass harvest yield;
- Macroinvertebrates densities, either on aquatic plants or the substratum, seasonal changes in ecological indices, and species identification;
- Fish abundance, species composition, and other ecological indices, as well as fishing catch rate;
- Spawning activities of fish and identification of species; and
- Water birds species identification, frequency, and related ecological information.

1.3 Methods and Sampling Locations

1.3.1 Monitoring Plan

The main monitoring plan was formulated in numerous meetings between DAI experts and Iraqi scientists in Basrah, after field visits to the marshes in 2003 and 2004. The plan's final version was developed by Professor Curtis Richardson (scientific consultant of the project), and consisted primarily of monthly and seasonal field sampling of key water quality parameters and biological indicators, as well as essential biannual and annual measurements of plant and algal productivity and soils. In addition, lab work was done at the University of Basrah's labratories, newly refurbished and equipped by USAID. Key components measured were:

- Primary production and community structure via chlorophyll-a concentrations in phytoplankton, annual plant harvest yield, density

and cover of aquatic plants, density of macroinvertebrates on bottom sediments and aquatic plants.

- Identification of the structure of the marsh ecosystem through species composition of the restored marshes, and comparison of those results with historical records before desiccation.
- Recognition of the monthly and seasonal changes in marsh ecosystem diversity.
- Marsh water resources quality each month.
- Annual marsh soil quality measurements.
- Estimation of decomposition rates of organic material in the marshes.
- Evaluation of the fish catches in the marshes.

Six stations were selected at different locations in the marshes. The monitoring team decided that those locations reasonably represent the ecological and environmental changes over time in the restored marshes. The site information is given in Table 1.1. To undertake the full task as designed, the following methodology was adopted. (See Appendix 6 for methods and supporting references):

- Monthly water quality included measurements of temperature (air & water) conductivity, salinity, TDS, pH, dissolved oxygen, nutrients (Total N, Total P, NO_3-N & NH_4-N), Na, SO_4-S, and HCO_3. We measured air and water temperature, DO, conductivity, salinity, pH, and TDS by using a YSI portable instrument (YSI 556MPS). Water flow and depth were measured using a Sontek instrument.
- Seasonal water quality samples were collected from the water sources of the monitored marshes and from the outlet. Water parameters measured were the same as in the monthly samples.
- Phytoplankton was gathered, using a 25 μm mesh size net, to determine the concentration of chlorophyll-a, total number of cells, and species.

- Zooplankton was collected, using a plankton net of 60 μm mesh size, to determine the major orders and number of individuals.
- Submerged and emergent aquatic plants were collected, using a 25 cm quadrat, to determine the species frequency, percentage of cover, and density.
- Macroinvertebrate samples were assessed on aquatic plants, utilizing a 25 cm quadrat. Benthos sampling was done using a grab sampler of 25 cm width.
- Fish were collected to identify species, abundance, diversity, evenness, and similarity among different marshes using several methods: (1) hiring a local fisherman with his tools (electrical device, cast net; fixed gill net), (2) using hand nets for the small specimens, and (3) purchasing supplementary samples from local fish markets.
- The numbers of bird species and individuals were counted by most of the team. Local markets were visited to monitor numbers of ducks for sale. Since the number of mammals was limited, no formal counts were done; however, the presence of species in each marsh was noted.
- A database was established to record all the data collected by different groups (tasks), and to make these data accessible and easy to utilize in future analysis.
- General observations of the prevailing ecological parameters, weather conditions, wind, numbers of fishermen, and new settlers were recorded on each sampling trip.

1.3.2 Monitored Marshes (Stations)

A total of six stations (2 in each marsh) were established at appropriate locations to provide a basis for the monthly sampling (Table 1.1). GPS readings and other details of those locations are shown in Table 1.1 and Figure 1.1.

Table 1.1. Marsh sampling locations in two restored and the natural Al-Hawizeh marsh.

Marsh	Station	GPS	Environment	Status
Al-Hawizeh	Um Alnaaj	N 31 38 30 E 47 35 21	Open Water	Natural station
Al-Hawizeh	Taraba	N 31 29 48 E 47 31 48	Dense Vegetation	Desiccated station
Suq Al-Shuyukh	Amia	N 30 51 41 E 46 38 13	Channel Water	Desiccated station
Suq Al-Shuyukh	Al-Wineas	N 39 51 50 E 46 40 42	Dense Vegetation	Desiccated station
East Hammar	Saddah	N 30 40 04 E 47 38 06	Tidal Sparse Vegetation	Natural station
East Hammar	Burkah	N 30 40 22 E 47 33 03	Tidal Open Water	Desiccated station

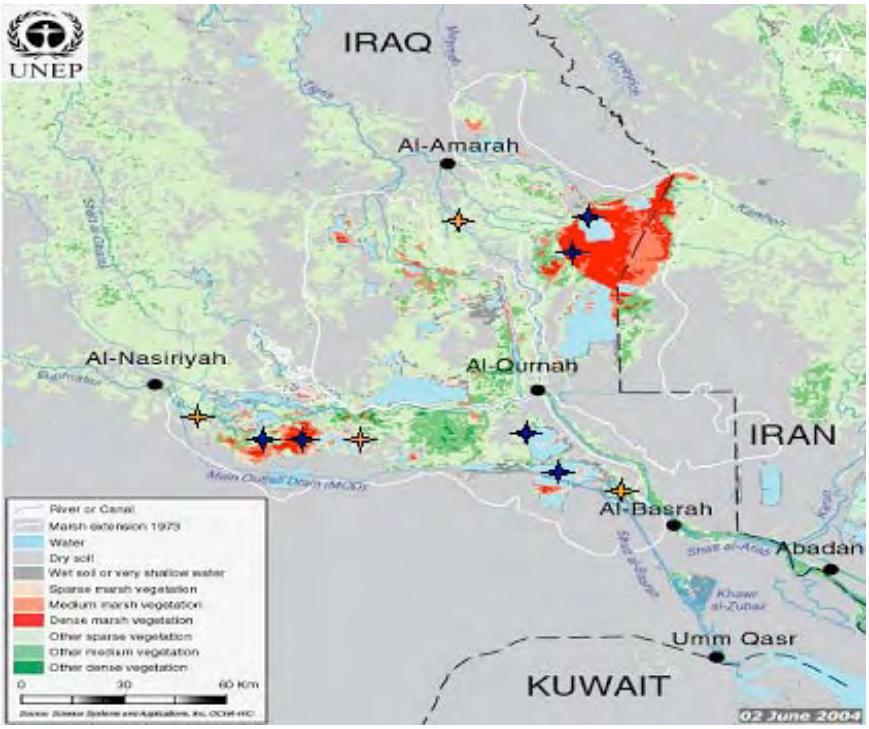


Figure 1.1. Map showing (solid black crosses) the general location of the pairs of sampling stations in Hammar marsh (East Hammar and Suq Al-Shuyukh) and the natural Al-Hawizeh marsh, and the input and output water stations (gold crosses).

Al-Hawizeh marsh: This marsh extends over the Iranian border on the west, but the major part lies in Iraq, where it is bordered on the east by the Tigris River and it's outflow waters. It was the only part of marshes to be left partly natural (undesiccated), leaving only about 10% of the total original marsh area intact. Two stations were selected for field studies and monitoring. The first was Um Alnaaj, which represents the natural environment, with open water extended to the Iranian side and several stands of *Phragmites australis* appearing like islands. Our station of record, according to GPS readings, was located at (N 31 38 30, E 47 35 21). The actual field sampling sites were further away in the marsh (green island N 31 38 31, E 47 35 21, left side N 31 38 29, E 47 35 45). The second station was Taraba, as indicated by GPS (N 31 29 48, E 47 31 48). It was 20 km south of Um Alnaaj and represented the drained marsh now shallowly reflooded (in comparison with the first station). It had heavy growth of aquatic and emergent plants (*Phragmites australis* & *Certophyllum demersum*) (Figure 1.1).

Suq Al-Shuyukh: This marsh is located south of Euphrates River, the source of its water. It had been completely desiccated, but was reflooded in April 2003. It represents the western part of the Hammar marsh. Two stations were chosen. The first was Amia station, after the union of Amia River and the marsh. Its location GPS reading is (N 30 51 41, E 46 38 13). The second station, Alwineas, was in the middle of the marsh, located at GPS reading (N 30 51 50, E 46 40 42). It was characterized by heavy growth of emergent and aquatic plants, especially *Phragmites australis* & *Ceratophyllum demersum* (Figure 1.1).

East Hammar Marsh: This eastern part of the huge original Hammar marsh receives its water from the Euphrates and Shatt al Arab Rivers. It was completely desiccated, except for the connection with the Karmat Ali River. This area was originally affected by the tidal regime of the Arabian Gulf. Two stations were chosen. The Saddah, GPS reading (N 30 40 04, E 47 38 06), represents a natural marsh environment. The second sampling station, Burkah, as indicated

by GPS reading (N 30 40 22, E 47 33 03), was previously desiccated, but is now in open shallow water with scattered *Typha domingensis* islands and the aquatic plant *Myrophyllum verticillatum* (Figure 1.1).

Marsh River Inputs (Water Source): In order to study the input water quality entering the monitored marshes, one station was selected in each marsh at the source. The Al-Hawizeh marsh water source was theTigris River at the town of Qalat Salah, GPS (N 31 31 51, E47 16 45). The Suq Al-Shuyukh marsh water source was the Al Haffar River (a tributary of the Euphrates), GPS (N 30 53 49, E46 28 03). The East Hammar's water source was the Shatt al Arab River at Karmat Ali, GPS (N 30 34 29, E 47 36 51).

1.3.3 Field Activities Schedule

Our main field activities were performed monthly, with monitoring occurring at Al-Hawizeh, Suq Al-Shuyukh, and East Hammar (2 stations in each marsh). Less intensive surveys were done as part of the monthly monitoring of water quality at the three marsh tributaries—the Tigris, Euphrates, and Shatt Al Arab Rivers.

1.3.4 Problems Encountered

Security was a problem for the sampling regimen. The threat of team members being kidnapped and held for ransom limited our activity, preventing the team from expanding its movements and taking extra samples in the marshes. Local inhabitants were suspicious about the purpose of our studies, which was not surprising, considering the horrifying events of past years. This made our activities difficult, and considerable effort was made—and much time spent—to convince them of the scientific and management aims of our studies. Minor, but limiting, problems occurred with the lack of several chemicals and of basic instruments needed to analyze of the samples.

1.4 Results and Key Findings of the Marsh Monitoring Program

1.4.1 Water Quality, Flow Rate, and Soils

The Iraq marshlands can be classified generally as oligohaline. The water quality values of each marsh depend on the water sources of either the Tigris, Euphrates, or Shatt Al-Arab Rivers. Water temperature exhibited large seasonal variations, with lowest winter temperatures about 10°C, and summer highs over 30°C—typical of the arid climate of southern Iraq. Water currents in the marshland play a substantial role, affecting light penetration through re-suspension of fine sediments.

All water parameters were found to be within ranges that would support growth of the historic main marsh species. The water of the restored marshes exhibited nearly the same quality recorded in historical times, except for higher nutrients and slightly elevated sodium at some locations. Water parameters of the monitored marshes showed the same seasonal variation as previous studies. Monitored marshes retained their role as a sedimentation sink, due to slow water currents. Water transparency remained high but not as good as in historic times. Higher nutrients support the restoration process of the marshes and improve primary productivity. Water leaving the monitored marshes was characterized by lower nutrients, indicating uptake by bacteria, phytoplankton, and macrophytes. Specific findings are:

Air and water temperature: Maximum temperature values were recorded during the summer months and lowest in winter months (Figures 1.2, 1.3). Variations in water temperature were synchronized with air temperature; again the maximum values were encountered in July and the lowest in January for all monitored stations (Figures 1.2, 1.3). All stations showed similar patterns, with minor differences in the fall of 2005. Water sources (Tigris, Euphrates and Shatt al Arab Rivers) showed the same temperature trends as the monitored marshes (figures not shown).

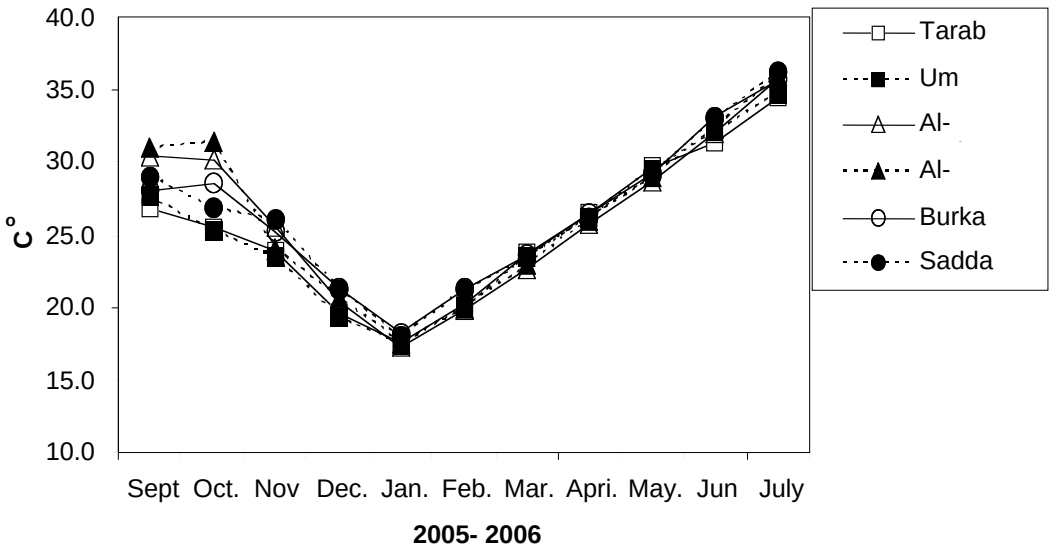


Figure 1.2. Mean monthly air temperature at study stations

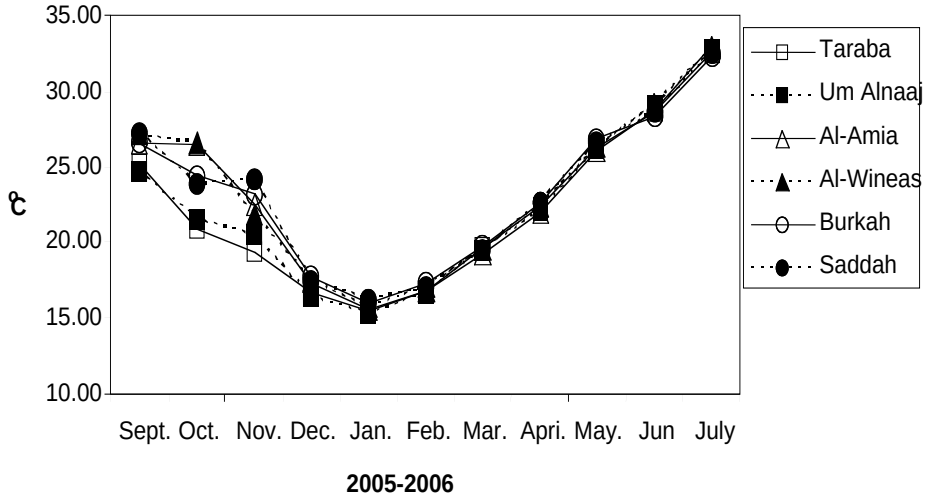


Figure 1.3. Mean monthly water temperature at study stations Sept. 2005-July 2006.

Salinity & conductivity (E.C): Monthly changes in salinity and conductivity values reveal three types of chemistry patterns. The first was that of the East Hammar, which is considered an oligohaline marsh (tidal marsh), compared to other two (Figures 1.4, 1.5). The second type appeared in Suq Al-Shuyukh

marsh, and the third was Al-Hawizeh, a fresh water marsh. These trends were similar to those noted in the 2004-2005 studies (Richardson and Hussain 2006). The water sources had salinity and conductivity values showing the same trends as the stations/marshes, except that the Euphrates in spring months had higher salinity figures (data not shown).

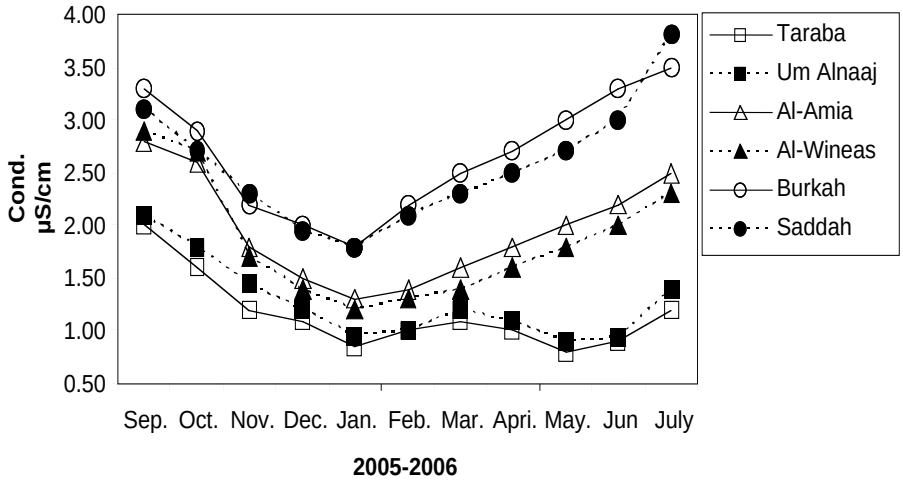


Figure 1.4. Mean monthly conductivity in study stations

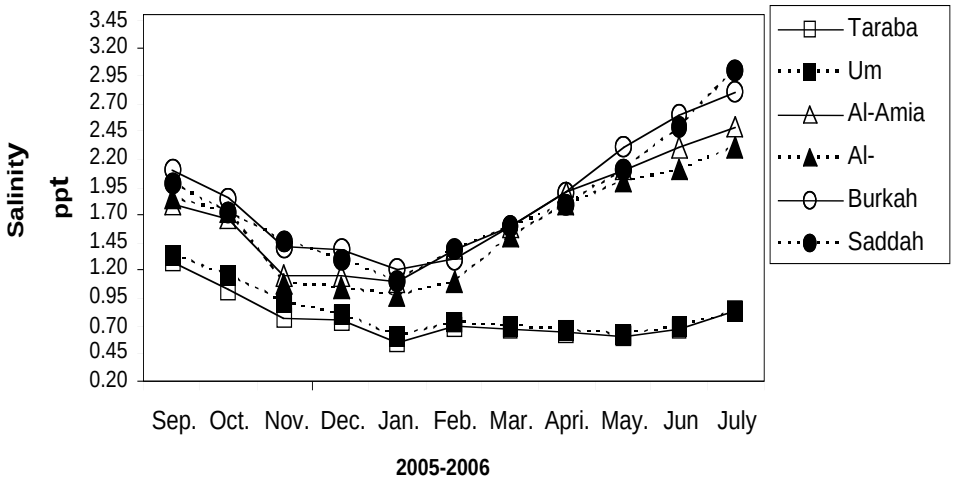


Figure 1.5. Mean monthly salinity in study stations

Total dissolved solids (TDS): The monthly changes in TDS at the Al-Hawizeh marsh stations (Um-Alnaaj and Taraba) were comparable to those of the Suq Al-Shuyukh stations (Al-Wineas and Al-Amia) (Figure 1.6). The highest values were recorded in East Hammar at the Saddah and Burkah stations. Two phases appeared, a winter-spring phase, in which the three marshes had similar low values, and the second a summer and fall phase, in which each station/marsh had its own pattern—the highest in East Hammar and the lowest in the Al-Hawizeh marsh. The Shatt Al-Arab water source had the same seasonal behavior as the three monitored marshes, with higher values in the fall and spring and lowest in the summer, while the other sources had lower input TDS values (Figure 1.7).

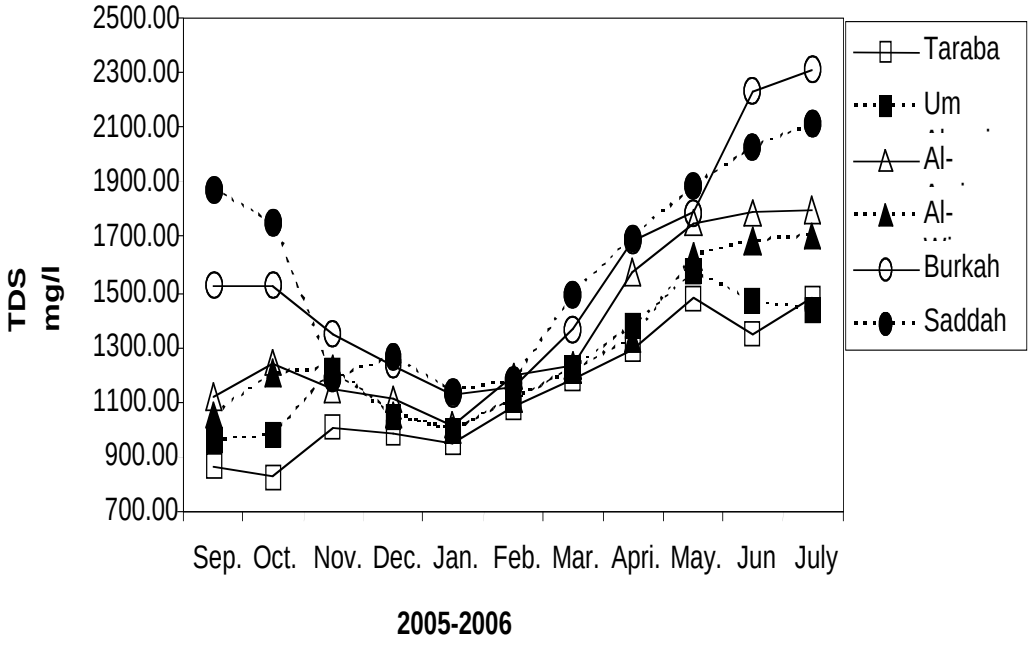


Figure 1.6. Mean monthly Total Dissolved Solids in study stations.

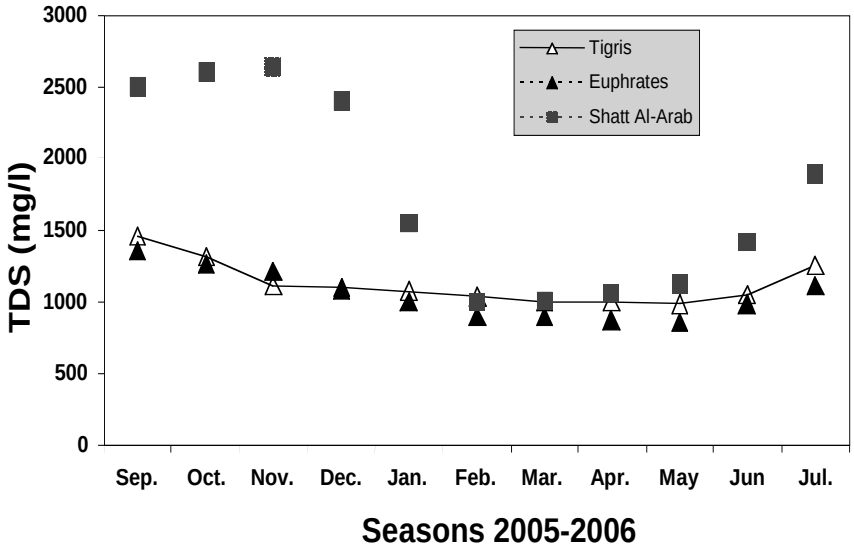


Figure 1.7. Monthly changes in TDS (mg/l) in the water quality of the sources of the monitored marshes.

Light transparency: The highest transparency value was recorded in Al-Hawizeh marsh. The lowest transparency was recorded in East Hammar, due to tidal action (Figure 1.8). In general, three patterns appeared, depending on whether the current is fast or slow at the station. The highest transparency was recorded in stations with low current, as at Taraba in Al-Hawizeh and Al Wineas in Suq Al-Shuyukh. With medium current, transparency values were intermediate in Saddah and Um Alnaaj. The highest current in Al Amia and Burkah produced the lowest transparency due to re-suspension of particles. The sources of water exhibited three modes that were different from the monitored marshes. The highest transparency was found in the Euphrates and lowest in Tigris, with the Shatt Al-Arab having intermediate values (data not shown).

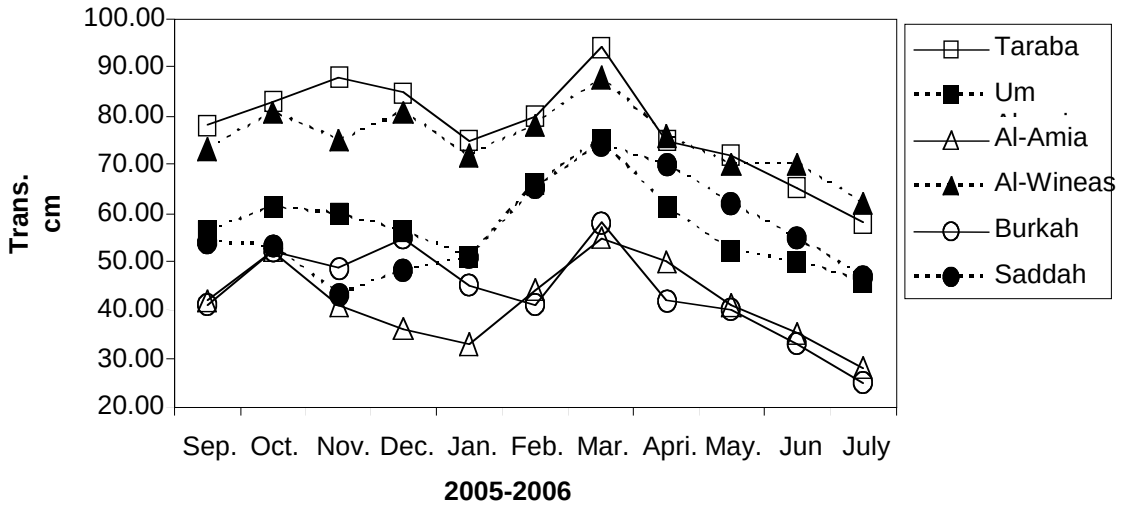


Figure 1.8. Mean monthly Transparency in study stations.

Dissolved Oxygen (DO) and Biological Oxygen Demand (BOD): All the marshes showed the same seasonal oxygen trend in water (Figure 1.9). The highest values were recorded in winter (January) and the lowest in summer (July). However, the marshes were well oxygenated, and values never dropped to less than 5 mg/l at the monitored stations. River water bodies showed a similar trend, except for the Shatt Al-Arab, which had higher values of DO than the Tigris (Figure 1.10). The lowest values were recorded during the warm period (summer and spring) and the highest in the cold seasons (winter and fall). The oxygen curves and BOD curves are inversely related with highest DO and lowest BOD in the winter. The source with the highest BOD was the Tigris and lowest the Euphrates (Figure 1.11). The marsh water sources and marshes showed a similar seasonal trend, but the marshes had the highest BOD in the summer of 2006. The Tigris and Shatt Al-Arab have slightly higher values than the marshes most of the year, but still have values that show the rivers are not polluted (Figures 1.11, 1.12).

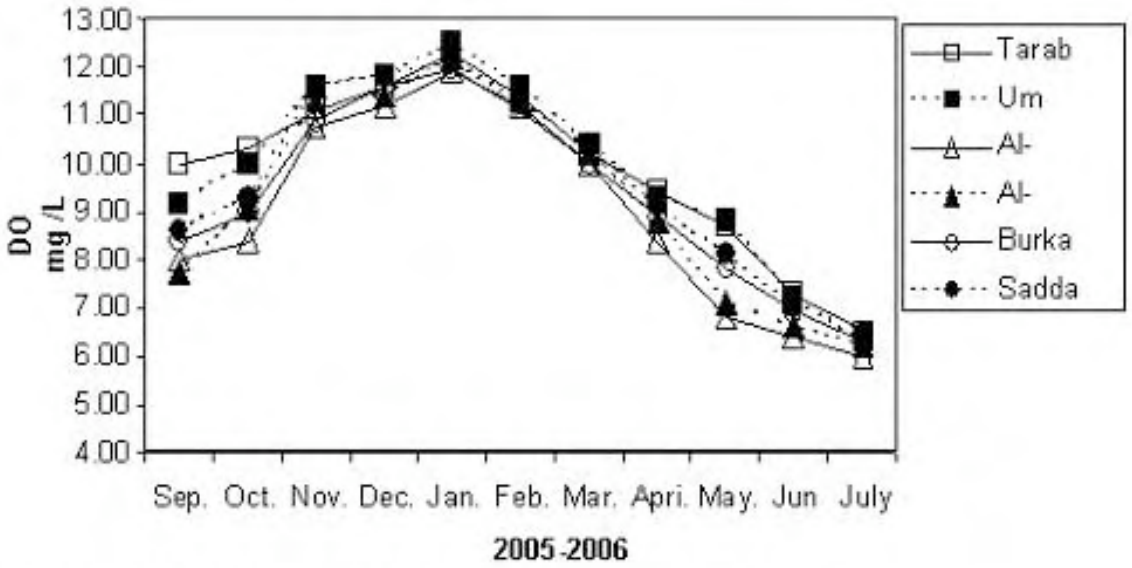


Figure 1.9 Mean monthly Dissolved Oxygen in study stations.

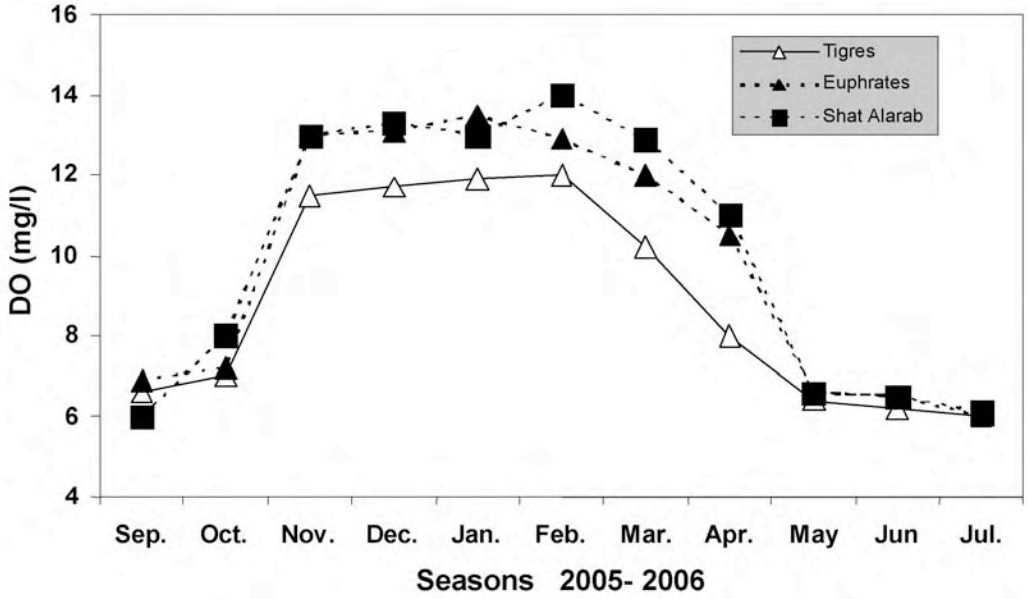


Figure 1.10 Monthly changes in DO (mg/l) in the water source of the monitored marshes.

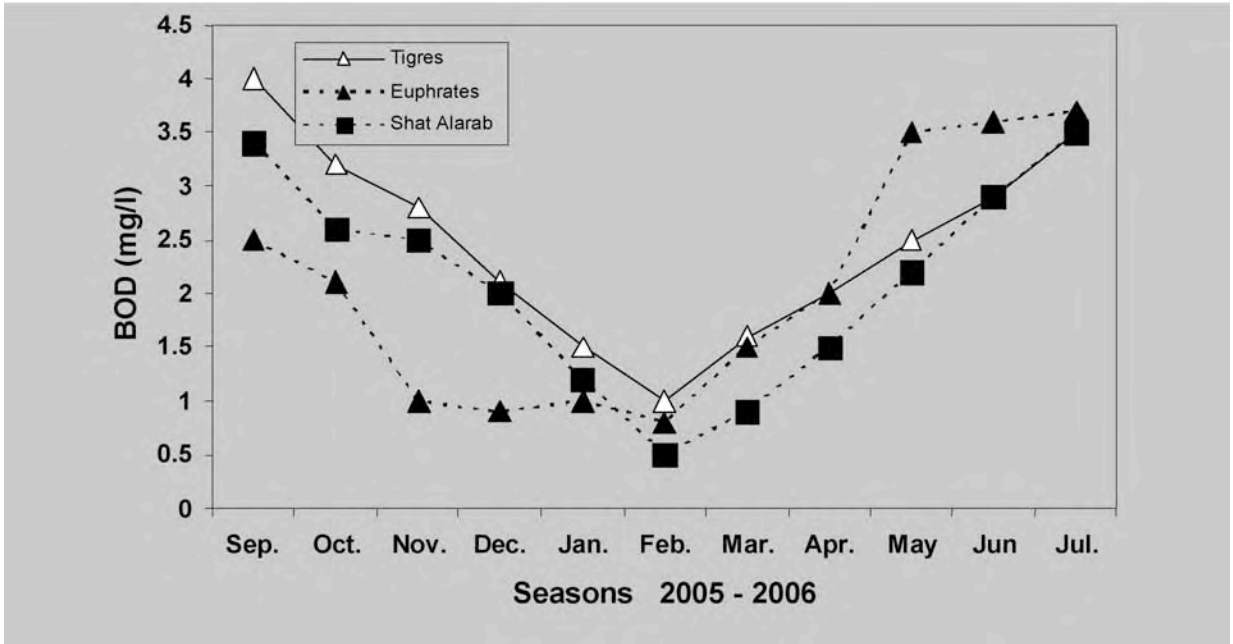


Figure 1.11 Monthly changes in BOD (mg/l) in the water source of the monitored marshes.

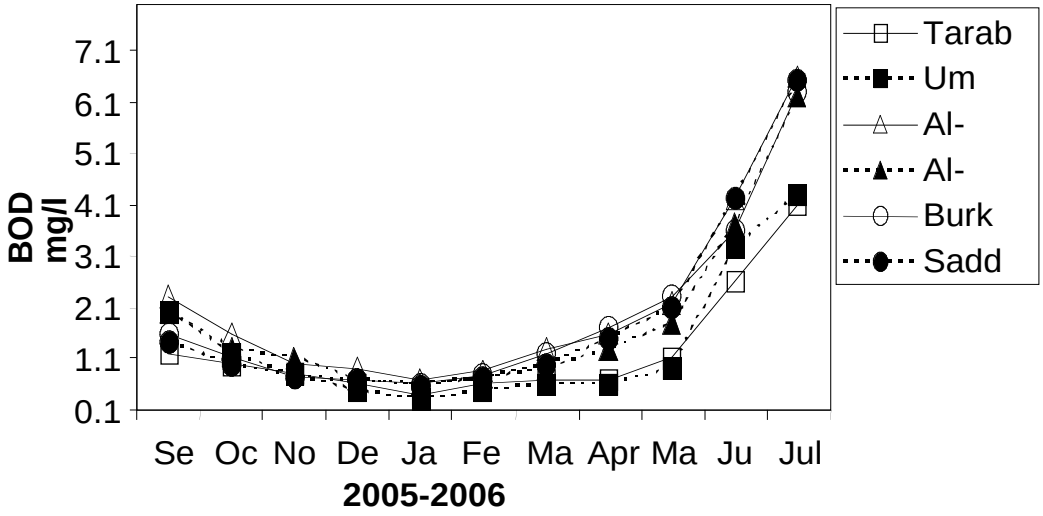


Figure 1.12 Mean monthly BOD in study stations,

Nitrate (NO_3-N) and reactive phosphate (PO_4-P): The highest values for nitrate-N were recorded during winter months and the lowest in spring (Figure 1.13). Nitrate-N values were highest in Al-Hawizeh and Suq Al-Shuyukh marshes and lowest in the East Hammar (Figure 1.13). Riverine sources of marshes illustrated more dramatic seasonal changes (Figure 1.15). In general, the highest values were recorded during summer months and the lowest in spring. Water sources showed the same seasonal trend with some differences, especially that of Tigris had higher values of NO_3-N (> 29 mg/L) during the summer of 2006, while the Shatt-Al-Arab and Euphrates exhibited values nearly 50% lower. The highest values for phosphate were recorded in East Hammar during winter months and the lowest were recorded in Al-Hawizeh marsh. Suq Al-Shuyukh values were in between (Figure 1.14). Phosphate concentrations were higher in the winter and lowest in the early spring when plants and algae are growing and taking up PO_4-P from the water column. The river sources for the marshes illustrated more dramatic seasonal changes in both nitrate and phosphate (Figures 1.15, 1.16).

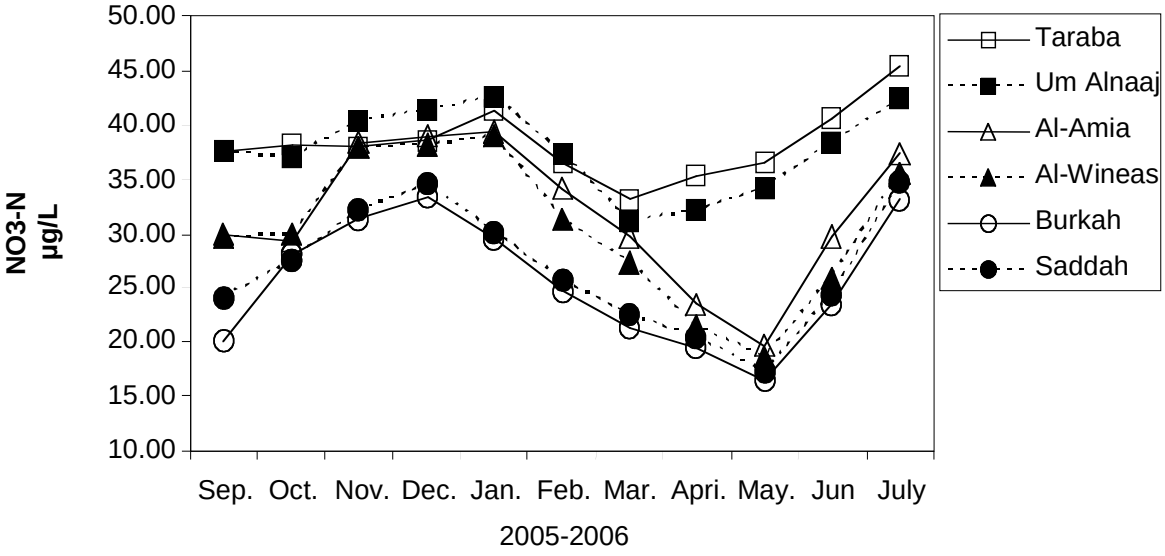


Figure 1.13. Mean monthly concentrations of nitrate in study stations.

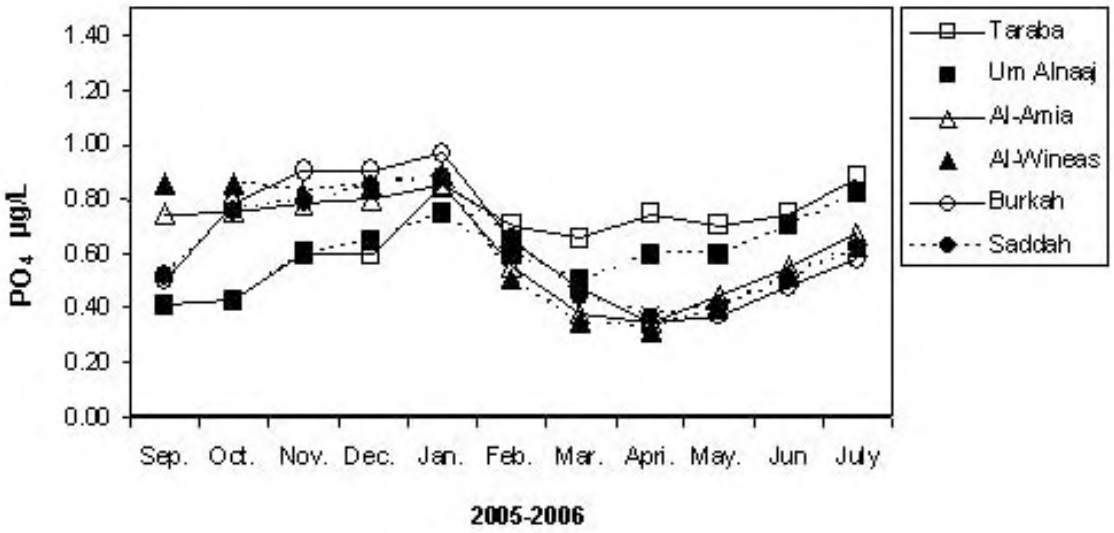


Figure 1.14 Mean monthly values of reactive phosphate in study

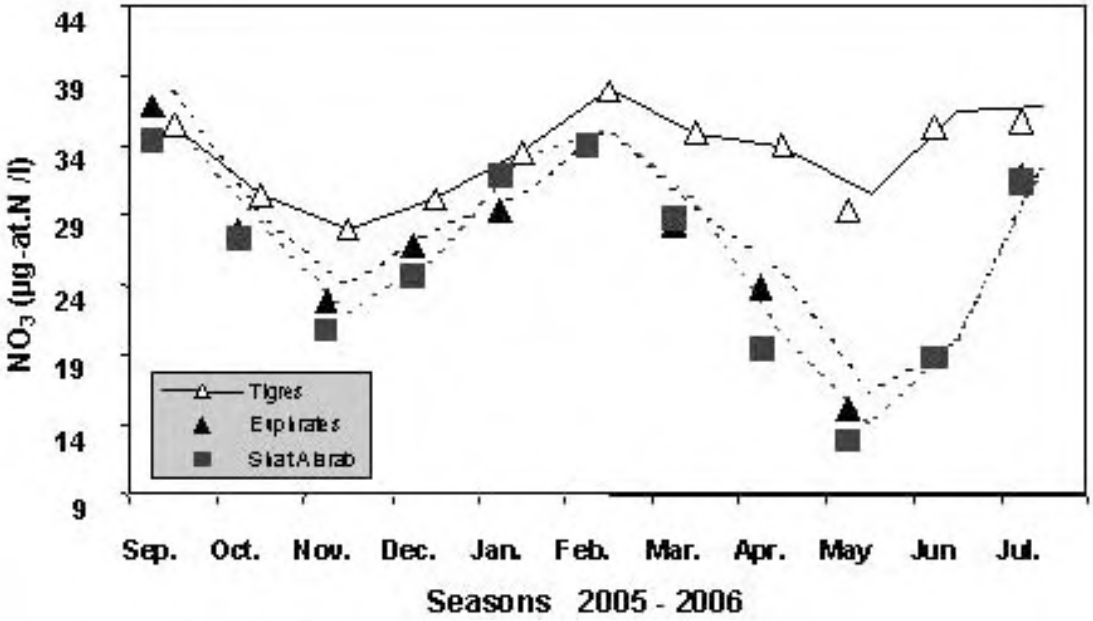


Figure 1.15 Monthly changes in Nitrate quality of the sources of the monitored marshes.

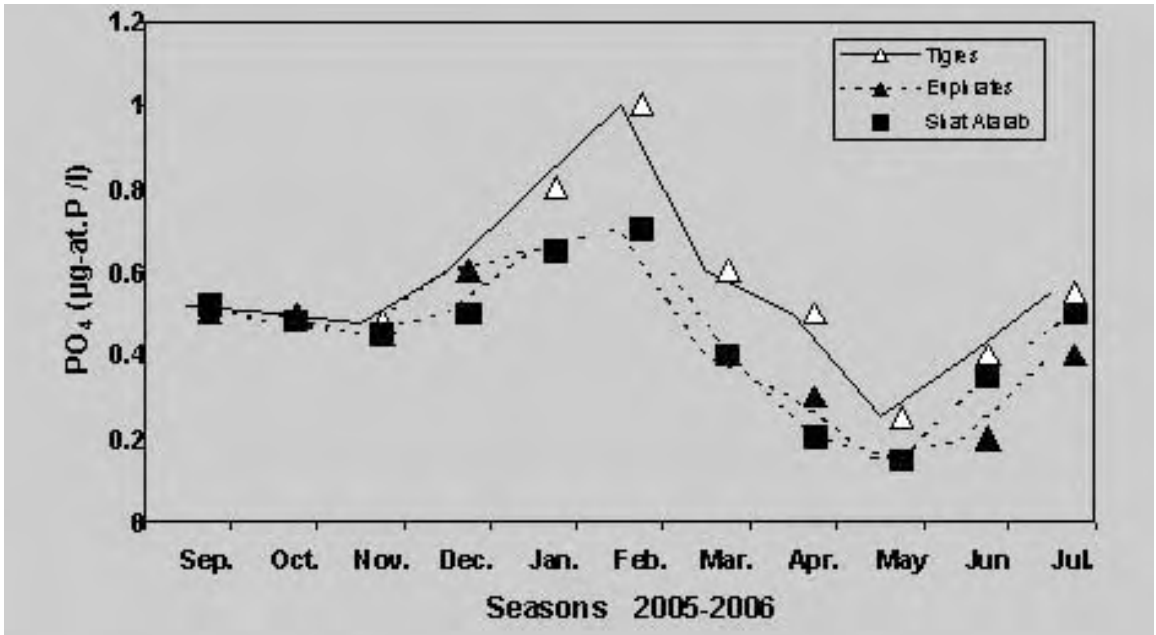


Figure 1.16 Monthly changes in PO_4-P in the Water quality of the sources of the monitored marshes.

Total Nitrogen (TN) and Ammonium (NH_4): Monthly values show a slight winter increase in TN in all marshes, with concentrations being slightly higher at Al-Hawizeh. The lowest values were recorded in East Hammar (Figure 1.17). Total N values decreased in the spring in all marshes, with Al-Hawizeh maintaining slightly higher values. In contrast, ammonium values were low most of the year and increased in the summer of 2006 (Figure 1.18). Monthly values were comparable in all monitored marshes (stations). The Tigris River source displayed the largest amount of TN, with peaks in the fall and summer. The highest values of ammonium in the river sources were in the summer and fall seasons, and the lowest in the winter months (Figure 1.20). The sources of water to marshes did not display the same exact patterns as the those of the monitored marshes.

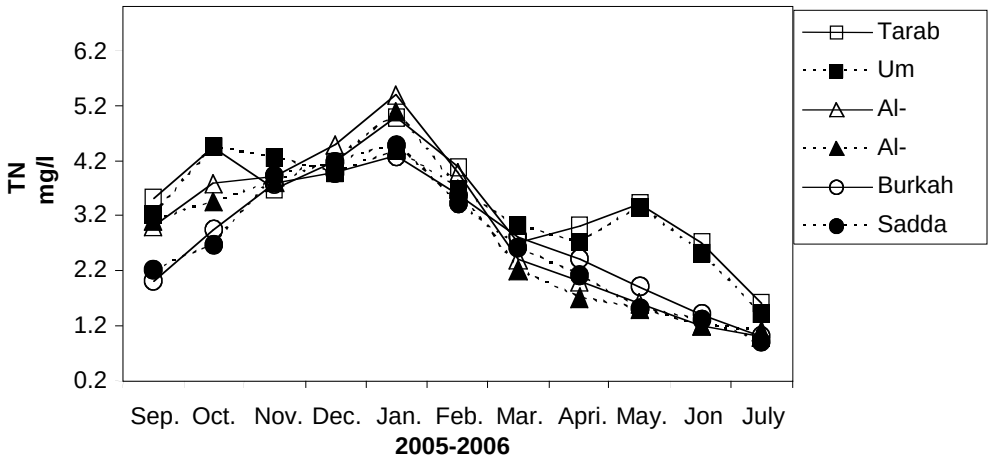


Figure 1.17. Mean monthly values of Total N in study stations.

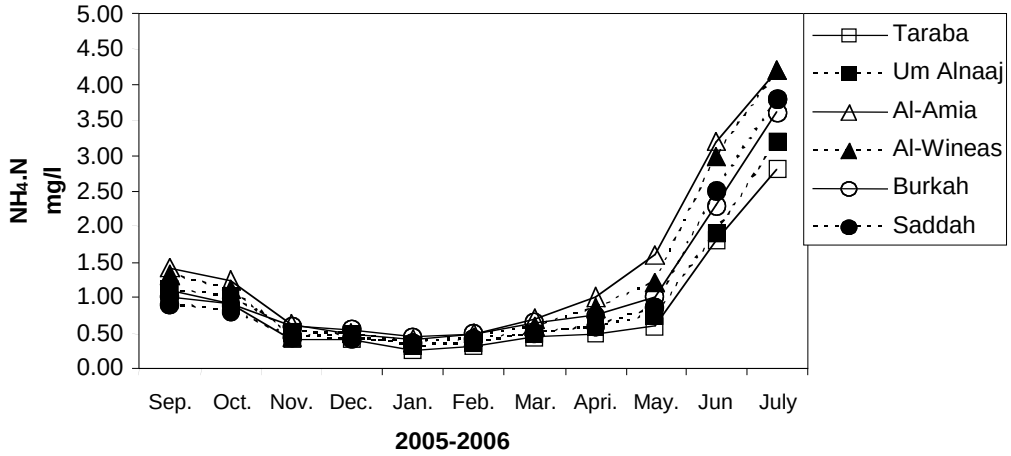


Figure 1.18. Mean monthly values of Ammonium in study stations.

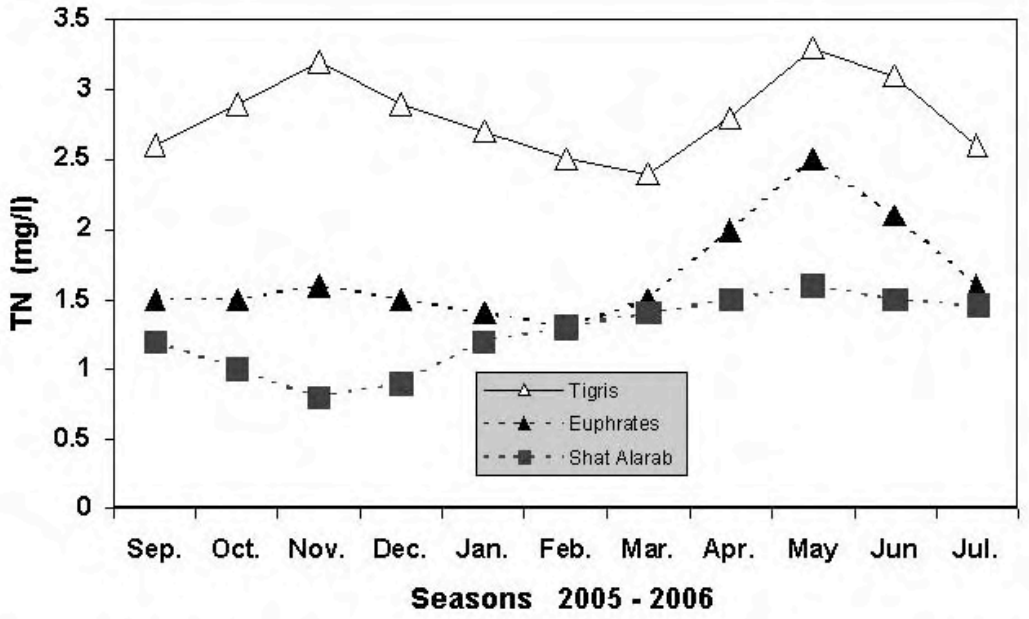


Figure 1.19 Monthly changes in TN in the Water quality of the sources of the monitored marshes.

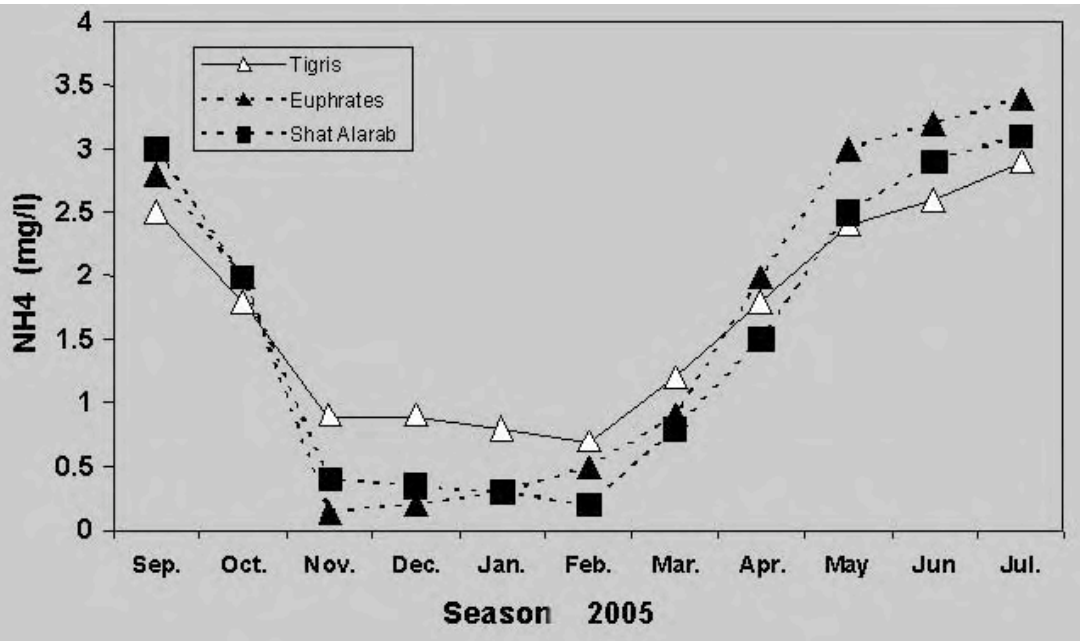


Figure 1.20 Monthly changes in the Water quality of the sources of the monitored marshes.

pH and total alkalinity: Two levels of monthly changes in pH were recognized, the first being slightly higher alkaline values in East Hammar and the second representing lower values in Al-Hawizeh marsh (Figure 1.21). These values represent the amounts of dissolved CO_2 and bicarbonate in the waters. Higher HCO_3^- (alkalinity) values occur in summer months in the marshes (Figure 1.22). Water sources for the marshes presented the same general pattern for pH and alkalinity as the marshes (Figures 1.23, 1.24). The Tigris River had the highest HCO_3^- values, which peaked in the winter months (Figure 1.24).

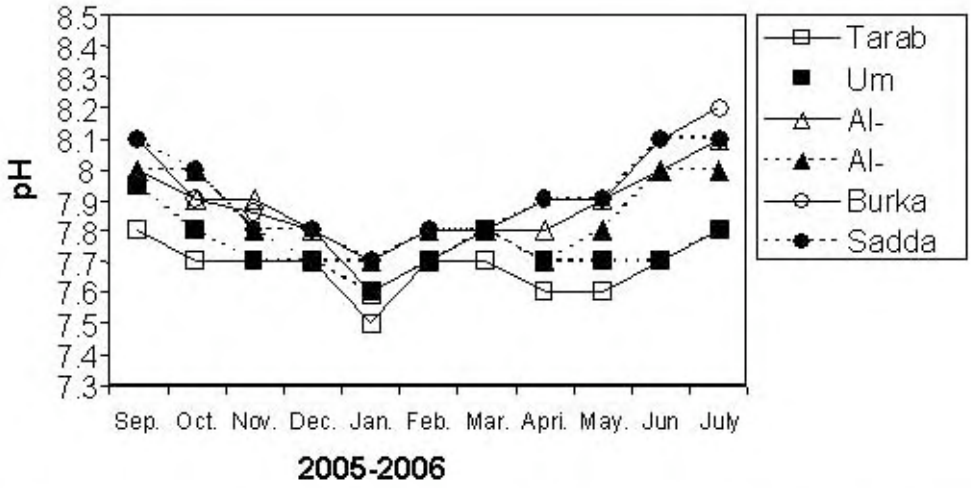


Figure 1.21. Mean monthly values of pH in study stations

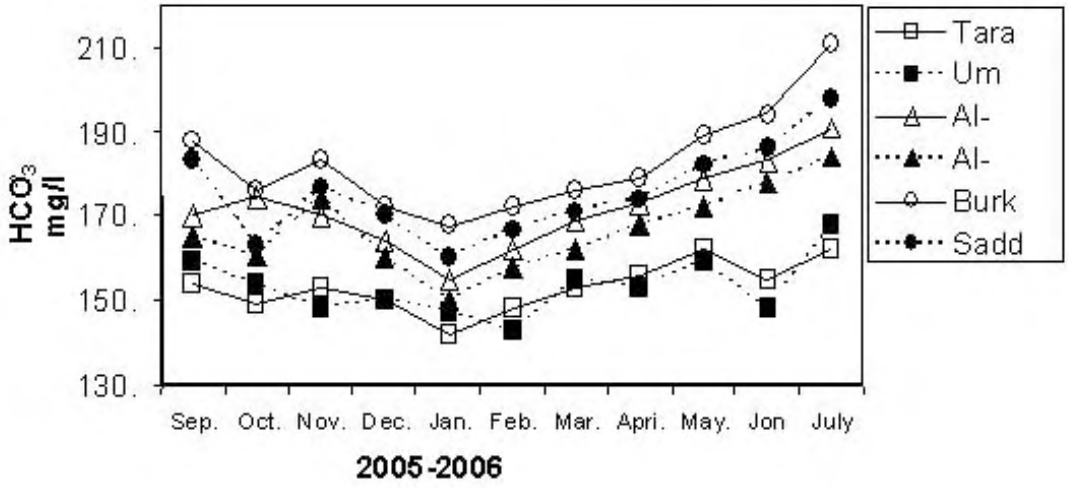


Figure 1.22. Mean monthly values of HCO_3^- in study stations.

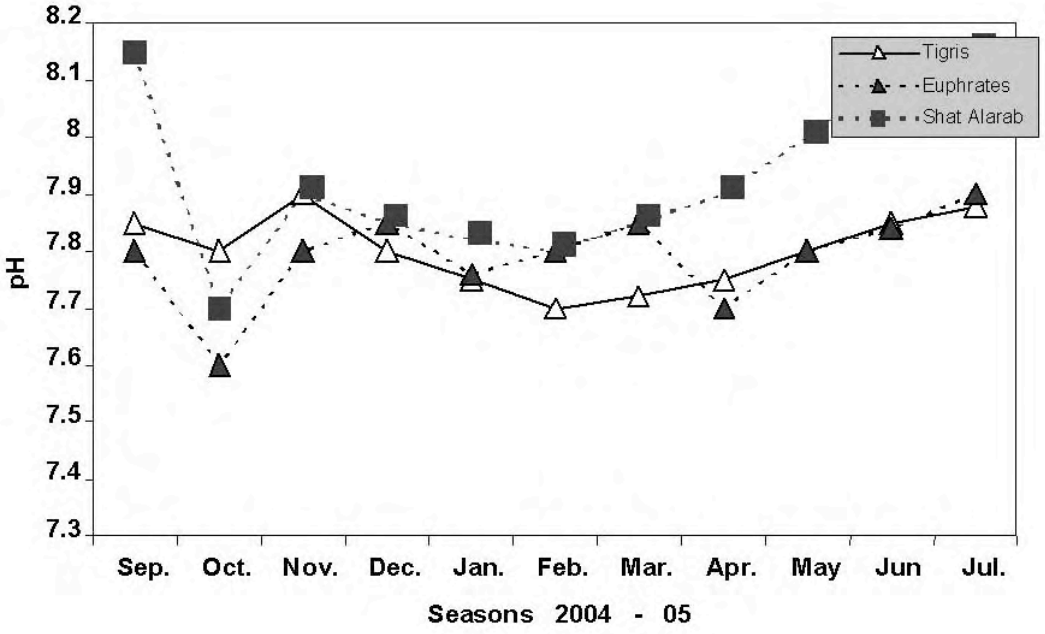


Figure 1.23. Monthly changes in pH in the water sources of the marshes.

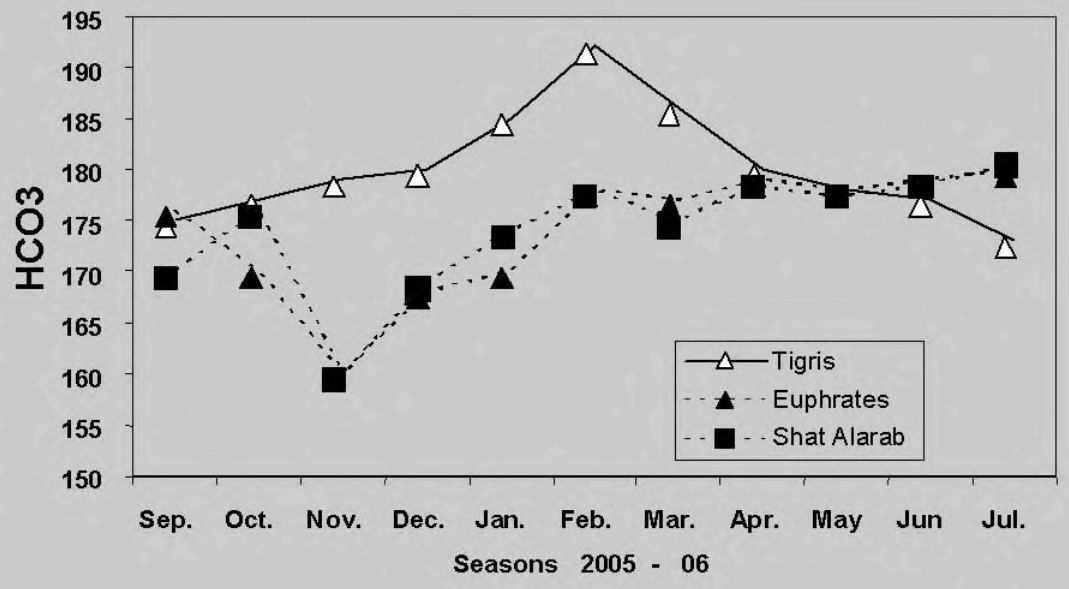


Figure 1.24. Monthly values of the water sources of the monitored marshes.

Sodium (Na) and sulphate (SO_4): Monthly values of sodium were highest in East Hammar and lowest in Al-Hawizeh (Figure 1.25). In general, lower values occurred in the winter and higher concentrations in the summer. Riverine waters showed a slight increase in peaks (spring/summer months) as compared to lower values in the fall (Figure1.26). Sulfate concentrations were highest in East Hammar due to the influence of Persian Gulf water inputs (Figure 1.27). Sulfate values varied little over the year and Al-Hawizeh and Suq Al-Shuyukh had similar values. Sulfate concentrations were highest in the Shatt Al-Arab, due to the tidal influence, and peaked during the winter months (Figure 1.28). The sulfate values were lowest in the Tigris River.

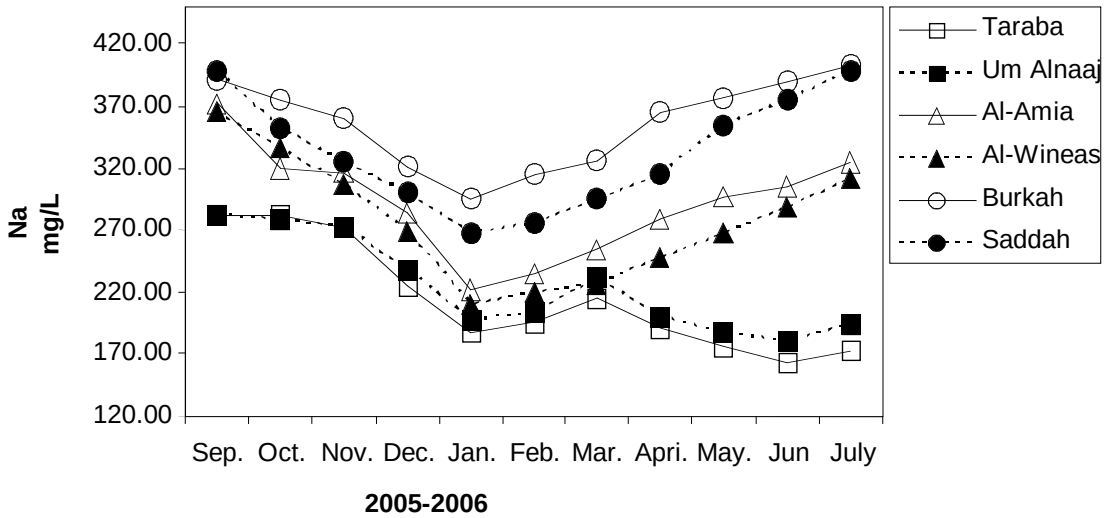


Figure 1.25 Mean monthly values of sodium in study stations.

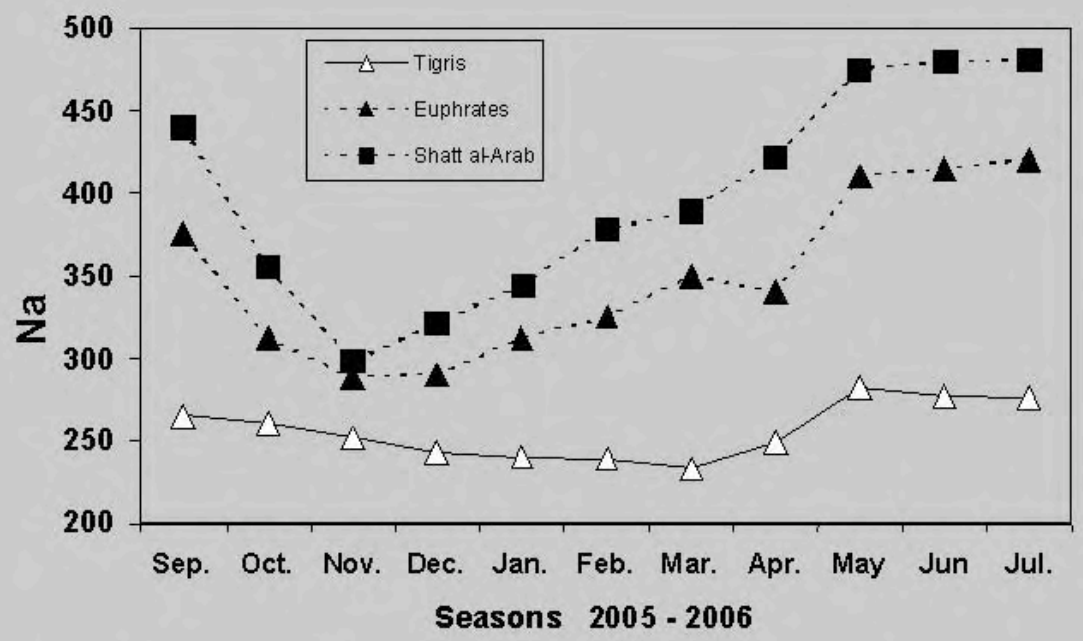


Figure 1.26. Monthly changes in Na (mg/l) in the Water quality of the sources of the monitored marshes.

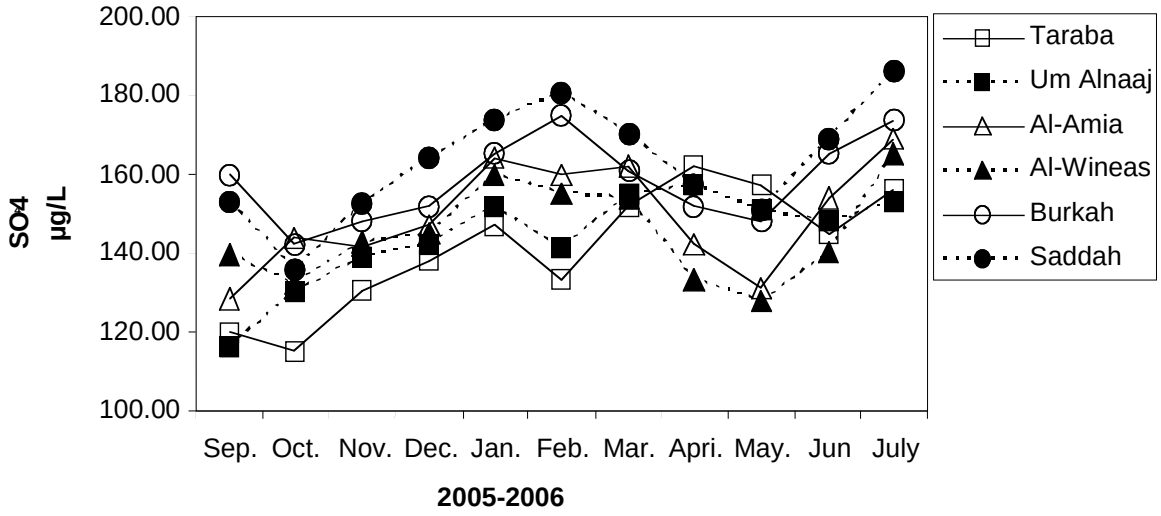


Figure 1.27. Mean monthly values of sulphate in study stations.

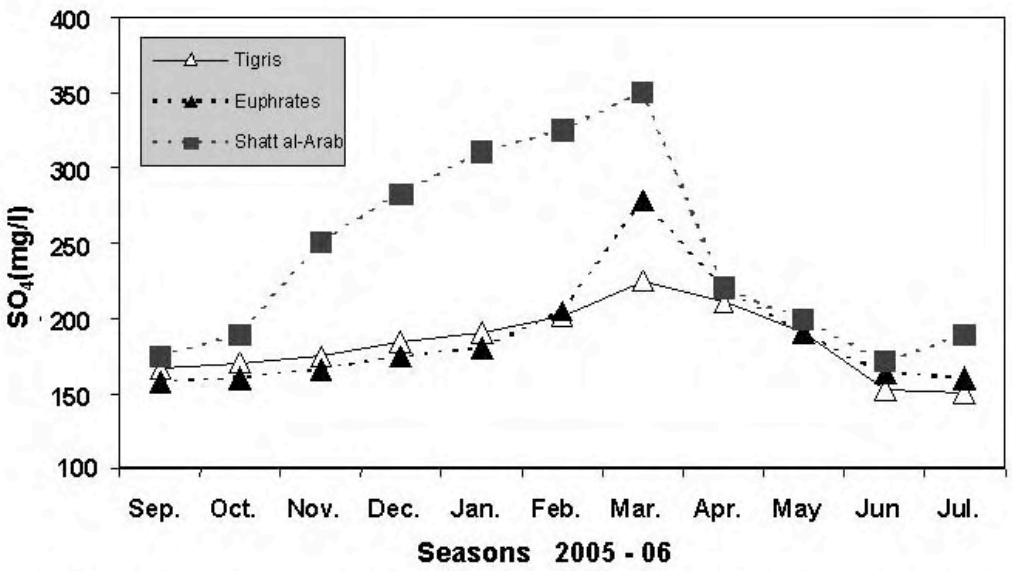


Figure 1.28. Monthly changes in quality of the sources of the monitored marshes

Mean of Flow rate (cm/sec.): The flow rate values of monitored marshes revealed two trends, with the highest flows in the East Hammar and the lowest in the Suq Al-Shuyukh. Highest values for all stations were recorded during autumn, and the lowest in the summer months (Figure 1.29).

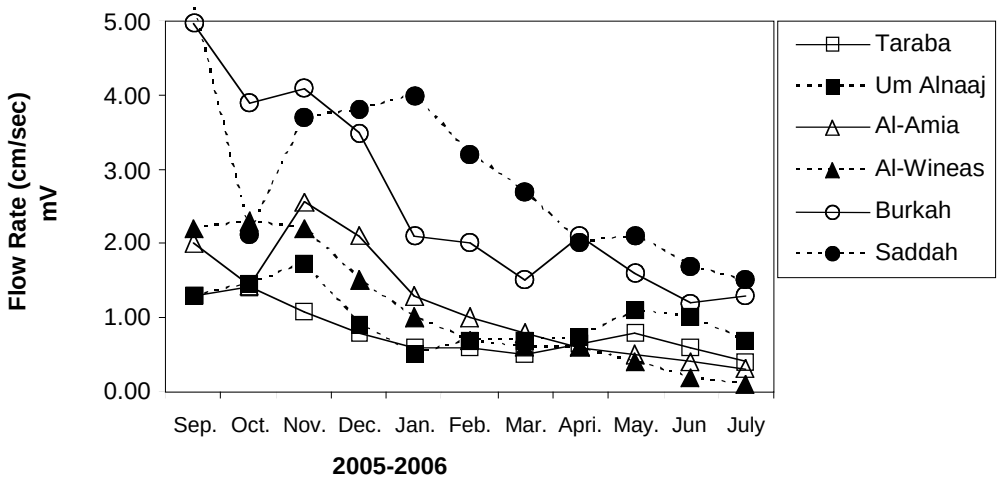


Figure 1.29. Mean monthly flow rates in study stations.

N:P ratio: The N:P ratio for water was estimated for the three monitored marshes, as shown in Figures 1.30, 1.31, and 1.32. Al-Hawizeh marsh had the highest means ratio, 25.5; Suq Al-Shuyukh and East Hammar marshes were lower, with 19.7 and 19.3, respectively. These ratios suggest that all three marshes are P limited according to the classic Redfield ratio (Wetzel 1983).

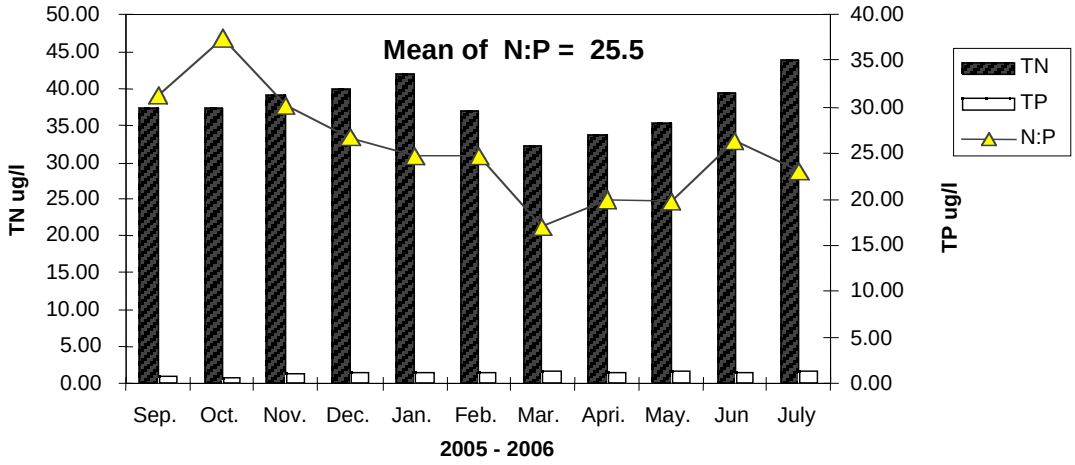


Figure 1.30. N:P Ratio in AL-Hawizeh marsh

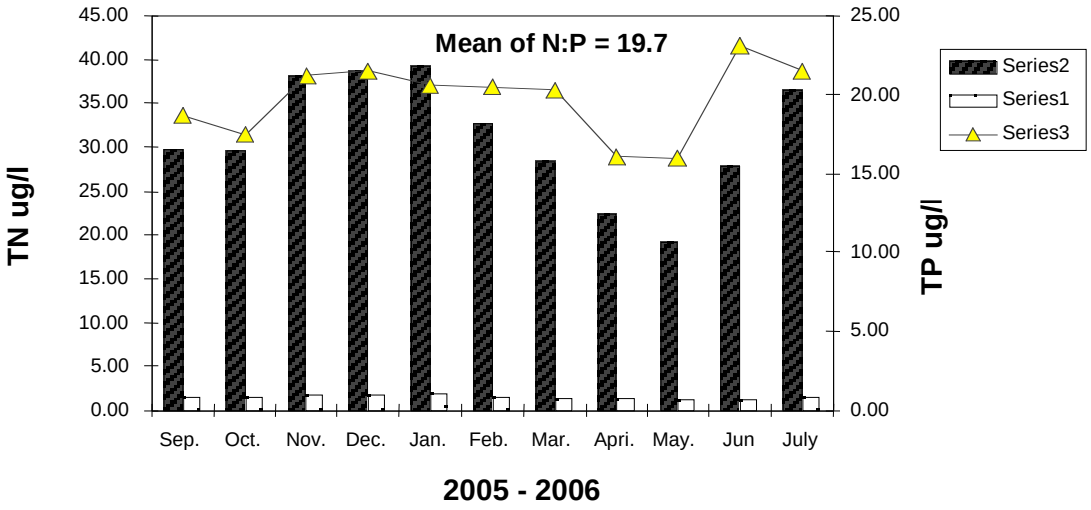


Figure 1.31. N:P Ratio in Suq Al-Shuyukh

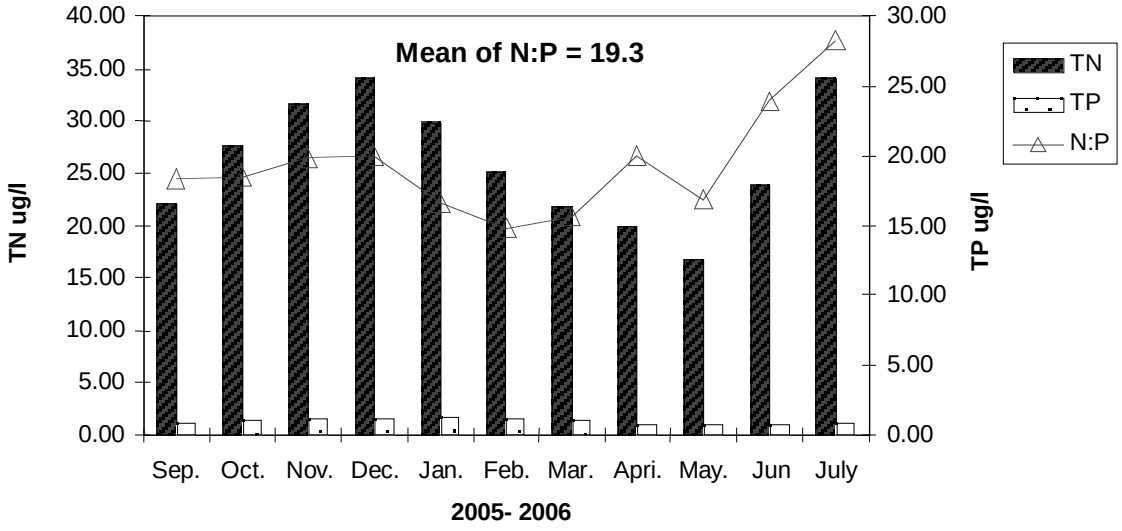


Figure 1.32 N:P Ratio in East Hammar marsh

1.4.2 Soil Analysis

Soil analysis: Three types of soil texture–silt-clay, sandy-clay, and clay–were found in the three monitored marshes (Table 1.2). Al-Hawizeh was dominated by silt-clay sediments, East Hammar by clay soils, and Suq Al-Shuyukh by sandy-clay soils. The total organic carbon (TOC) was highest in Al-Hawizeh and lowest in East Hammer, although all values were low. East Hammer had virtually no organic matter in the top sediments. pH values were nearer neutral in Al-Hawizeh marsh and slightly alkaline in East Hammer and Suq Al-Shuyukh marshes. Soil conductivity was lowest in Al-Hawizeh and highest in East Hammer Marsh. These conductivities followed the amount of fresh versus saltwater sources of inputs for Al-Hawizeh and East Hammar, respectively.

Table 1.2. Comparison of soil texture, pH and conductivity in sediments of study marshes taken during 2005-2006

EC (mS/cm^2) (SD±)	pH (SD±)	TOC % (SD±)	Type of sediment	Station
2.0 – 1.2 0.5	7.7 – 7.7 0.0	2.8 – 3 0.14	SILT-CLAY	Um-Alnaaj
2.2 – 1 0.8	7.7 – 7.5 0.14	3 - 3.1 0.07	SILT-CLAY	Taraba
4.3 – 4.0 0.21	7.9 – 8 0.07	2.1 – 2.6 0.35	SAND-CLAY	Al-Wneas
4.2 – 3.9 0.21	7.9 – 8 0.07	1.3 – 1.7 0.28	SAND-CLAY	Al-Amia
5.3 – 5.5 0.14	8 – 8.2 0.14	0.7 – 0.85 0.10	CLAY	Saddah
5.5 – 5.6 0.07	8 – 8.2 0.14	1.2 – 1.3 0.07	CLAY	Burkah

1.4.3 Phytoplankton

Chlorophyll-a concentrations showed a bimodal pattern in all stations of the three monitored marshes. The highest peaks occurred in spring (May) and a second smaller peak in autumn (October). The lowest values in general were in winter (January). The highest value of chlorophyll-a during spring bloom was recorded from East Hammar marsh at the Burkah station. Um Alnaaj station in Al-Hawizeh marsh showed a different pattern, with the highest peak in the autumn bloom (October) and the lowest peaks in winter (January) (Figure 1.33). Primary productivity was estimated by using measurements of dissolved oxygen and converting these to C fixed for summer months (June, July, August). Values averaged 420, 250, and 207 $mgC/m^2/h$, respectively. Values demonstrated a decline in phytoplankton production as the summer progressed.

Monthly variations in chlorophyll-a concentrations from June 2004 to July 2006 exhibited a winter-summer trend of high values in the summer months and lowest values in the cooler winter period (Figure 1.37). The pattern was clearly repeated each year, with highest chlorophyll values recorded at um Alnaaj in the Al-Hawizeh marshes and lowest values at Al Wineas in Suq Al-Shuyukh. Of interest in the long-term trend was the great increase in chlorophyll-a concentrations in the restored East Hammar by summer 2006, the highest values recorded in that year.

The number of phytoplankton cells revealed monthly variations, with a major peak in spring (May) and the lowest values in winter (January). The second smaller peak was in autumn (October). This was true for all monitored stations. The highest number of cells was recorded from Burkah station in East Hammar marsh and the lowest in Al Wineas in Suq Al Shuyukh (Figure 1.35).

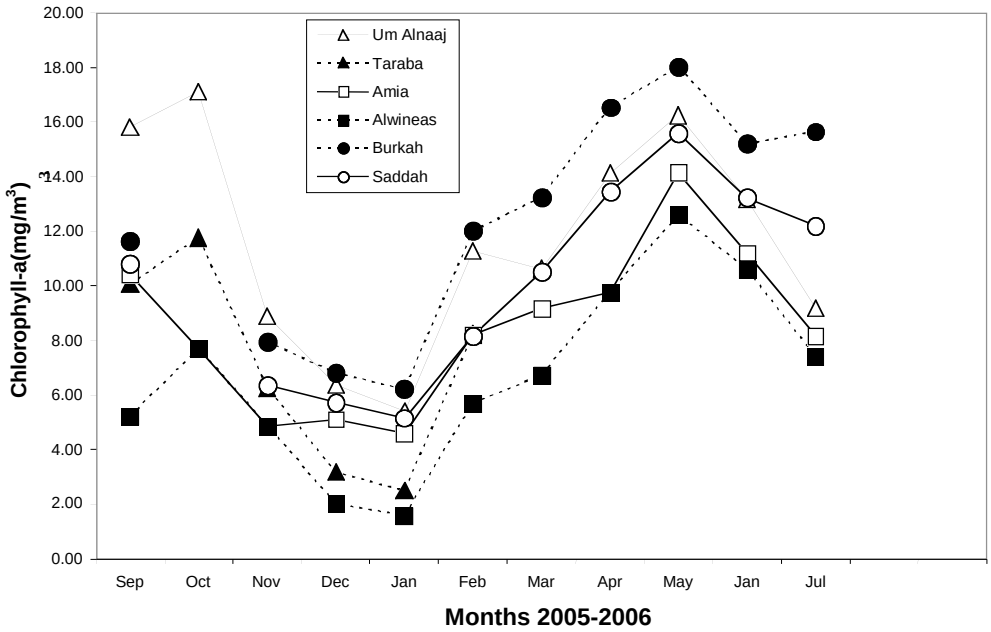


Figure 1.33. Monthly variations of chlorophyll-a in Al-Hawizeh, Suq Al-Shuyukh Hammar marshes

Figure 1.34. An Iraqi scientist collects phytoplankton samples.

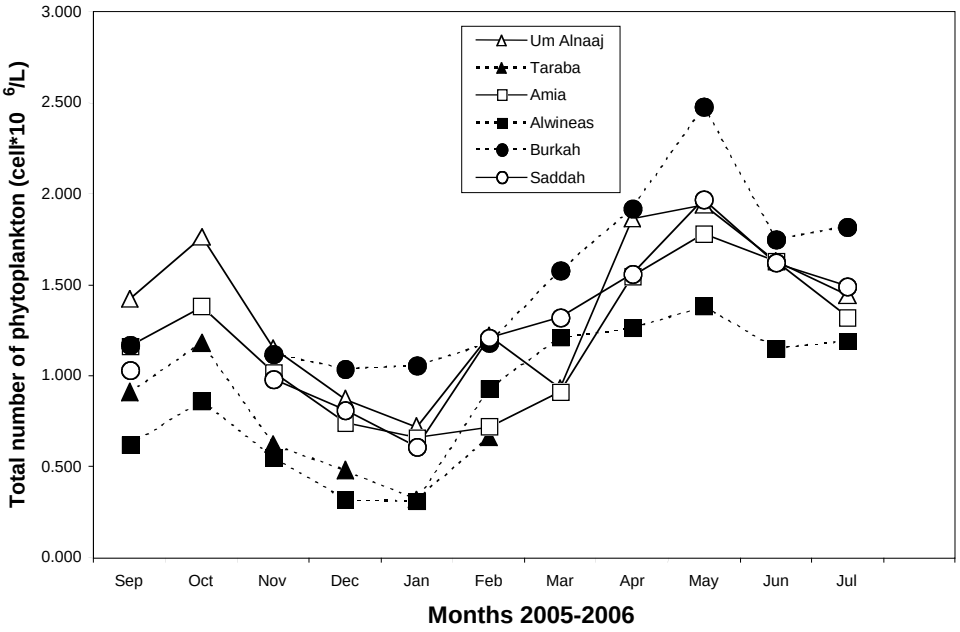


Fig 1.35. Monthly variations in total number of phytoplankton in Huwayzah Alshuyukh and East Hammar marshes

Phytoplankton groups in all the marshes were dominated by diatoms (*Bacillariophyta*), which–with 81 taxa–represented 58.3% of total phytoplankton. The majority belonged to Pennales (93.8%) and Centrals (6.2%), followed by green algae (*Chlorophyt*a) at 20.15% with 28 taxa, then blue green algae (*Cyanophyta*) at 15.1% with 21 taxa, euglena (*Euglenophyta*) at 2.9% with 4 taxa, golden algae (*Chrysophyta*) at 1.45% with 2 taxa, and one taxa of red aglae (*Rhodophyta*) in all monitored marshes. The same was true for all stations (Figure 1.36).

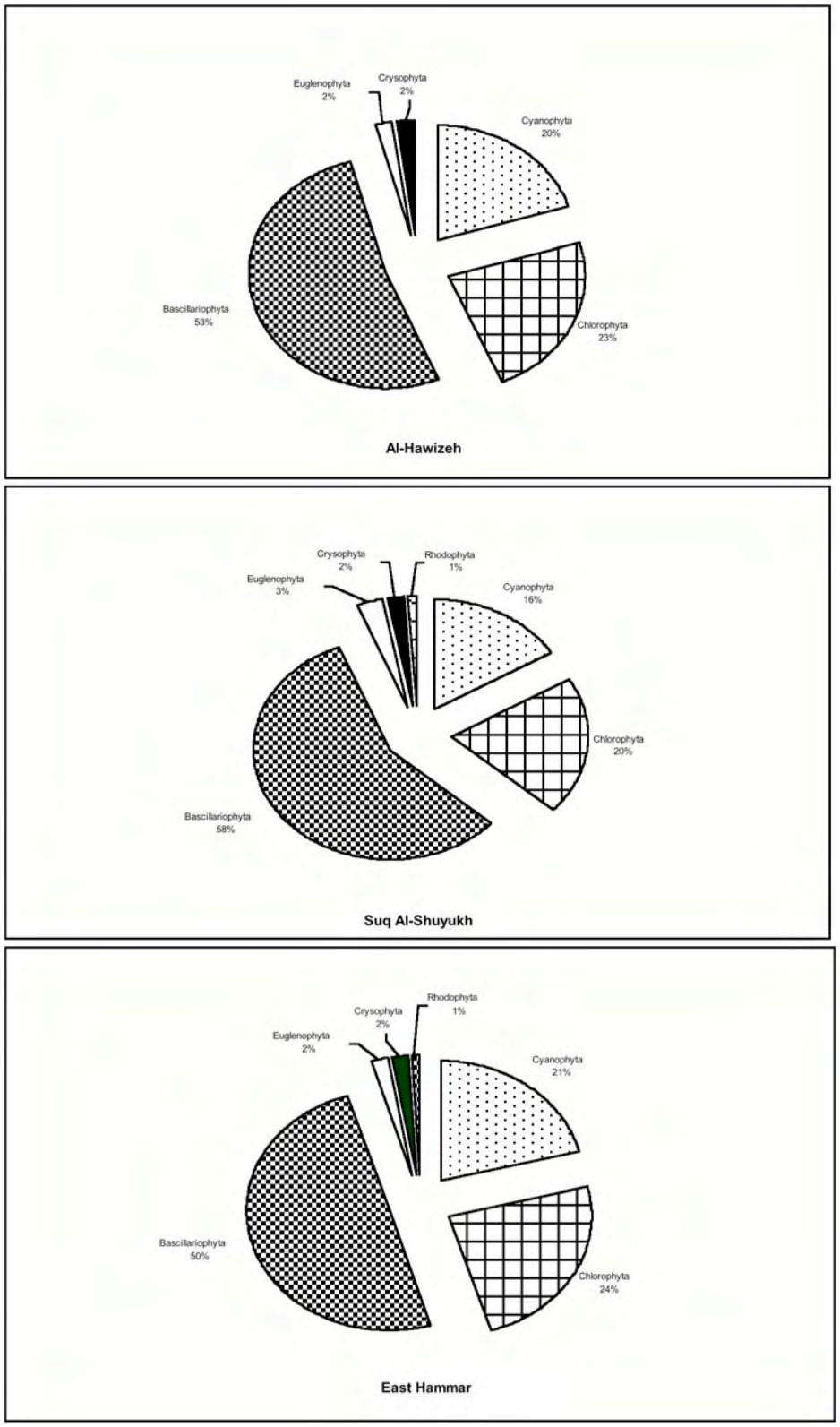


Figure 1.36. Percentage of phytoplankton groups in the two restored marshes of East Hammar and Suq Al-Shuyukh and the natural Al-Hawizeh in 2005-2006

Monthly variations in total number of phytoplankton cells for the last two years of the monitoring (June 2004 to July 2006) had a pattern similar to that of chlorophyll-a (data not shown). Two peaks were detected in 2005 and again in 2006, with the largest peak occuring in May both years.

Assessment of average chlorophyll-a indicated that Burkah, Um Alnaaj, Saddah, and Amia were eutrophic, while other stations were mesotrophic. Peak chlorophyll-a concentrations indicate that Burkah and Um Alnaaj were mesotrophic and the others oligotrophic (Table 1.3).

Table 1.3. Assessment of studied marsh stations trophy on basis of chlorophyll-a (according to Zalewski *et al.*, 2004)

Parameter	Stations	Oligotrophic<2.5	mesotrophic2.5-8.0	Eutrophic8.0-25	Hypertrophic>25
Average chlorophyll-a (μg/l)	Um Alnaaj			*	
	Taraba		*		
	Alamia			*	
	Alwineas		*		
	Burkah			*	
	Saddah			*	
	Stations	Oligotrophic 4.2-16.1	mesotrophic 16.1-42.6	Eutrophic42.6-500	Hypertrophic>500
Chlorophyll-a (peak concentration) (μg/l)	Um Alnaaj		*		
	Taraba	*			
	Alamia	*			
	Alwineas	*			
	Burkah		*		
	Saddah	*			

Table 1.4. Comparison between the chlorophyll-a, total of phytoplankton and number of species in the present study and the historical data.

Chlorophyll-a (mg/m^3)	Total number of phytoplankton ($cell*10^6/l$)	Number of species	Location of study	References
-	0.044 - 0.15	68	East Hammar Marsh	Maulood *et al.,* (1981)
0.14 - 22.18	0.3 - 21.717	-	Qurna Marsh	Al-Zubaidi (1985)
0.15 - 8.46	0.839 - 17.052	113	East Hammar Marsh	Al-Laami (1986)
0.24 - 10.7	0.309 - 4.021	-	East Hammar Marsh	Al-A'argy (1988)
		129	Qurna Marsh	Pankow *et al.*,(1979)
		178	Brakish water of southern Iraq	Hinton and Maulood *etal*,.(1980,1982)
	0.00043-0.01856	149	Samarra Reservoir	Al-Lami *et al.*,(1996)
0.28-68.5	0.15-521.25	126	Al-Qadisia Lake	Kassim *etal.*,(1999)
		169	Tigris and Euphrates rivers	AL-saadi *et al* ., (1999)
>0.4 - <7.5	>1 - <16.5	103	East Hammar Marsh	Al-Saadi and Al-Lami (1992)
2.51-16.26	**0.32-1.94**	**94**	**Al-Hawizeh Marsh**	**Present study in 2005- 2006**
1.6-14.16	**0.31-1.78**	**98**	**Suq Al-Shuyukh Marsh**	
5.16-18.04	**0.61-2.48**	**104**	**East Hammar Marsh**	
Recovery index of Al-Hawizeh's phytoplankton species =**91.04%**				
Recovery index of Suq Al-Shuyukh's phytoplankton species =**94.91%**				
Recovery index of East Hammar's Phytoplankton species = **100.72%**				

Note: The mean of number of species for historical data = (68+113+129+103)/4=103.25)

Comparisons of the present results for chlorophyll-a, total number of cells, and number of species with historical data indicate that the recovery is well under way. Comparing recent figures with an index of species historically present shows that 100% of species have returned to East Hammar and 94% to Al-Hawizeh (Table 1.4).

Spatial differences in phytoplankton species occurence were as follows: Al Hawizeh–94 total species; Suq Al-Shuyukh–98 total species; East Hammar–104 total species. Many species were found in only one of the three marshes (Appendix 1). A few genera were represented by higher numbers of species, such as *Nitzschia* (16 species), *Navicula* (9), *Fragiralira* (6) *and Cymbella* (5). Twelve genera occurred throughout the monitoring period, while others occurred seasonally (Appendix 2). A list of identified species is given in Appendix 1, showing the occurrence of different species in the monitored marshes.

1.4.4 Zooplankton

Total numbers of zooplankton individuals in the three monitored marshlands are shown in Figure (1.37). A pattern appears with two peaks, one in spring and a smaller one in autumn. This pattern was more obvious in 2005-2006**.** Suq Al-Shuyukh generally had the lowest number of individuals throughout the year. In 2005 Al-Hawizeh displayed the highest counts, but in 2006 East Hammar had the highest overall counts throughout most of the year.

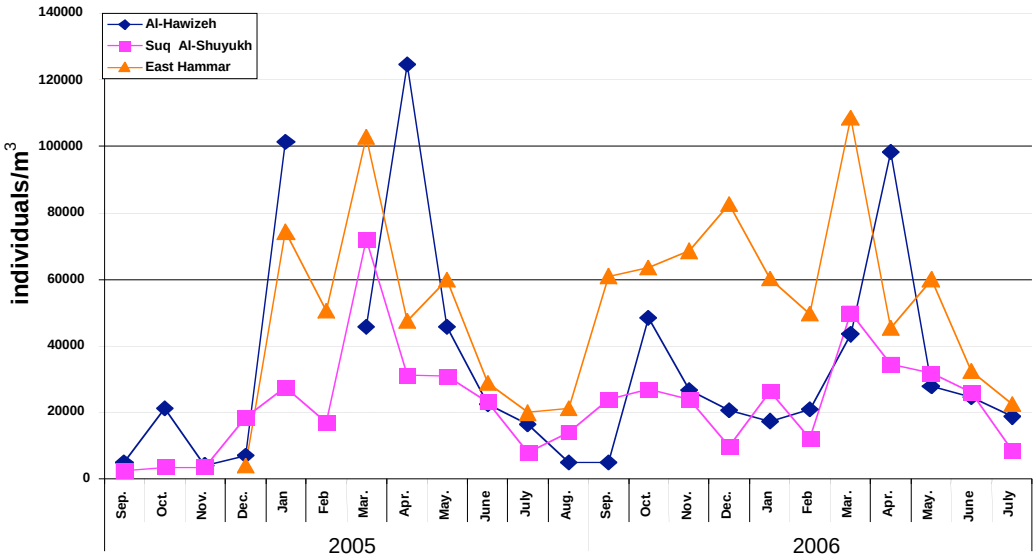


Figure 1.37. Total number of zooplankton individuals in all marshes

Each marsh had its own timing for zooplankton peaks but still followed a general seasonal pattern. In Al-Hawizeh, two peak patterns existed. The first appeared in April and a second smaller one in October. The fewest individuals were recorded in September. In Suq Al-Shuyukh, more pronounced peaks could be detected in March and a smaller one in October, with the lowest values occuring in December and again in July (Figure 1.37). In the East Hammar marsh the picture was slightly different, with peaks occurring in March at both stations in both years, and the lows in July. Several secondary peaks appeared in November, December, and January at both stations. The number of zooplankton during the monitoring period June 2004 to July 2006 indicates a closer pattern relationship between Al-Hawizeh and Suq Al-Shuyukh than East Hammar.

A comparison of the number of individuals in each order of zooplankton in Al-Hawizeh marsh during 2004-2005 and 2005-2006 reveals that Rotifers were the dominant order, comprising a larger proportion in 2006 than 2005 (Figure 1.38ab). The mean number of copepods decreased, compared to that of 2005, but still ranked second. Cladocera occupied the third position in both periods (Figure 1.38ab).

Comparing the number of individuals in each order of zooplankton in Suq Al-Shuyukh marsh 2004-2005 and 2005-2006 revealed that Rotifers were dominant and comprised a higher share of the total population in 2006 than 2005. The mean number of copepods decreased compared to that of 2005, but still occupied the second position. Free nematodes were in third place in both periods (Figure 1.39ab).

In East Hammar marsh during 2004-2005 and 2005-2006, Rotifers were dominant, with lower composition in 2006 than 2005. The mean number of copepods increased above that found in 2005, but still ranked second. Cladocera occupied the third place in both periods (Figure 1.40ab).

The grand total of zooplankton in the three monitored marshes exhibited clear differences between 2004-2005 and 2005-2006. In the first period of sampling in 2004-2005, East Hammar had the highest number of zooplankton (45%), followed by Al-Hawizeh (35%) and Suq Al-Shuyukh (20%) (data not shown). In the second period (2005-2006) East Hammar scored an even higher percentage (51%), followed by Al-Hawizeh with a lower percentage compared to the first period (28%). Suq Al-Shuyukh exhibited a similar percentage in both sampling periods. Comparison

between the monthly numbers of zooplankton in the first period (2004-2005) and with that of second (2005-2006) indicated a general increase in numbers of zooplankton in all three investigated marshes (Appendix 3).

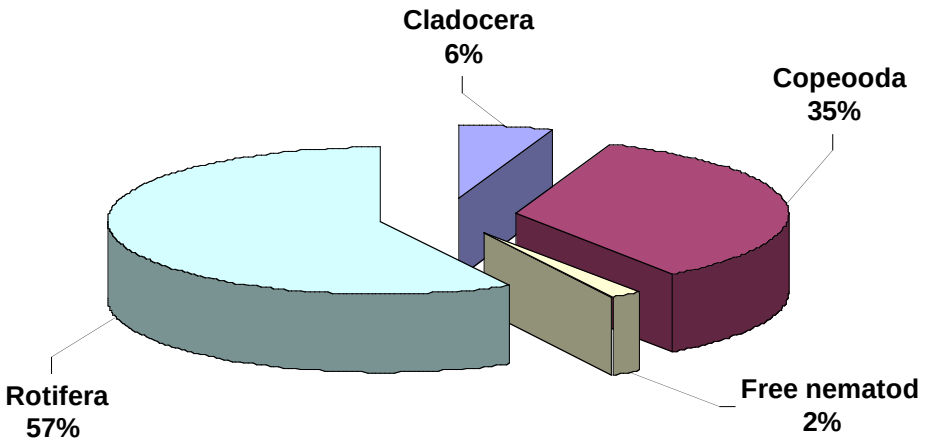


Figure 1.38a. Mean number of individuals in each order of zooplankton at Al-Hawizeh Marsh, 2004 - 2005

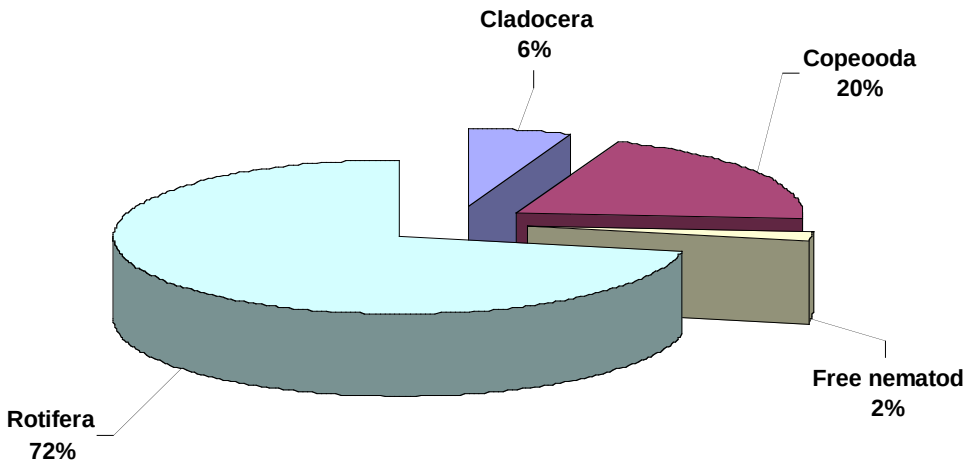


Figure 1.38b. Mean number of individuals in each order of zooplankton at Al-HawizehMarsh, 2005 - 2006

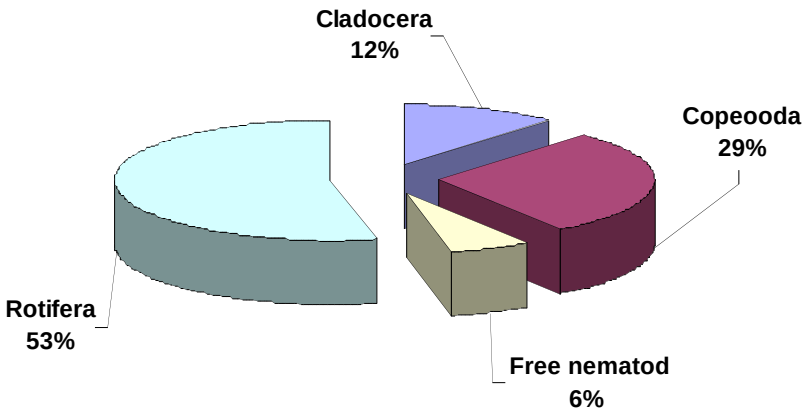


Figure 1.39a Mean number of individuals in each order of zooplankton at Suq Al-Shuyukh Marsh, 2004 - 2005

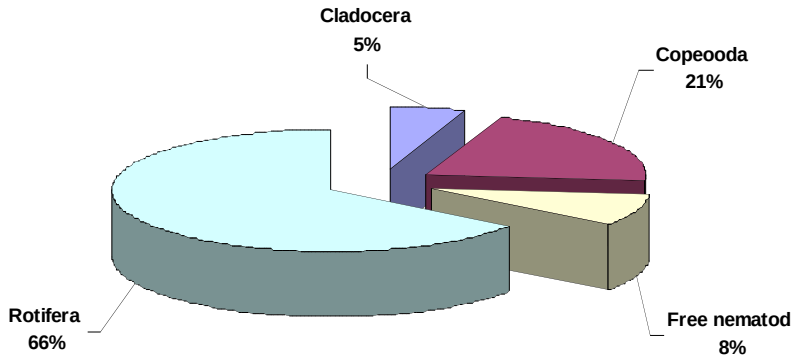


Figure 1.39b. Mean number of individuals in each order of zooplankton at Suq Al-Shuyukh Marsh, 2005 - 2006

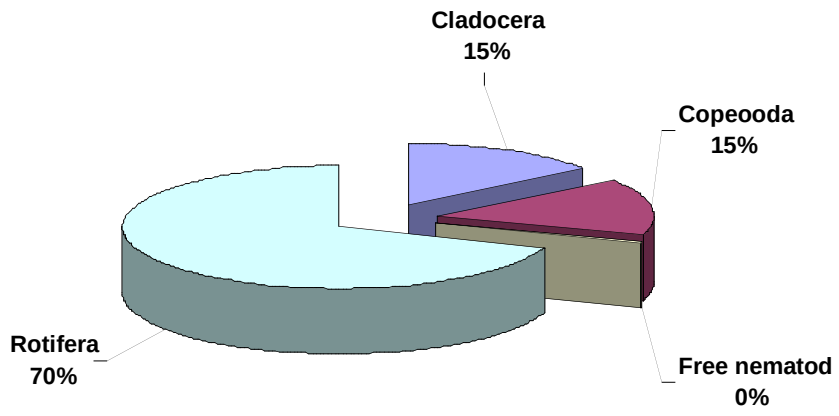


Figure 1.40a. Mean number of individuals in each order of zooplankton at East Hammar Marsh, 2004- 2005

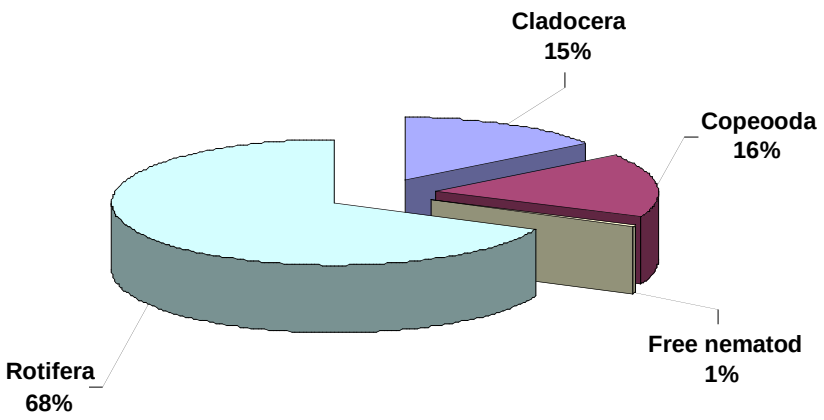


Figure 1.40b. Mean number of individuals in each order of zooplankton at East Hammar Marsh, 2005- 2006

1.4.5 Macroinvertebrates

The number of macroinvertebrates species found in the three marshes during 2005 and 2006 is presented in Tables 1.5 and 1.6. The highest total number of species recorded in all monitored marshes was 84 in 2006. The numbers were composed of 13 snail species, 48 insect, 5 shrimp, 5 spider, 4 annelid, and 3 for mussel and crab, with only one amphipod, isopod, and cirriped species. This represented a 25% increase (or 17 species) from 2005, with insects and snails dominating the species list in both years. The specific number of macroinvertebrate species in 2006 in Al-Hawizeh, Suq Al-Shuyukh, and East Hammar were 62, 58, and 56, respectively. A comparison of the numbers of macroinvertebrates showed an increase from 2005 to 2006 in each marsh (Figure 1.41).

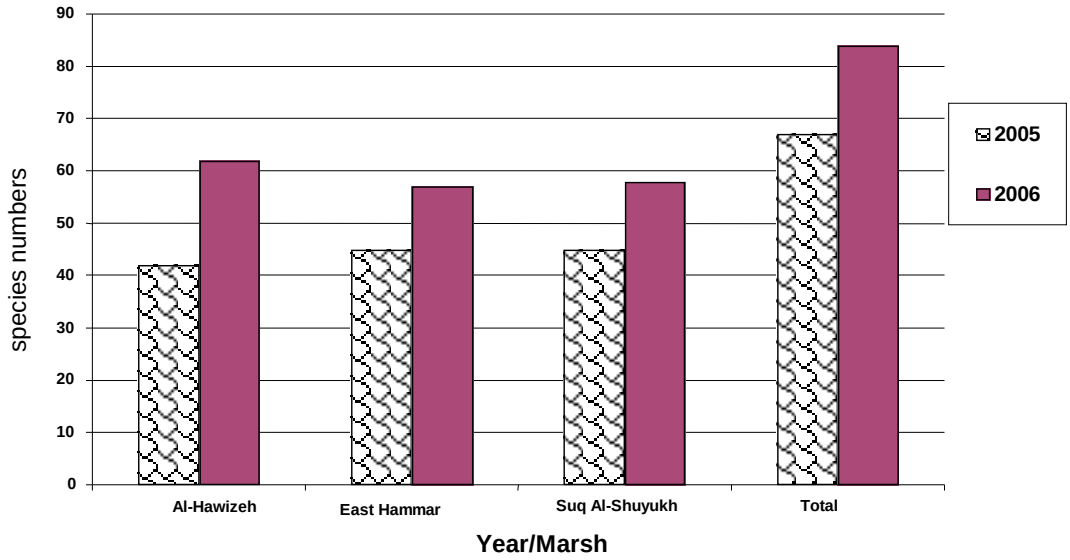


Figure 1.41. Comparison in the total number of macroinvertebrates species

Table 1.5. Number of macroinvertebrates species in three monitored marshes during 2005

	Snail	Insect	Shrimp	Mussel	Spider	Annelid	Isopod	Amphipod	Crab	Cirriped	total
Al-Hawizeh	12	22	3	-	1	3	-	1	-	-	42
Hammar	13	14	5	2	3	2	2	1	2	1	45
Shuyukh	13	17	3	3	3	2	1	1	1	1	45
Total	14	31	5	3	3	4	2	1	3	1	67

Table 1.6. Number of macroinvertebrates species in three monitored marshes during 2006

	Snail	Insect	Shrimp	Mussel	Spider	Annelid	Isopod	Amphipod	Crab	Cirriped	total
Al-Hawizeh	10	37	3	2	4	4	-	1	1	-	62
Hammar	12	25	5	2	5	3	1	1	2	1	56
Shuyukh	13	31	3	3	2	2	1	1	2	-	58
Total	13	48	5	3	5	4	1	1	3	1	84

Student research teams surveying in the marshes are shown on Figure 1.42 and 1.43. The density of main groups of macroinvertebrates in the three monitored marshes is given in Tables 1.7 and 1.8 and Figure 1.44. Maximum and minimum densities recorded for snails were 56.8 ind/m^2 in East Hammar and 21.9 ind/m^2 in Suq Al-Shuyukh. Recorded densities for insects were 33.2 ind/m^2 in Al-Hawizeh and 19.7 in Suq Al-Shuyukh. Shrimp densities were 110.2 ind/m^2 in Al-Hawizeh and 65.3 ind/m^2 in Suq Al-Shuyukh, while those for amphipods were 142.5 ind/m^2 in East Hammer and 22.2 ind/m^2 in Suq Al-Shuyukh. Some groups were absent from certain marshes, e.g., isopoda from Al-Hawizeh. Cirriped were not present in either the Al-Hawizeh or Suq Al-Shuyukh marshes.

Figure 1.42. Iraq students in a boat along the dike in the Al-Hawizeh preparing to sample for macro-invertebrates in June 2006.

Figure 1.43. Iraqi graduate students collect macroin-vertebrates during a sampling trip into the marshes.

Table 1.7. Density of macroinvertebrates species (ind. /m^2) in three monitored marshes during 2005

	Snail	Insect	Shrimp	Mussel	spider	Annelid	Isopod	Amphipod	Crab	Cirriped
Al-Hawizeh	5.6	4.3	15.96	-	2.2	10.26	-	-	-	-
Hammar	30.6	5.27	19.5	2.9	2	11.3	36.6	17.8	10.8	6.9
Shuyukh	4.6	1.98	12.06	1.18	1	3.14	30	3	1	1
Total										

Table 1.8. Density of macroinvertebrates species (ind. /m^2) in three monitored marshes during 2006

	Snail	Insect	Shrimp	Mussel	spider	Annelid	Isopod	Amphipod	Crab	Cirriped
Al-Hawizeh	45.4	33.2	110.8	21.3	43.6	86.3	-	32.6	4	-
Hammar	56.8	21.6	65.3	49.6	58	27.9	19	142.5	26.18	37.3
Shuyukh	21.9	19.7	82.9	38.2	19.9	13.6	12.9	22.2	13.25	-
Total										

A comparison of the distribution percentages for the main groups of macroinvertebrates suggests some differences between the two restored marshes and the Al-Hammar marsh (Figure 1.44). Al-Hawizeh had the highest density of isopods and annelids, East Hammar the highest density of amphipods and ciripeds, and Suq Al-Shuyukh the most mussels. There was a clear increase in species number in all groups and also sharp rises in densities for all groups in 2006 (Figures 1.41,1.45). These results apply to all three monitored marshes.

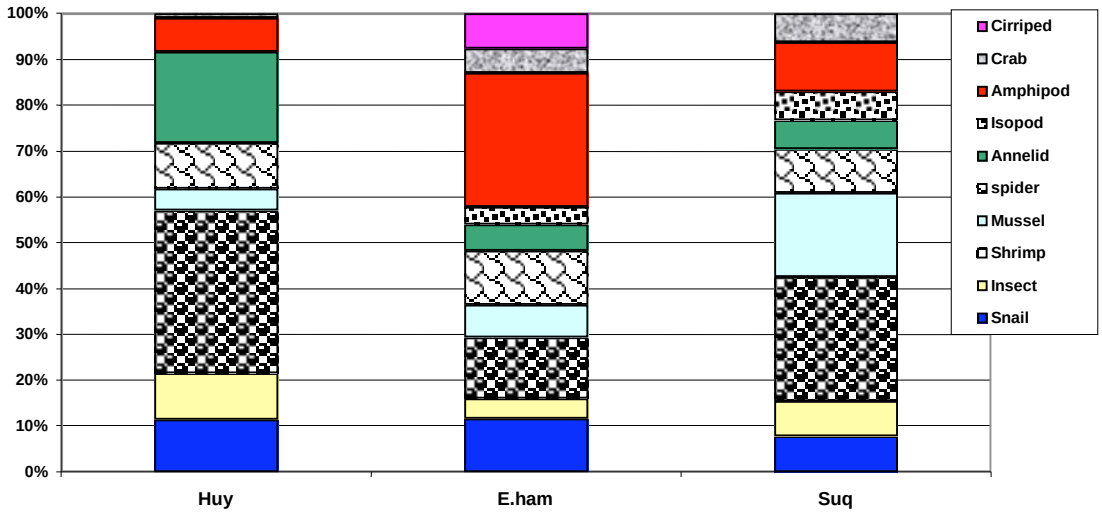


Figure 1.44. Density (ind./m^2) of macroinvertebrates group in all restored marshes in 2006

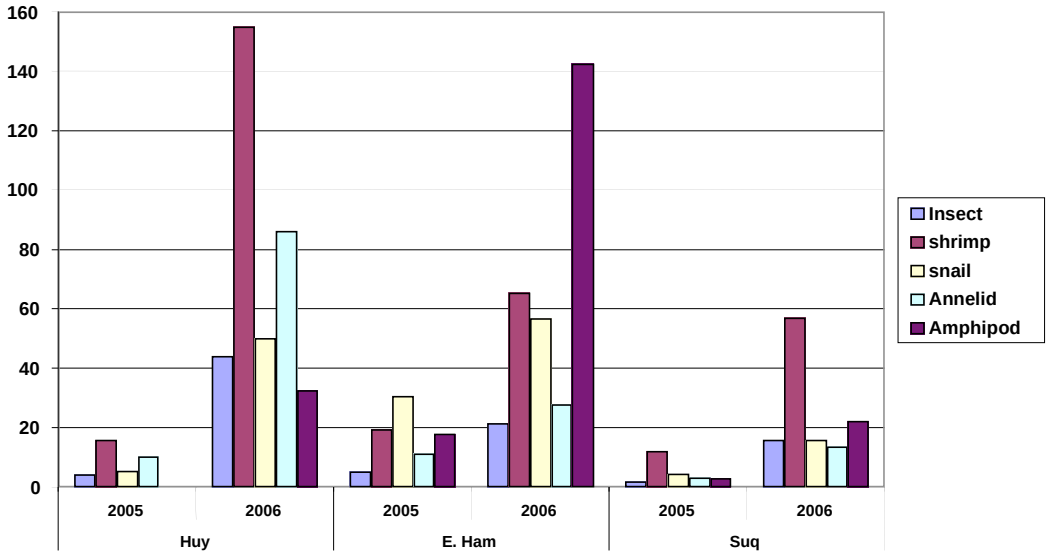


Figure 1.45. Comparison in density of macroinvertebrates species between 2005-2006

A comparison of the diversity, richness, and evenness of each group of macroinvertebrates in the three monitored marshes between 2005 and 2006 showed that insects responded better than all other groups in all marshes. The overall diversity and evenness were similar among the marshes in 2006, but richness was slightly higher at Suq Al-Shuyukh (Figure 1.46). A similarity analysis among the three monitored marshes indicated a higher similarity existed between the East Hammar and Suq Al-Shuyukh marshes (73.7%), than between East Hammar and Al-Hawizeh (69.2%). The lowest was between Al-Hawizeh and Suq Al-Shuyukh (64.0). The occurrence of different species of macro-invertebrates groups in the three monitored marshes are shown in Appendix 4.

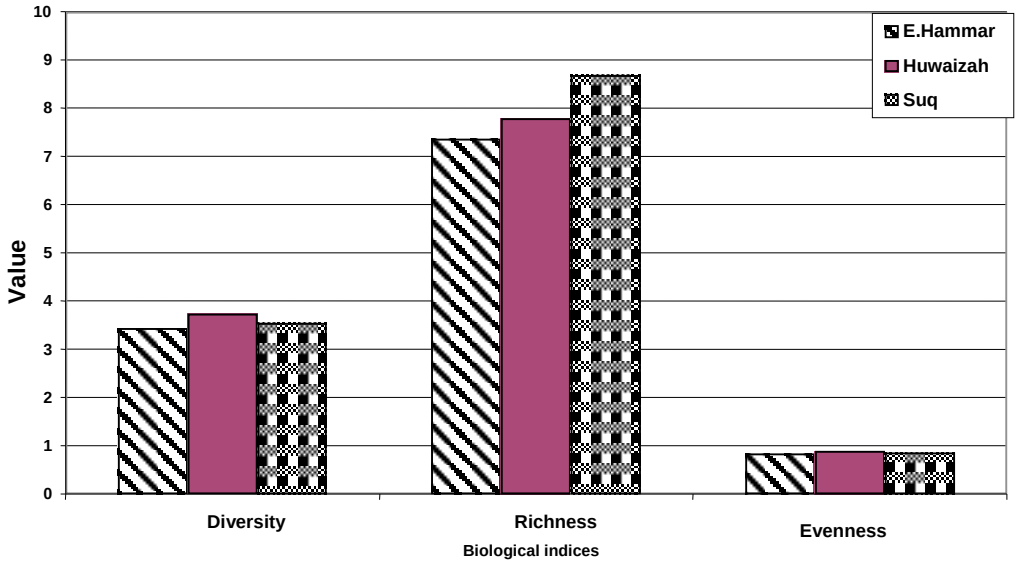


Figure 1.46. Comparison of biological indices of macroinvertberates in the 3 marshes during 2006

1.4.6 Aquatic Macrophytes

The richness of aquatic macrophyte species in Al-Hawizeh, Suq Al-Shuyukh, and East Hammar, expressed as species composition, is shown in Tables 1.9 and 1.10. There was a slight increase in the number of species recorded in comparison with that of 2005, indicating improved species richness and improved macrophyte restoration. The number of species found during the monitoring period, compared with historical records, indicates a significant amount of plant restoration has occurred (Table 1.11). A restoration percentage calculated as the number of species now present compared to historical records indicated that recovery was 100% in Suq Al-Shuyukh and 71.4% in East Hammer. No historical data are available for Al-Hawizeh.

Table 1.9. Species composition of aquatic Macrophytes in Suq Al-Shuyukh and Al-Hawizeh Marshes during 2005-2006. Pluses indicate presence of species and minuses an absence of species.

Species	Suq Al-Shuyukh		Al-Hawizeh	
	Alwineas	Amia	Um Alnaaj	Taraba
Wholly submerged				
Ceratophyllum demersum	+	+	+	+
Najas armata	+	-	+	+
Vallisneria spiralis	+	+	-	-
Chara sp.	-	+	-	-
Partly submerged				
Jussiae repens	-	-	+	+
Potamogeton crispus	+	+	-	-
P. pectinatus	+	+	-	-
Ranuculas sphaerospermus	-	-	+	-
Floating				
Lemna minor	-	-	+	+
Salvinia natans	+	+	+	+
Nymphoides indica	-	+	-	-
Seasonally submerged land				
Bacopa monnieri	+	+	-	-
Cyperus longus	+	-	-	-
Panicum repens	-	+	-	-
Phragmites australis	+	+	+	+
Polygonium salicifolium	-	-	+	-
Rumex sp.	-	+	+	-
Schoenoplectus litoralis	+	+	+	+
Typha domengensis	+	+	+	+
Occasionally wet land Xerohalophytic				
Juncus rigidus	-	+	-	-
Species richness	11	14	11	8

Table 1.10. Species composition of aquatic Macrophytes in East Hammer Marsh during 2005-2006. Pluses indicate presence of species and minuses an absence of species.

Species	East Hammar	
	Burkah	Saddah
Wholly submerged		
Vallisneria spiralis	+	+
Ceratophyllum demersum	+	+
Myrophyllum verticillatum	+	+
Najas armata	+	-
Chara sp.	+	-
Partly submerged		
Potamogeton crispus	+	+
P. pectinatus	+	+
P. perifolitus	+	+
Jussiaea repens	+	+
Seasonally submerged land		
Bacopa monnieri	-	+
Phragmites australis	+	+
Schoenoplectus litoralis	+	+
Typha domengensis	+	+
Cyperus malaccensis	-	+
Species richness	**12**	**12**

Absent species until 2006
Nymphoides peltata,
Potamogeton nodosus

Table 1.11. Comparison of the number of species in 2005 & 2006 with historical recorded number of species.

Marsh	Recorded 2005	Total 2006 (T)	Recruitment	References (H)	Restoration % T / H
Suq Al-Shuyukh	12	15	3	Hilli (1977) 15	100
Al-Hawizeh	9	11	2	No Record	----------
East Hammar	11	15	4	Al- Saadi & Al-Mousawi (1988) 21	71.4

Densities of major species in the three monitored marshlands have increased over the past three years for all species (Table 1.12). When comparing the improvement in densities during the three years of restoration from 2004 to 2006, common reeds (*Phragmites australis*) increased in all three monitored marshes. In Suq Al-Shuyukh, the marsh submerged plant species *C. demersum and* emergent *S. litoralis* had the highest densities (See Figure 1.47 for pictures of *Phragmites* in background and submerged aquatics in foreground.) In Al-Hawizeh, *C.demersum* and another submerged aquatic plant, *S. natans*, formed the main densities. East Hammar was dominated by the submerged plants *M.verticillatum* and emergent *S. litoralis.* Importantly, densities increased each year in the marshes for all species.

Variations in densities among stations revealed that highest densities of common reeds (*P. australis*) were recorded at the Um Alnaaj and Taraba stations during summer (Figure 1.48), which was considered as the season of maximum growth for this species.

Figure 1.47

Figure 1.48

For *C. demersum*, the highest densities were recorded in autumn at the Amia station in Suq Al Shuyukh and at Taraba in Al-Hawizeh (data not shown). In general, autumn was the highest peak season for this species.

Table 1.12. Comparison of densities of major species 2004/2005/2006 in SuqAl-Shuyukh, Al-Hawizeh, and East Hammar. Proportional density measurements based on weight per unit area (g/m^2) along a 100 m transect.

Species in Suq Al-Shuyukh	2004	2005	2006
Phragmites australis	21	26	30
Ceratophyllum demersum	153	176	201
Schoenoplectus litoralis	23	29	36
Typha domengensis	3	4	4
Species in Al-Hawizeh	**2004**	**2005**	**2006**
Phragmites australis	20	24	28
Salvinia natans	133	156	193
Ceratophyllum demersum	154	169	197
Typha domengensis	3	3	5
Species in East Hammar	**2004**	**2005**	**2006**
Phragmites australis	-	23	27
Myrophyllum verticillatum	-	143	166
Schoenoplectus litoralis	-	42	54
Jussiaea repens	-	53	61

The cover of major species for each marsh is given in Table 1.13. Common reeds (*P. australis*) provided the main cover in all marshes. *S. Natans,* followed by *C. demersum* and *M. Verticillatum,* were next in importance.

Table 1.13 A comparison of the plant cover of major plants species during 2004/2005/ 2006 in each marsh along surveyed transects.

Al-Hawizeh	Suq Al-Shuyukh	East Hammar
Phragmites australis	*Phragmites australis*	*Phragmites australis*
Salvinia natans	*Ceratophyllum demersum*	*Myrophyllum verticillatum*
Ceratophyllum demersum	*Schoenoplectus litoralis*	*Schoenoplectus litoralis*
Typha domengensis	*Typha domengensis*	*Jussiaea repens*

To estimate the biomass of the marshes, we harvested a series of plots to determine the standing crop of the major species. The average harvests of the two major species were compared, and the biomass of common reeds (*P. australis*) in 2006 exceeded the historical record in most stations in the monitored marshes (Table 1.14). The average biomass of *C. demersum* harvested in East Hammar also exceeded the historical record, while the other stations had values below historical levels.

Variations in biomass between stations revealed that the highest amount of standing crop of common reeds (*P. australis*) was recorded in the Um Alnaaj and Taraba stations during summer. This was considered as the season of maximum growth for this species. For *C. demersum*, the highest densities were recorded in autumn at the Amia station in Suq Al-Shuyukh marsh and at Taraba in Al-Hawizeh. In general, the highest biomass for this species was recorded in autumn.

Additional measurements of some dominant species found at each station were done in 2006, to determine maximum biomass for these species (Table 1.15). *Schoenoplectus litoralis, Typha domengensis,* and *Salvinia natans* were the dominant species, with the top two species averaging nearly 3000 g/m^2 of peak biomass. *Salvinia* biomass was less than 20% of that for *Typha* and *Schoenoplectus.*

The most frequent species in the Al-Hawizeh marsh at both the Taraba and Um Alnaaj stations was *C. demersum*, followed by *S.natnas*. In general, the numbers for other species were low, indicating localized or confined population (Figures 1.49, 1.50).

The most frequent species in Suq Al-Shuyukh at the Amia and Al-Wineas stations was *C. demersum*, followed by *M verticillatum.* In general, the number of species found along the transects was higher than in Al-Hawizeh, reaching 10 and 8 respectively (Figures 1.51, 1.52).

Table 1.14. Average harvest field (g/m^2 dry wt.) for macrophytes during July 2005 and 2006 compared with historical records.

Species	Huyawzah				Suq Shuyukh				East Hammar		Historical studies	
	Um Al-Naaj		Tarabah		Al-Wineas		Amia				Hilli,1977	Al-Mayah,1994
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006		
Phragmites australis	2906.6	3831.5	3866.6	4932.4	2266.6	3431.2	2016.6	3109.4	3383	4211.3	3608.7	883.5
Ceratophylum demersum	466.6	576.3	433.3	620.4	833.3	914.7	703.3	820.2	1200	2320.4	-	1294.4

Table 1.15 Average harvest field (g/m^2 dry wt.) for macrophytes during July 2006

Species	Al-Hawizeh		Suq Al-Shuyukh		East Hammar
	Um Al-Naaj	Tarabah	Al-Wineas	Amia	
Schoenoplectus litoralis	2721.5	2451.3	2420.5	2613	2108.7
Typha domengensis	2811.3	2623.7	2730.3	2851.2	2368.4
Salvinia natans	451.2	432.4	621.5	590.6	358.3

The most frequent species in East Hamma, at both the Burkah and Saddah stations, was *C. demersum*, followed by *M.verticillatum.* In general, the number of species measured along the transects was higher than at Al-Hawizeh, but similar in number to Suq Al-Shuyukh, scoring 10 and 9 respectively (Figures 1.53. 1.54).

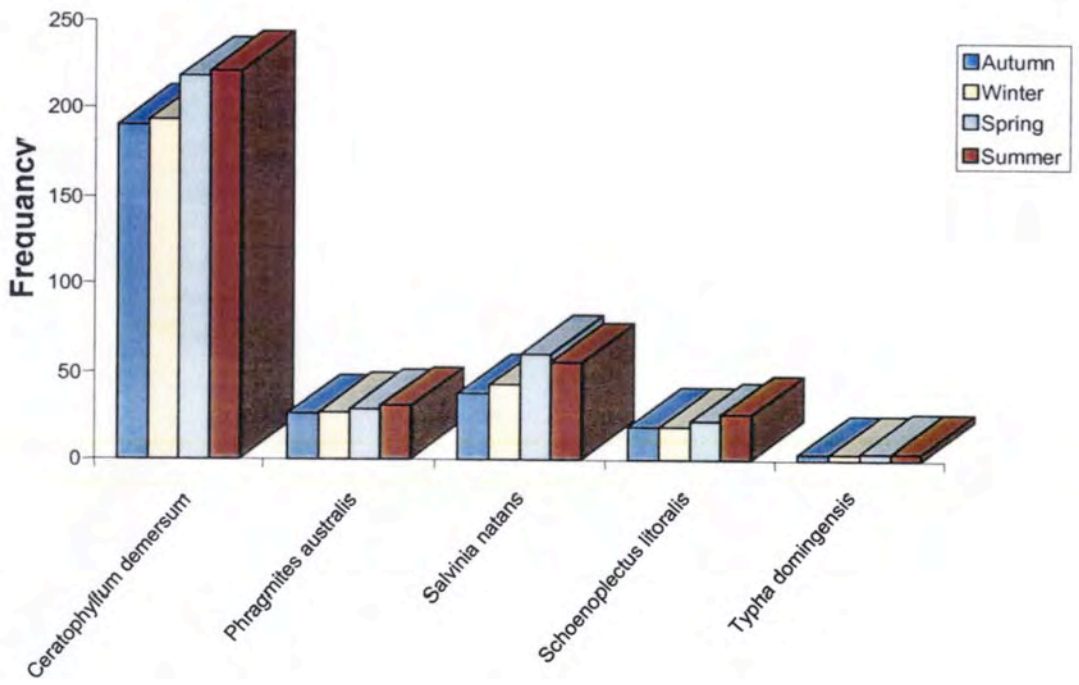


Figure 1.49. Frequency of plant species in Tarabah station during 2005-2006

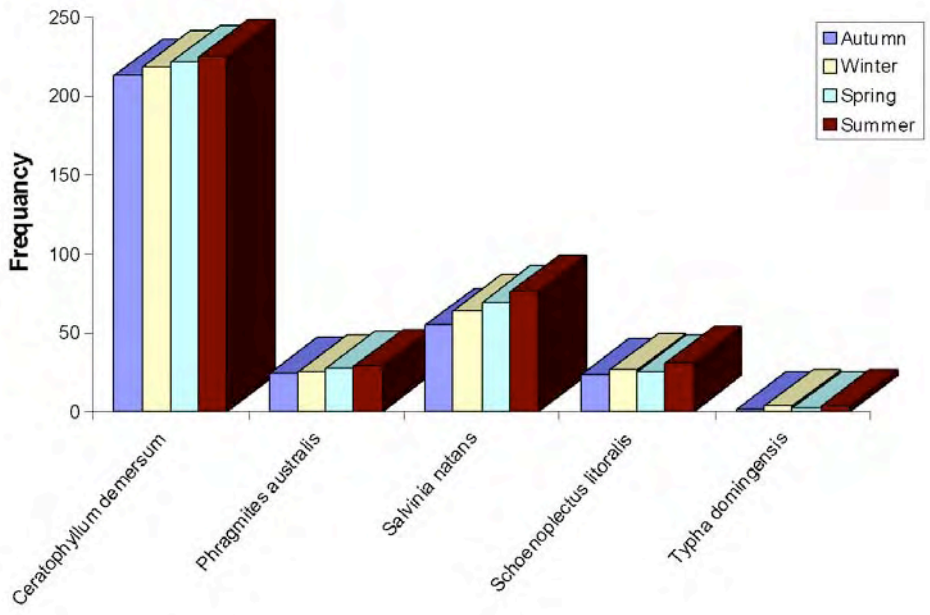


Figure 1.50. Composition of plant species in Um Alnaaj station during 2005-2006.

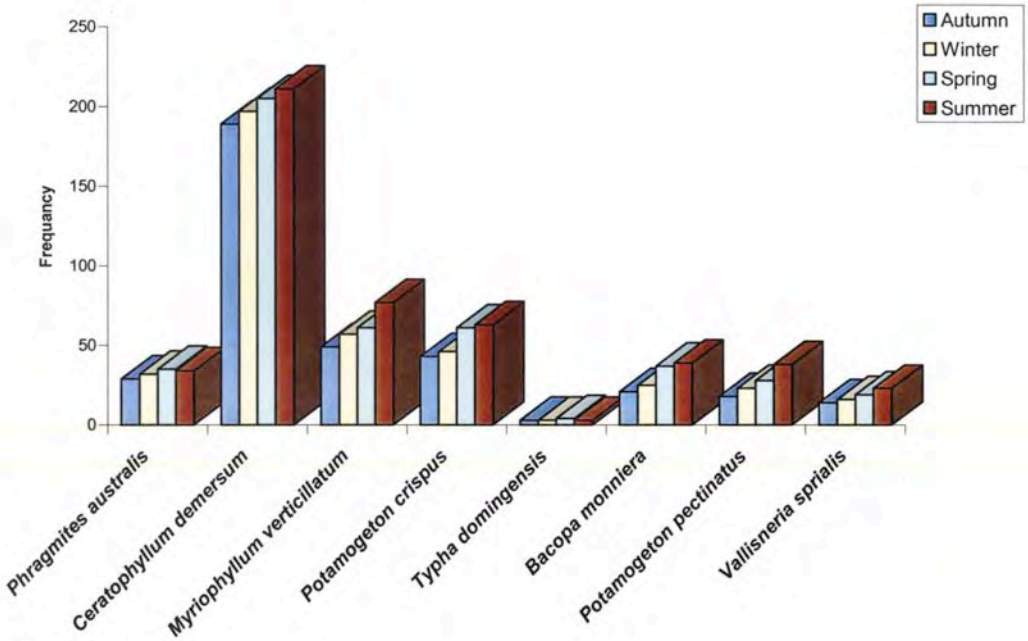


Figure 1.51. Composition of plant species at the Al-Amia station during 2005-2006

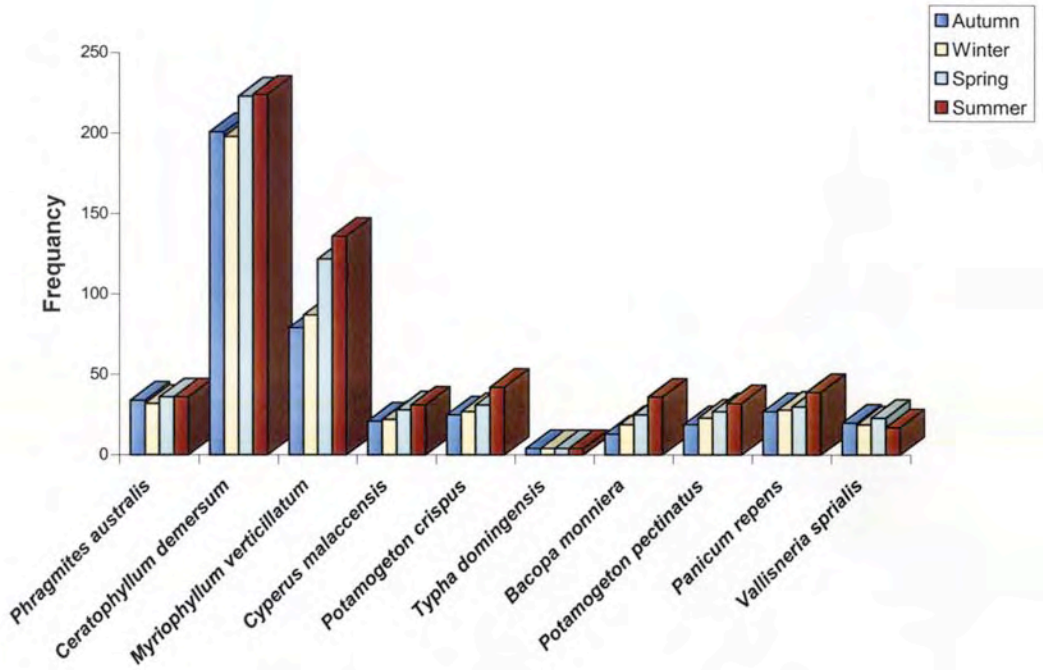


Figure 1.52. Composition of plant species at Al-Wineas station during 2005-2006

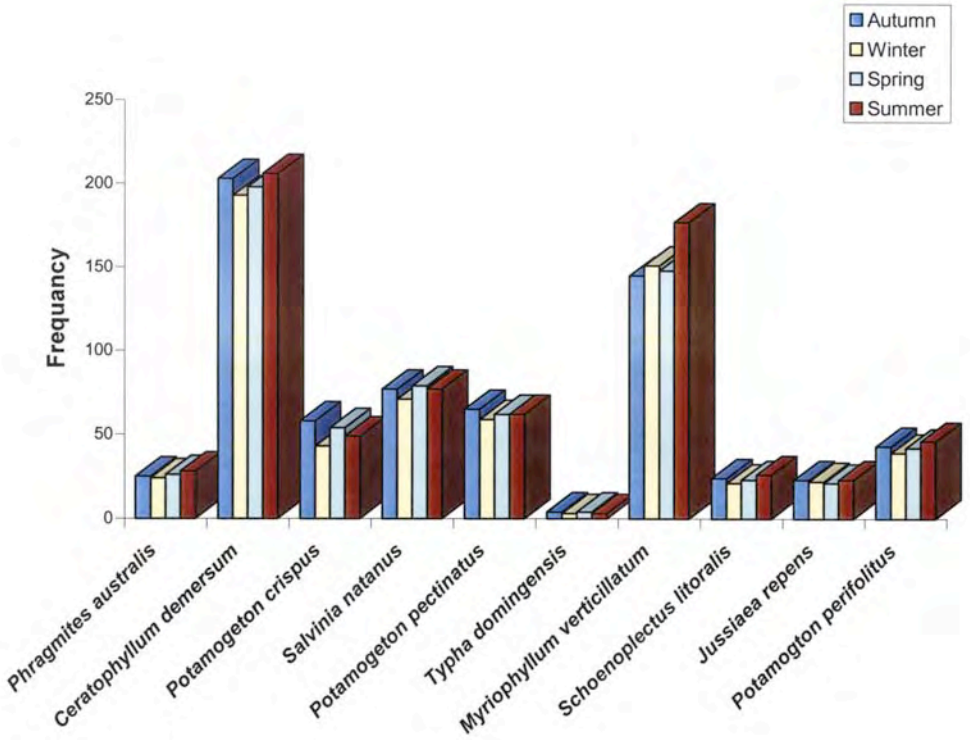


Figure 1.53. Composition of plant species at Al-Burkha station during 2005-2006

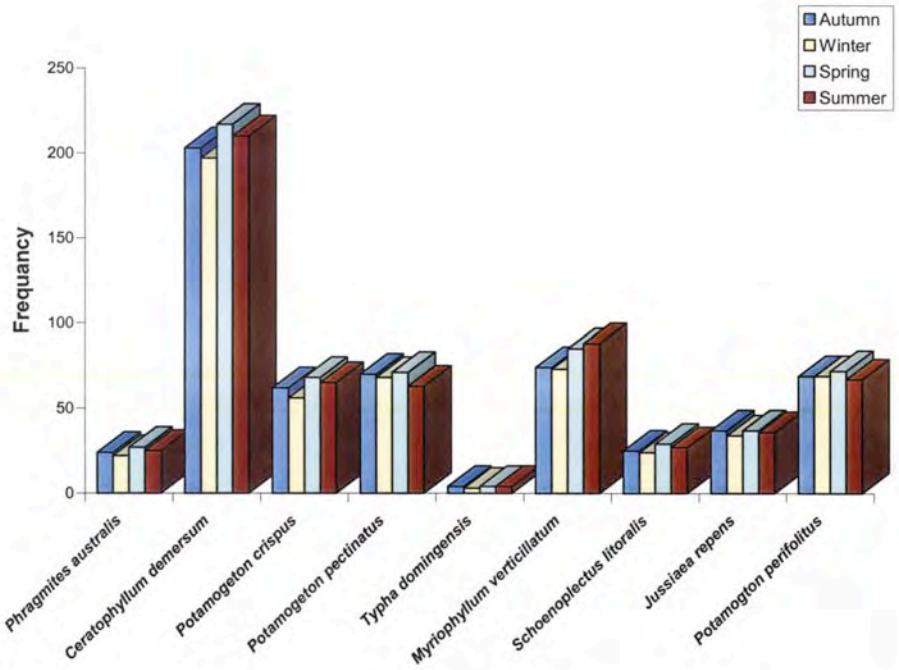


Figure 1.54. Composition of plant species at Saddah station during 2005-2006

1.4.7 Fish

The abundance of fish species in Suq Al-Shuyukh marsh is shown in Table 1.16. Seventeen species were collected from that marsh. The numerical values of abundance differed from those in 2005, but species ranking was the same for the first three species. The assemblage shows a better balance between number of species and number of individuals in 2006 than in 2005. The numerical abundance of fish in Al-Hawizeh marsh differed from that in 2005 and was more similar to Suq Al-Shuyukh in 2006 (Table 1.17). Eighteen species were collected from this marsh. *L. abu* ranked first in 2006, up from 2005 when it was the fourth most abundant species. *C. carassius* was second most abundant in 2006, but in 2005 it was in third position. The numerical abundance of fish in 2006 in East Hammar was similar to that of 2005, but with different dominant species. In total, eighteen species were reported. *C.carassius* ranked first,

followed by *L. abu* and *A.mossulensis* in 2006 (Table 1.18). Figure 1.55 shows Iraqi fisherman casting their nets, and in Figure 1.56 we see their fish catch being analyzed for abundance, size, and food preferences.

Native species exhibited higher abundances compared to migratory and alien species. Some alien species (introduced) with high commercial value, like carp (C*. carpio*) and grass carp (*C. idellus*), and the marine migratory fish sabour (*T. ilish*) had high abundances as well (Tables 1.19 –1.21). Other noncommercial species are shown in Table 1.21, indicating the occurrence of ornamental species like *P. velifera* in both East Hammar and Suq Al-Shuyukh.

The size of the sampled fish increased dramatically from 2005 to 2006, with some species achieving historic records for total length (Table 1.22). These results indicate that the restored marshlands support better fish growth and reproduction, both excellent indicators that the restored marshes are providing habitat and water quality conditions conducive to fish productivity.

Table 1.16. Numerical abundance of fish species in Suq Al-Shuyukh

Species	No. of individuals					Numerical abundance %	
	Autumn	Winter	Spring	Summer	Total	2005	2006
Liza abu	211	203	91	107	612	42.21	28.39
Carassius carassius	107	249	167	84	607	25.88	28.16
Barbus luteus	41	59	122	34	256	13.82	11.87
Alburnus mossulensis	123	29	78	19	249	3.20	11.55
Acanthobrama marmid	4	57	43	8	112	2.95	5.19
Aspius aspius vorax	26	38	14	3	81	3.50	3.75
Ctenopharyngodon idella	53	7	-	-	60	0.30	2.78
Cyprinus carpio	10	26	9	-	45	2.65	2.08
Barbus sharpeyi	15	-	-	20	35	2.65	1.62
Cyprinion macrostomum	-	-	8	18	26	0.35	1.20
Silurus triostegus	10	-	7	6	23	1.50	1.06
Mastacembelus mastacembelus	2	-	8	5	15	-	0.69
Heteropneustes fossilis	2	-	1	11	14	-	0.64
Tor grypus	1	-	6	4	11	0.10	0.51
Gara rufa	-	-	-	3	3	-	0.41
Barbus xanthopterus	3	2	2	1	8	0.45	0.37
Tenaulosa illisha	1	-	-	-	1	-	0.04
Total	609	670	556	320	2158		

Table 1.17. Numerical abundance of fish species in Al-Hawizeh

Species	No. of individuals					Numerical abundance %	
	Autumn	Winter	Spring	Summer	Total	2005	2006
Liza abu	58	326	143	49	576	9.34	28.69
Carassius carassius	95	61	59	21	236	10.96	11.75
Aspius aspius vorax	112	50	8	7	177	23.22	8.81
Barbus luteus	248	201	55	45	549	36.48	27.35
Cyprinus carpio	72	17	12	-	101	6.15	5.03
Alburnus mossulensis	18	5	41	13	77	0.42	3.83
Silurus triostegus	19	9	28	21	77	3.29	3.83
Acanthobrama marmid	6	6	50	-	62	0.33	3.08
Barbus sharpeyi	21	14	14	2	51	9.20	2.54
Heteropneustes fossilis	13	10	3	10	36	0.14	1.79
Ctenopharyngodon idella	32	-	-	-	32	0.38	1.59
Mastacembelus mastacembelus	7	1	7	4	19	-	0.94
Barbus xanthopterus	1	4	6	-	11	0.04	0.54
Mystus pelusius	2	-	-	-	2	-	0.09
Cyprinion macrostomum	1	-	-	-	1	-	0.04
Tor grypus	-	-	-	-	-	-	-
Liza carinata	-	-	-	-	-	-	-
Tenaulosa illisha	-	-	-	-	-	-	-
Total	705	704	426	172	2007		

Table 1.18. Numerical abundance of fish species in East Hammar

Species	No. of individuals					Numerical abundance %	
	Autumn	Winter	Spring	Summer	Total	2005	2006
Carassius carassius	121	242	74	35	472	29.65	34.17
Liza abu	57	159	91	85	390	29.65	28.24
Alburnus mossulensis	4	1	2	97	104	2.94	7.53
Cyprinus carpio	6	22	26	27	81	0.92	5.86
Acanthobrama marmid	11	1	-	65	77	3.31	5.57
Barbus luteus	15	7	35	5	62	4.97	4.48
Liza carinata	29	8	13	-	50	14.73	3.62
Aspius aspius vorax	5	33	5	6	49	2.39	3.54
Tenaulosa illisha	-	-	39	8	47	0.73	3.40
Silurus triostegus	2	-	9	14	25	0.18	1.81
Barbus sharpeyi	-	3	5	-	8	1.10	0.57
Tor grypus	-	-	8	-	8	0.73	0.57
Heteropneustes fossilis	3	-	3	1	7	1.65	0.50
Thrysa mystix	-	-	-	1	1	-	0.07
Barbus xanthopterus	-	-	-	-	-	0.36	-
Ctenopharyngodon idella	-	-	-	-	-	0.18	-
Cyprinion macrostomum	-	-	-	-	-	0.18	-
Mastacembelus mastacembelus	-	-	-	1	1	-	0.07
Total	253	476	310	342	1381		

Table 1.19. Numerical abundance of migratory fish species

Migratory Species	Suq Al-Shuyukh	Al-Hawizeh	East Hammar
Liza carinata	-	-	3.62
Tenaulosa illisha	0.04	-	3.40
Thrysa mystix	-	-	0.07

Table 1.20. Numerical abundance of alien fish species

Alien Species	Suq Al-Shuyukh	Al-Hawizeh	East Hammar
Carassius carassius	28.16	11.75	34.17
Ctenopharyngodon idella	2.78	1.59	-
Cyprinus carpio	2.08	5.03	5.86
Heteropneustes fossilis	0.64	1.79	0.50

Table 1.21. Other noncommercial fish species in restored marshes

Suq Al-Shuyukh	Al-Hawizeh	East Hammer
Aphinus dispar	*Aphinus dispar*	*Aphinus dispar*
Aphinus spp.	*Aphinus* spp.	*Aphinus* spp.
Gumbosia holbroki	*Gumbosia holbroki*	*Gumbosia holbroki*
Poecilia (mollienesia) velifera		*Poecilia (mollienesia) velifera*

Table 1.22. The size of fish individuals in the restored marshes

Species	Al-Hawizeh		Suq Al-Shuyukh		East Hammar	
	2005	2006	2005	2006	2005	2006
Acanthobrama marmid	6.5-8.0	3.6-14.0	4.0-15.0	4.0-12.0	10.3-19.0	4.3-11.5
Aspius aspius vorax	22.7-70.0	16.5-70.0	19.5-60.0	77.6-60.0	15.2-40.0	10.0-45.0
Alburnus mossulensis	5.3-20.0	3.6-19.2	2.1-15.3	5.0-16.3	11.3-17.0	5.0-18.1
Barbus luteus	6.5-30.0	6.5-35.0	6.1-25.2	4.0-26.8	12.5-29.5	10.0-33.4
Barbus sharpeyi	16.0-50.0	9.0-52.0	17.6-50.0	24.0-60.0	30.0-45.0	13.0-48.9
Barbus xanthopterus	10.7	10.0-83.0	22.5-45.0	7.5-31.5	28.2-95.0	-
Carassius carassius	7.4-38.2	5.5-38.1	5.7-25.5	5.5-32.3	8.9-26.7	5.8-29.0
Ctenopharyngodon idella	21.1-38.5	15.0-73.0	29.5-70.0	17.6-82.2	48.2	-
Cyprinion macrostomum	-	10.5	6.0-11.0	4.5-8.2	14.1	-
Cyprinus carpio	11.2-95.0	10.0-97.5	13.4-45.0	12.7-75.0	14.0-65.0	9.0-66.0
Heteropneustes fossilis	13.4-17.8	7.5-25.5	-	8.0-16.5	9.5-21.2	10.0-23.0
Liza abu	6.4-10.0	4.4-19.0	7.7-16.5	5.2-17.8	9.0-16.2	5.4-22.0
Liza carinata	-	-	-	-	9.9-17.9	6.0-21.0
Mastacembelus mastacembelus	16.0-26.0	12.0-90.0	24.4-37.5	10.0-45.5	-	-
Mystus pelusius	-	13.0-13.2	-	-	-	-
Silurus triostegus	25.0-95.0	7.0-101.0	25.4-75.0	6.0-90.0	73.9	6.0-90.0
Tenaulosa illisha	-	-	-	13.0	18.5-36.0	9.2-37.0
Tor grypus	-	-	20.2-39.9	5.5-15.1	19.7-45.5	29.5-47.0

In general, the biological indices (Diversity, Richness, and Evenness) reflected better values in 2006 than 2005, emphasizing environmental improvement in the restored marshes. Diversity was slightly improved in Al-Hawizeh and Suq Al-Shuyukh marshes. In East Hammer there was a slight decrease in diversity (Table 1.23 & Figure 1.57). Richness improved in all monitored marshes, revealing an increased number of individuals to number of species collected (Table 1.23). Evenness was also improved, but no species was dominant in the fish assemblage in the three marshes, and species were represented by a balanced number of individuals (Table 1.23).

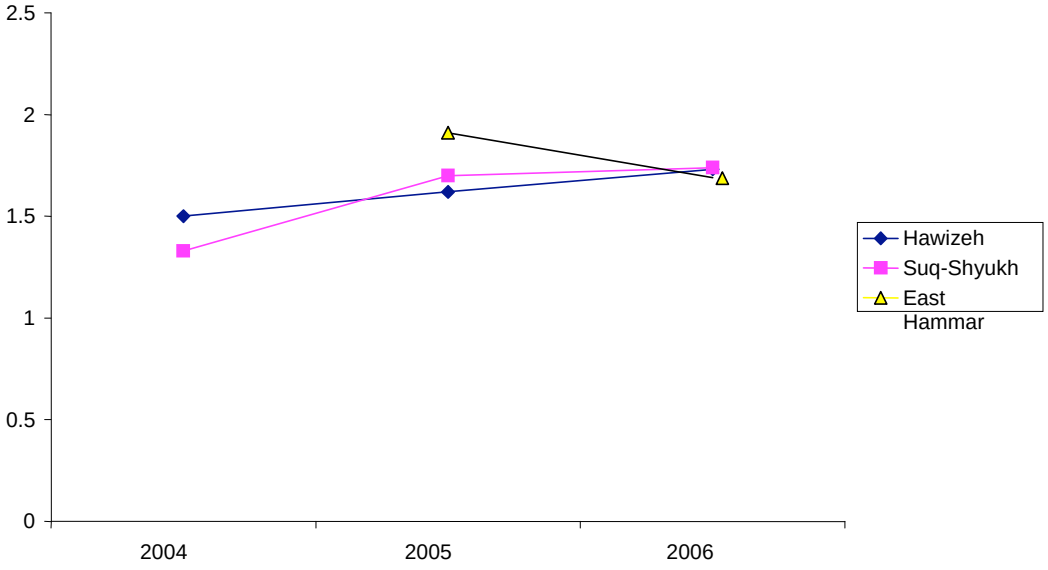


Figure 1.57. Fish diversity in the monitored marshes from 2004-2006

Table 1.23. Ecological indices in the marshes during the period study

Indices	Suq Al-Shuyukh		Al-Hawizeh		East Hammar	
	2005	2006	2005	2006	2005	2006
Diversity	1.62	1.73	1.70	1.74	1.91	1.69
Richness	1.71	1.95	1.43	1.84	1.70	1.79
Evenness	0.61	0.62	0.68	0.64	0.60	0.64

The highest similarity in fish assemblages was recorded between Al-Hawizeh and Suq Al-Shuyukh marshes. The lowest was between East Hammar and Al-Hawizeh (Table1.24). The same trend was recorded in 2005. Fish catch in kg/h was highest in Al-Hawizeh marsh and lowest in East Hammar (Table 1.25). An estimate of fish recovery was based on the percent of species return. The index reached 71% in Al-Hawizeh and Suq Al- Shuyukh marshes, and it was slightly lower, 64%, in East Hammar (Table1.26).

Table 1.24. A similarity index between the monitored marshes according to Jaccard (1908)

Similarity between Al-Hawizeh & Suq Al-Shuyuk	80.9 %
Similarity between East Hammar & Suq Al-Shuyuk	66.6%
Similarity between East Hammar & Al-Hawizeh	55.5%

Table 1.25. The amount of fish catch by electrical fishing in kg per hour

Marsh	The catch kg /hour
Al-Hawizeh	17.16 kg/h
SuqAl-Shuyuk	9.75 kg/h
East Hammar	4.45 kg/h

Table 1.26. A calculated recovery index (R I) based on present species / historical species number for each marsh.

Marsh	P/H	RI
SuqAl-Shuyuk	20/28	71%
Al-Hawizeh	18/28	64 %
East Hammer	20/28	71%

Food pyramids for all the fish in the monitored marshes are shown for 2005 and 2006 (Figures 1.58, 1.59, 1.60). These figures show an improvement in the shape of the food pyramid as the numbers of herbivores are increasing over time (from 2005 to 2006), approaching the normal state for a sustainable fish food pyramid. This was especially true for East Hammar. Importantly, the width of the herbivore base is wider in respect to predators at the apex, which indicates a more balanced and stable fish population.

Figure 1.58. Food pyramid of fish in Suq Al-Shuyukh

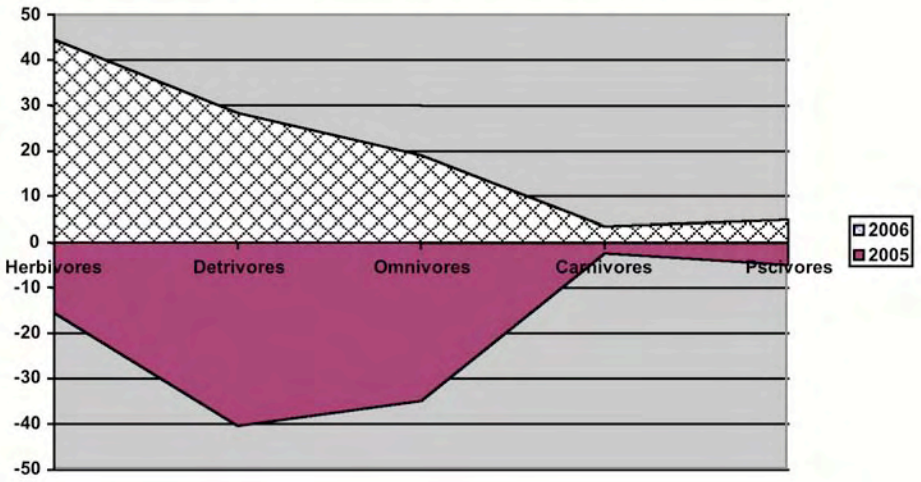


Figure 1.59. Food pyramid of fish in Al-Hawizeh

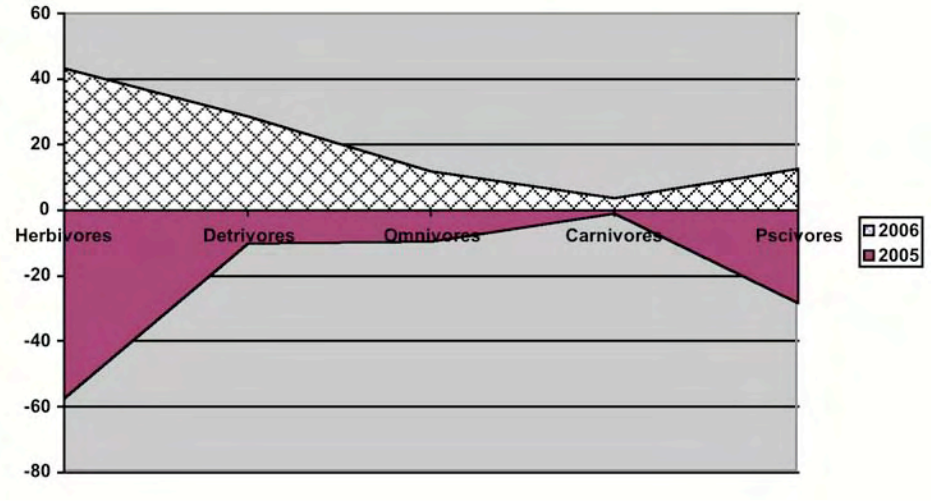
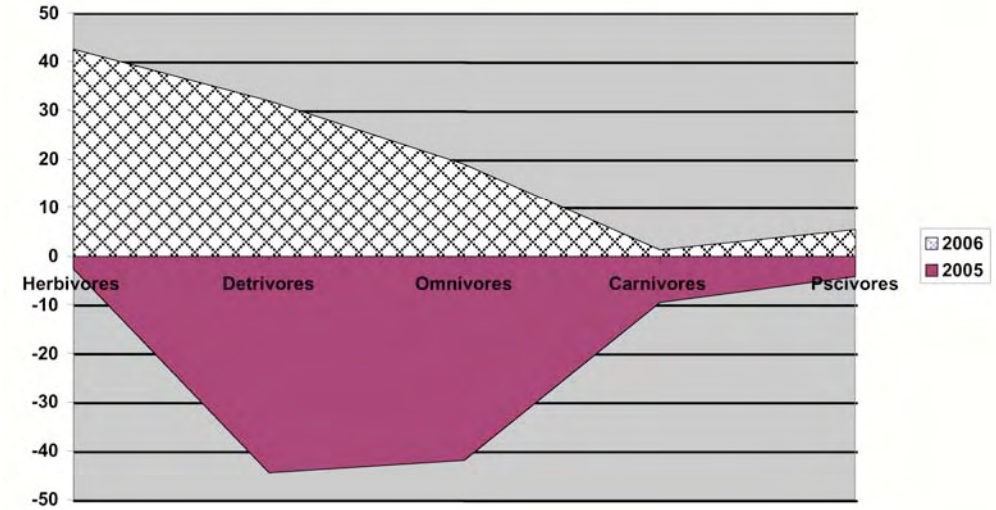


Figure 1.60. Food pyramid of fish in East Hammar



To determine the food source, a diet composition was completed for the major fish species by checking gut contents. The food sources of these species are shown in Appendix 5. *B. sharpeyi (*Bunni), in the three monitored marshes, consumed mostly aquatic plants. The analysis indicated that this species is herbivorous. The diet composition of *C. carassius* (Curcian) in the three monitored marshes was also herbivorous, but algae composed the highest

amount of food. The diet composition of *C. carpio* (carp) in the three monitored marshes varied among the sites; however, snails, insects, and organic matter made up the main diet, thus the species was classified as a carnivore. The diet composition of *A. vorax* (Shilig) in the three monitored marshes was almost 100% fish, and it was classified as a predator. The diet composition of *B. luteus* (Himri) in the three monitored marshes was primarily algae and plants, and it was consider a herbivore. The diet composition of *S. triostegus* in the three monitored marshes consisted mostly of fish (> 95%), with a few percent crustaceae, and it was classified as a predator. The diet composition of *L. abu,* in contrast to the other species, was mostly clay and detritus in the three monitored marshes, and it was classified as a detritivore (Appendix 5).

1.4.8 Water Birds

Figures 1.61 and 1.62 show examples of the birds surveyed for species numbers recorded in the three monitored marshes during 2005-2006 samplings.

Figure 1.61

Figure 1.62

The Al-Hawizeh marsh had the highest number of species in all months except April 2006, with a peak (37) detected in January 2006 (Figure 1.63). The peak bird populations in Suq Al-Shuyukh and East Hammar marshes (25) were recorded in December and September, respectively. The lowest number of species recorded (13) was in East Hammar marsh.

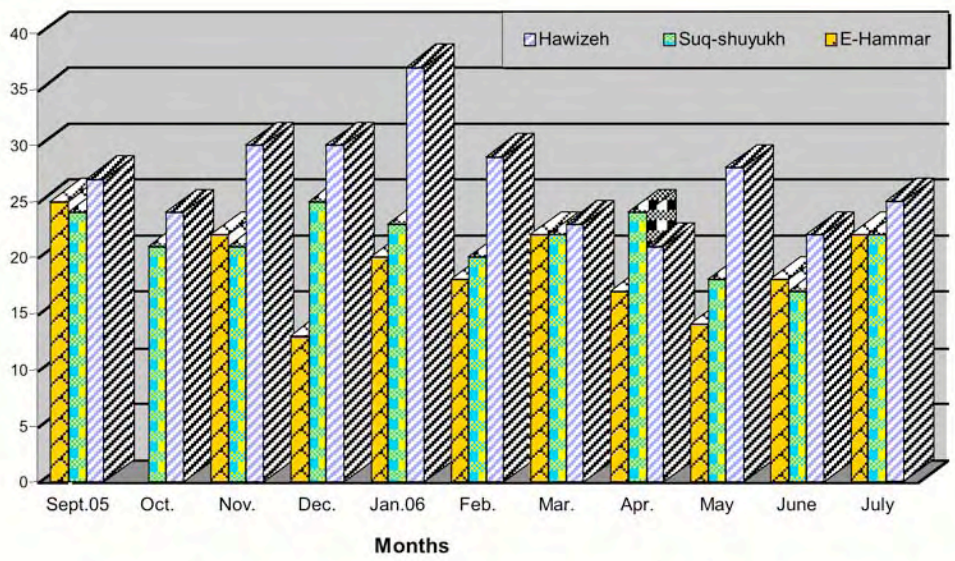


Figure 1.63. Number of bird species recorded in the monitoring marshes.

The number of individual birds counted in the Al-Hawizeh marsh topped 6,500 in the winter months (Figure 1.64). Al-Hawizeh marsh had the highest number of individuals except during March, April, and July 2006. The peak numbers in our survey were 6893, 760, and 2222 individuals in Al-Hawizeh, Suq Al-Shuyukh, and East Hammar marshes respectively.

Figures 1.65 and 1.66 show the avifauna percentages of species (species composition) and number of individuals within each order in the Al-Hawizeh marsh. Charadriiformes ranked first followed by Ciconiiformes (Figure 1.65). Ralliformes occupied the first rank followed by Pelecaniformes in number of individuals (Figure 1.66).

The avifauna percentage of species and individuals of each order in Suq Al-Shuyukh marsh are shown in Figures 1.67 and 1.68. Charadriiformes occupied the first rank in species and individuals composition, followed by Ciconiiformes. Anseriformes ranked third in species and Coraciiformes in individuals. Pelecaniformes, however had the lowest numbers in species and individuals. The avifauna species and individuals percentages in East Hammar marsh are shown in Figures 1.69 and 1.70. Charadriiformes ranked first in species followed by Ciconiiformes, while they were similar in number of

individuals. Anseriformes ranked third in species and individuals, and Pelecaniformes occupied last position in species and individuals.

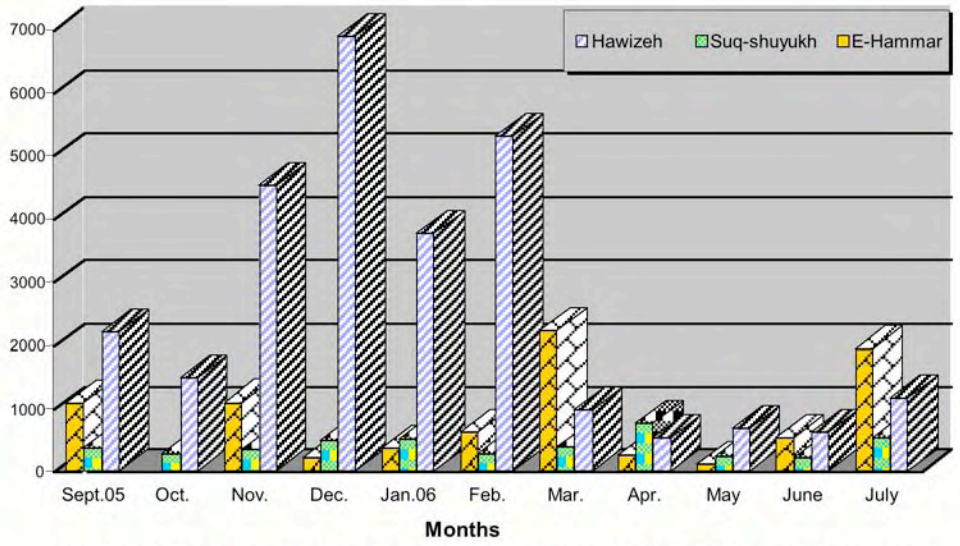


Figure 1.64 Number of individual birds recorded in the monitored marshes.

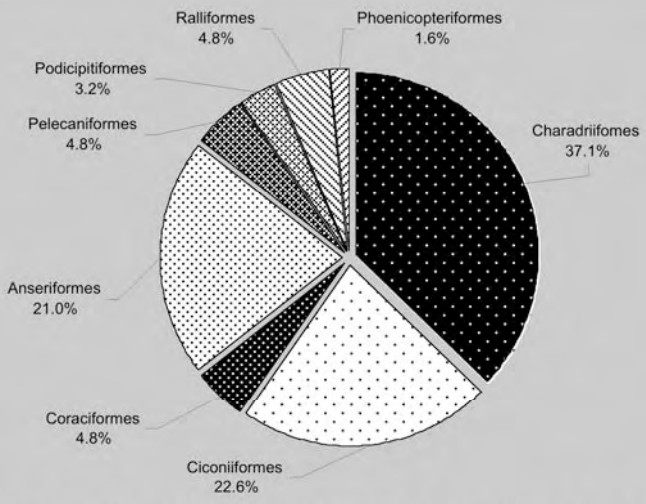


Figure 1.65. Avifauna percentage of species in each order in Al-Hawizeh

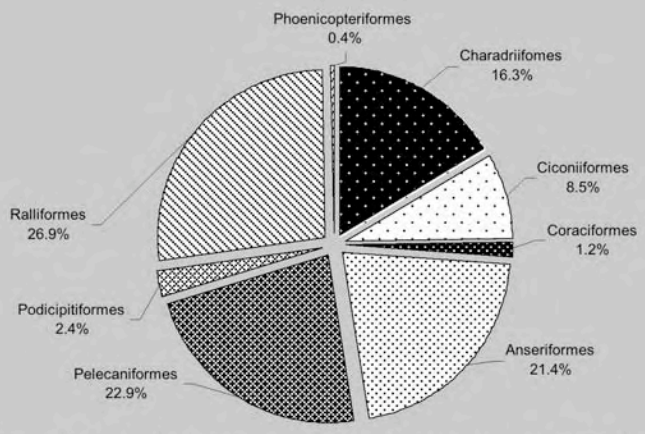


Figure 1.66. Avifauna percentage of individuals in each order in Al-Hawizeh

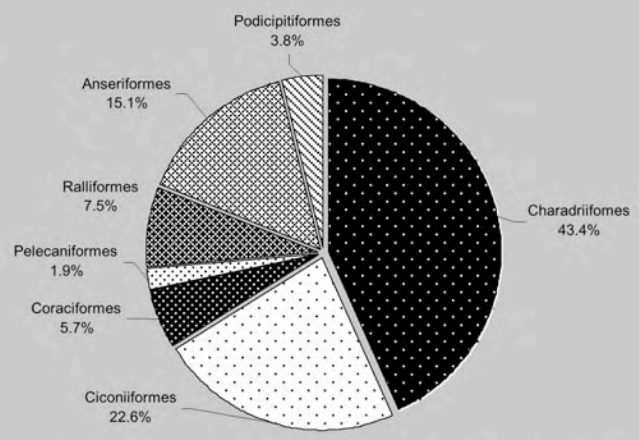


Figure 1.67 Avifauna percentage of species in each order in Suq Al-Shuyukh

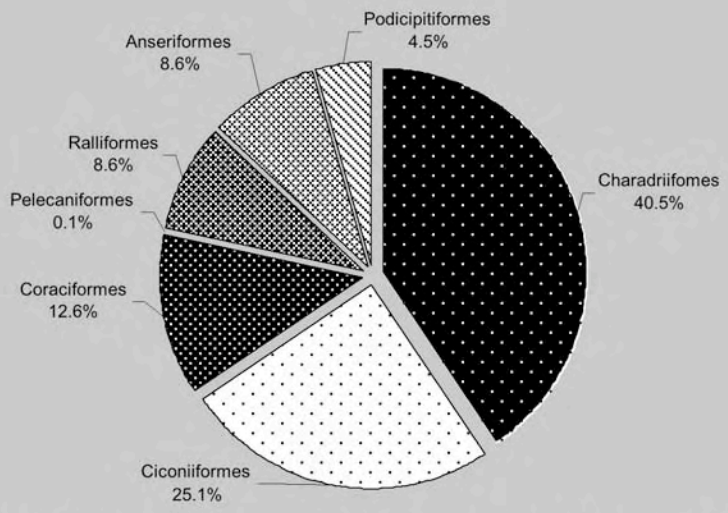


Figure 1.68. Avifauna percentage of individuals in each order in Suq Al-Shuyukh

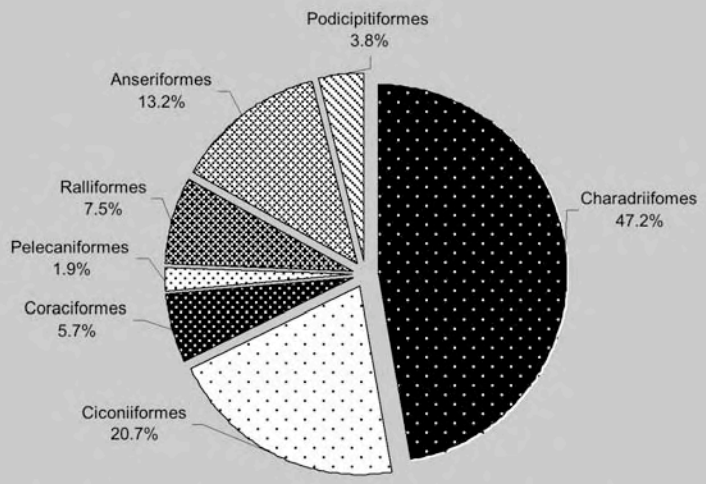


Figure 1.69. Avifauna percentage of species in each order İn East-Hammar

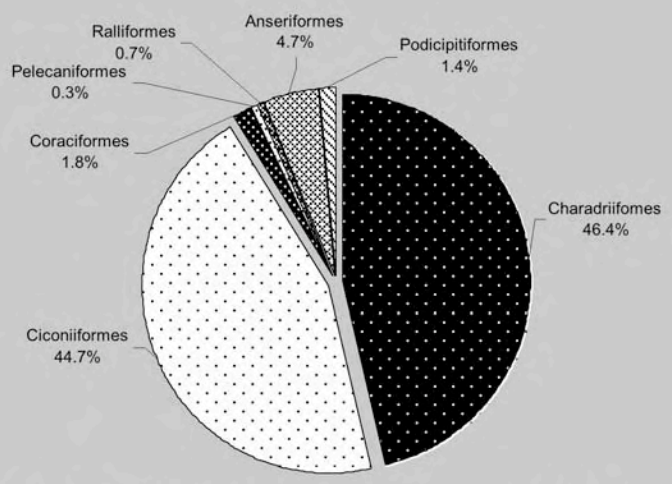


Figure 1.70. Avifauna percentage of individuals in each order in East Hammar

Several peaks for diversity were seen in Al-Hawizeh marsh (Figure 1.71). Values ranged from 2.9 in May to 1.6 in July 2006. The peaks of diversity were encountered in December and January in Suq Al-Shuyukh and Al-Hawizeh. Bird diversity in East Hammar peaked in December. Lowest values were recorded in July, February, and November. Values of evenness ranged from 0.5-1.0 in Suq Al-Shuyukh and East Hammar, which reflected the highest month values, while Al-Hawizeh had the lowest at about 0.75 most months (data not shown). Species richness was higher in Al-Hawizeh than Suq al-Shuyukh during some months, with the ranking reversed in others. East Hammar had the lowest richness values. Higher evenness values indicated that total numbers were not dominated by a few species. Equal numbers of several species were reported. The peaks were recorded in June, December, and May in Al-Hawizeh, Suq Al-Shuyukh and East Hammar marshes, while the lowest values were recorded in July, April, and November in the same order as above.

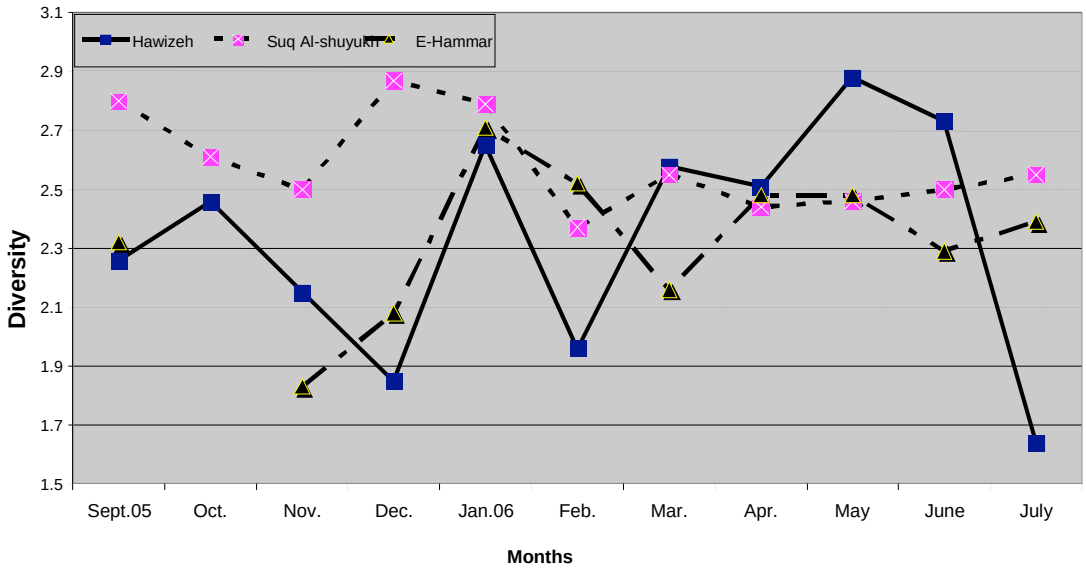


Figure 1.71. Monthly bird diversity in the monitored marshes

Table 1.27 shows the number of species recorded within each order in the three monitored marshes. Al-Hawizeh marsh recorded 62 species, while Suq Al-Shuyukh and East Hammar recorded 53 species. Charadriiformes had the highest recorded number, followed by Ciconiiformes in the monitored marshes. Phoenicopterifomes were seen only in Al-Hawizeh.

Table 1.27. Number of species recorded within orders in the 3 marshes

Order	Al-Hawizeh	Suq-Al-Shuyukh	East Hammar
Charadriiformes	23	23	25
Ciconiiformes	14	12	11
Coraciiformes	3	3	3
Pelecaniformes	3	1	1
Ralliformes	3	4	4
Anseriformes	13	8	7
Podicipitiformes	2	2	2
Phoenicopteriformes	1	0	0
Total	62	53	53

The number of bird species counted and total number of individuals in the marshes in 2006 was higher than found in 2005 (Table 1.28). This indicated that the marshes were providing an improved habitat for the bird populations. This information and the number of breeding birds found in the marsh provide evidence for an improved population of birds in the future in the restored marshes. The number of ducks also increased dramatically in Al-Hawizeh in 2006, compared to 2005 (Table 1.29). Duck counts also increased in the other marshes but not as significantly.

A comparison of the number of bird species and individual birds with historical records indicates that in 2004-2005 there was a 65% recovery in species (Table 1.30). In the 2005-2006 bird survey the number of species increased and the recovery index was 88%. This meant that 88% of the historically recorded bird species had returned to the restored marshes, but the numbers are much lower than the historical ones.

Table 1.28 A comparison of the 2005-6 counts of birds with previously collected data (2004-2005) in the monitored Iraqi southern marshes

Marsh	2004-2005		2005-2006	
	species	individuals	species	individuals
Al-Hawizeh	52	9,399	62	28,331
Suq Al-Shuyukh	37	1,975	53	4,443
East Hammar	29	1,998	53	8,465

Table 1.29. Comparison of the number of ducks recorded in 2005-06 with the previous monitoring in 2004-2005.

Species	Al-Hawizeh		Suq Al-Shuyukh		East Hammar	
	04-05	05-06	04-05	05-06	04-05	05-06
Marbled teal	104	1089	-	104	-	77
Teal	69	1161	34	90	-	2
Mallard	60	234	28	38	-	60
Wigeon	140	1420	4	-	-	128
Pochard	50	150	-	52	-	-
Gadwall	32	300	4	-	-	63
Gargany	10	9	2	23	-	4
Tufted duck	8	1480	-	-	-	-
Shoveler	-	35	13	3	-	70
Pintail	-	158	24	-	-	-
Ferruginous duck	-	50	4	-	-	-
Red-crested pochard	-	-	-	20	-	-
Greylag goose	6	26	-	43	-	-
Scup	-	50	-	-	-	-
Total	479	6162	115	373	-	404

Table 1.30. The number of species and individuals recorded in previous surveys compared to current bird surveys

Study	Marsh	No. of species	Total individuals all species
Georg and Vielliard, 1970	Lower Mesopotamia	55	59,378
Koning and Dijksen, 1973	Lower Mesopotamia	58	128,004
Carp, 1975	Lower Mesopotamia	45	52,151
Scott, 1995 (for 1972, 1975, 1979 census)	Hammar	73	288,222
Present work, 2005-2006	Al-Hawizeh	62	28,331
	Suq Al-Shuyukh	53	4,443
	East Hammar	53	8,465
	Total	74	

1.5 Discussion of Major Findings

1.5.1 Water Quality

The water quality of the marshes is largely affected by the arid climate, soil conditions, and upstream waters on the Tigris and Eupharates (Richardson and Hussain 2006). The three marshes, Al- Hawizeh, Suq Al-Shuyukh, and East Hammar, are in general on the alkaline side and resemble other Iraqi fresh water bodies (Al-Laami et al. 1996, IMRP 2005). Seasonal changes of different parameters in the marshes were more or less similar, especially during winter, while in other seasons they had their own distinct patterns. East Hammar had more fluctuations and exhibited different values in most measured parameters, due to the tidal effect of Arabian Gulf via Shatt Al-Arab.

Monthly changes in BOD values in the marshes were affected by the amount of organic material oxidized by the action of bacterial and other organisms (Best and Ross 1971, Stirling 1985), which represents a vital natural function of the marshes that increased in the summer months (Figure 1.12).

Fluctuations in values of nutrients were seasonal, with values highest in winter and lowest in summer, and generally followed the input values of the inputs sources. Marsh productivity responded through the uptake of nutrients by phytoplankton and aquatic macrophytes, with Al-Hawizeh and Suq-al-Shuyukh reflecting higher values than East Hammar. In general, these values were higher than historical records. This could be attributed to the rise in the use of fertilizer for agricultural purposes and the impact of domestic sewage. The low values of phosphorus, compared to previous recorded data, could be related to the large growth demand by phytoplankton and aquatic macrophytes, which have dramatically increased in the marsh during the past two years.

The changes in ammonium values are explained by the natural cycle of decomposition and decay in the marshes, a similar conclusion being reached earlier by Hussain et al. (1991). Nutrients (nitrate and phosphate) showed monthly changes, especially in the summer, and increased in winter months (Figures 1.13, 1.14). The seasonal patterns of parameters monitored were the

same as historically recorded; even the ranges were similar to previous records, with the exception of nutrients. Nitrate and sodium were higher than before, but the majority of values indicate that water quality was more or less the same as historically recorded.

From the above results, we concluded that the water quality is good and supports the natural life cycles of restored marshes. No significant differences exist between previous studies and the present one. The water quality of restored marshes allowed different organisms to grow, reproduce, and disperse in a manner similar to that of natural healthy water bodies that were historically recorded.

1.5.2 Phytoplankton

Primary production of phytoplankton is often considered the base of the aquatic food chain in open water marshes. The amount of net productivity changed seasonally and was affected by several limiting factors, such as concentration of nutrients, light penetration, and water temperature (Figures 1.3, 1.8). Primary production of the restored marshes was higher than in other Iraqi water bodies, which supports the existence and growth of numerous organisms including fish and birds (Mohammed 1994).

The highest peak of chlorophyll-a concentrations was recorded in Burkah station in East Hammar (18.4 mg C/m^3). The lowest peak was in Al-Wineas station in Suq Al-Shuyukh marsh (1.6 mg C/m^3). The total number of phytoplankton cells followed the same pattern. The high level of chlorophyll-a in East Hammar marsh could be due to the influx of nutrients from the Shatt Al-Arab River. These results were higher than historical studies in the area (Al-Lami et al.1998, Al-Saadi et al. 2000, Hussein et al. 2002). Interestingly, Um Alnaaj station in Al-Hawizeh marsh had a different timing for higher peaks, which happened in autumn instead of spring. In temperate regions, there are two peak patterns for high primary productivity of phytoplankton (Cushing 1975). This may indicate that the phytoplankton biomass in the marshes belongs to a temperate

type of primary productivity, controlled by temperature and nitrogen:phosphorus ratios (Al-Saadi et al. 2000).

The algal population of East Hammar was found to be characterized by the occurrence of some genera that did not exist in the Shatt Al-Arab estuary. Species such as *Gomphonema, Navicula, Bacillaria, Nitzschia, Cocconeis, Diploneis, Mastogloia, Melosira, Pleurosigma, Gyrosigma, Amphora* and *Oscillatoria,* mostly of marine origin, were found in East Hammar. In general, the timing of algal blooms in the southern marshes is not uniform, as it is dependant on several environmental factors (Al-Lami et al. 1997; Kasim et al.1999,2006; Salman et al. 2002). The dominance of diatoms found in the present monitoring program at restored marshes was reported to be common in other Iraqi water bodies, as indicated by several earlier studies (Al-Mousawi et al. 1990, Al-Saadi and Al-Lami 1992, Moulood et al. 1993, Al-Saadi 1994, Al-Saadi et al. 2000). The occurrence of Rhodophyte (a red phytoplankton group or class) can be considered to be a unique feature of the Iraqi marshes.

1.5.3 Zooplankton

Differences were found in the total number of zooplankton individuals at monitoring stations of open water and others more densely vegetated, due to slow current and thick submerged aquatic macrophytes. Rotifera was the dominant group in all studied stations, followed by Copepoda and then Cladocera. The same was recorded in previous studies of Iraq's inland waters by Al-Saboonchi et al. (1986), Sabri (1988), Al Laami et al. (1996 and 1998), and Nasha't (2001).

There were seasonal changes in the density of zooplankton (ind/m^3) during the spring, with a peak in April 2006, while values were the lowest in September (Figure 1.37). This pattern was shown previously by Al-Zubaidy (1988) and is in agreement with Ajeel (1998). The peak found in March and April is also in agreement with Mangol and Akbar (1986 a, 1986b, 1986c). Late summer declines in populations could be due to the feeding of fish larvae after the spawning season in early spring. Comparing the density (ind/m^3) obtained in

2005 with 2006 (Appendix 3) showed that the densities of zooplankton in 2006 were higher than in 2005, and approached those of previous studies (Ajeel1998, Mangalo and Akber 1998, Al-Zubaidy 1998). The orders of zooplankton were the same as recorded previously, similar to those in other Iraqi inland water bodies.

1.5.4 Aquatic Macrophytes

Ecological factors or man-made changes in an aquatic ecosystem play an important role in the distribution and productivity of aquatic macrophytes (i.e., temperature, salinity, content of organic substances, and grazing) and cause most of the variation in percentage of plant cover (Kheder and Loveit-Doust 2001). Quantitative characteristics of plant species were varied in the monitored stations. *C. demersum* was the dominant submerged aquatic species because it possessed a wide range of distribution and occurred in many aquatic habitats, like small narrow and shaded canals, ponds, and rivers, and also expanded to invade marshes and lakes. These habitats had different depths and salinity ranges, from 20-200 cm in depth and 0.4 -7.41 ppt salinity (Al-Mayah 1994) and more as shown by data of the IMRP program. Our ARDI monitoring program showed that *P. australis* was the dominant emergent macrophyte species, due to its tolerance to the drought conditions and its rapid regrowth from the seed imports or the soil seedbank, which was able survive through many years of dessication. The density of *P. australis* at Taraba station in Al-Hawizeh marsh was higher than at other stations, which was reflected in the high content of organic matter (TOC) in the substratum (Table 1.2, soil analysis/water quality section). Sanchez-Carriblle et al. (2001) pointed out that the percentage of cover of *P. australis* correlated with the degree of the sedimentation of organic matter in the freshwater wetlands of Spain. In contrast to the effect of the flooding regime and organic matter on structuring the vegetation, the variation in soil salinity between marshes appears to control the distribution of this plant species in Iraq. Higher values of salinity closer to East Hammar marsh are probably attributed to the complex interaction between daily and seasonal tidal input of salt (Brewer and Grace 1990) and may have resulted in the lower *P. australis* cover in this marsh and its absence in 2004 (Table 1.12).

The restoration index of macrophytes in Suq Al-Shuyukh was 100%, compared to the historical data. This means that water quality criteria and substrate are good enough to accommodate a diverse population of plants. However, the picture was different with East Hammar, as our comparison with previous data indicates that this marsh is not as healthy, because of higher salinity and low concentrations of organic matter.

1.5.5 Macroinvertebrates

The number of species in the three restored marshes increased in 2006 to 84. Insects composed more than half of the species (48), and snails the second largest number (13). The dominance of insects over the other groups is a healthy sign in water bodies, as it is known that insects make up 95% of the animal kingdom and are an important part of the trophic pyramid. The same is true of marshland fauna. Increased densities of individuals from 2005 to 2006 in all macroinvertebrate groups pointed to improved conditions in marsh communities, but densities were still below recorded values in natural Iraqi habitats (see Hamzah 1980, Ali and Salman 1986, Abdullah 1989, Rahma and Jaweir 1990, Ali et al. 1995, Ali and Salman, 1998, Hassan et al. 2000, Ali et al. 2002, Abdul-Saheb et al. 2003). However, the epiphytic fauna of Iraqi lakes and marshes have not been studied thoroughly, although the are considered an essential food resource for fish (Kornijow et al. 2001a), while studies of macrobenthos are very rare in lakes in Iraq (Kornijow et al. 2001b).

Our results indicate that densities and number of species in each square meter of plant cover were higher than those in the substratum. We found 1776-5381 individuals/m^2 on aquatic plants, in comparison to less than 500 individuals in the bottom substrate. These findings are similar to previous records in Habbaniya Lake (Kornijow et al. 2001a). In regard to species composition, Kornijow et al. (2001a) found 13 species from 14 taxa were insects on aquatic plants in the Thurthar and Habbaniya Lakes, and Kornijow et al. (2001b) recorded 20, 25, and 10 Insect species out of 40, 33, and 13 taxa in Thurthar and Habbaniya and Razzazah Lakes, respectively.

Our number of species in the three restored marshes in 2006 was slightly different from 2005. Al-Hawizeh had more species than the other marshes, in contrast to Suq Al-Shuyukh in 2005. This suggests that restoration in Al-Hawizeh was better and more developed than that in the other marshes, which may be related to its environmental characteristics (physical, chemical, and biological). For example, three of the macroinvertebrate groups that increased in Al-Hawizeh need high concentrations of calcium to build their shells. These groups include mussels, amphipods, and crabs. We speculate that the calcium, salinity, and hardness in Al-Hawizeh waters were higher in 2006 than in 2004 and 2005 (however, the hardness of Al-Hawizeh was about half that of Suq Al-Shuyukh in 2005). The minimum values in densities of macroinvertebrates were found in Suq Al Shuyukh marsh, which may be due to the presence of vast numbers of predators represented with Charadriiformes, especially plover, black stilit, etc. that feed mostly on snails, insects, shrimp, etc. This avian order comprised 40.5 % of total bird individuals in Suq Al-Shuyukh, in comparison to 16.3 and 46.4% in Al-Hawizeh and East Hammar, respectively, in 2006 (Abed/IRD 2006).

The decrease in richness in Al-Hawizeh and Suq Al Shuyukh was due to the huge increase in the number of individuals. The change in the number of species was not in the same sequences as individuals. The altered richness and evenness in East Hammar in 2006 could be related to the increased densities of pisivorous birds like Charadriformes, gulls and terns, which prey heavily on certain macroinvertebrate species.

Specific species of macrophytes were chosen by macroinvertebrates for feeding, shelter, and reproduction. *Ceratophyllum demersum* was the plant species to harbor the maximum species of macroinvertebrates (Hassan et. al 2000, Kornijow et al. 2001a, IRD 2006). The increased number of species of macroinvertebrates and their densities in 2006, compared to 2005, indicated that restoration is continuing to progress. A higher similarity was found been Suq Al-Shuyukh and East Hammar macroinvertebrates since both marshes were

receiving Euphrates stream water. Overall densities of macroinvertebrates were still below natural values in comparison with other marshlands of the world.

1.5.6 Fish

There was a large improvement in the size of fish collected or observed in the fish market over the survey period, indicating that the restored environment of the marshes supports the growth of these species. Moreover, there appeared to be plenty of resources available for the expansion of grass carp and common carp. Kishni (*L. abu*) was the most abundant species in the restored marshes, and this trend was the same as recorded in other Iraqi lakes by a Polish company in mid-1980s. An alien species (*C. carassius)* introduced in the early nineties was the second most common species, but in East Hammar it was the most prevalent species (Table 1.20). The introduced (alien) species may survive in the restored environment of the marshes better than native species, since no local enemies or predators have been recognized. The lack of the effect of local fish diseases for these species may also explain their large abundance in the restored marshes. The restored marshes are now considered a healthy environment, even after ten years of desiccation, and the species that survived are more resistant and their spawning has resulted in a high numbers of individuals for those species.

Improvement in the ecological indicators (diversity, richness, evenness) during 2006, compared with 2005, suggests that restoration is taking place and that the restored marsh environment is progressing towards recovery. The diversity index is important, since it can be used as an indicator of balanced restoration. Our restoration index (species present /historical record) was higher in 2006 than in 2005, meaning that more species have returned to the restored marshes. The highest percentage was in East Hammar marsh (71%).

The similarity index between Suq Al-Shuyukh and Al-Hawizeh was 80.9%, which reflects that fish species compositions in the two restored marshes was very close. This was probably due to the fact that the fish stock for both was derived from the same riverine fish assemblages (Tigris and Euphrates). A lower

similarity encountered between East Hammar and other marshes was due to the intrusion of few marine species to East Hammar. East Hammar is considered as a tidal oligohaline marsh.

The presence of several trophic levels, i.e., herbivorous, omnivorous, carnivorous, detritovorous, and predators reveals that a healthy trophic assemblage occurred in the restored marshes. A deviation in the trophic nature of studied fish species from historical records indicated that the restored environment did not match or resemble the previous natural one. The trophic pyramid of the monitored marsh was more natural in 2006 than 2005, because it more closely followed an ideal natural one, with a larger herbivorous base (Figures 1.58-1.60). The fish catch effort showed that Al-Hawizeh was more productive, because it was only partly desiccated and it has low salinity (Figure 1.5). East Hammar was less productive compared with other marshes, because of its higher salinity that is considered unsuitable for several fresh water species. Also, many marine species that cannot freely enter because of the oligohaline nature of the water. Heavy fishing pressure has also reduced the fish populations in this marsh.

1.5.7 Water birds

The Iraqi marshes have long been a refuge for millions of birds migrating from Europe and Northern Asia, and have contributed greatly as feeding, resting, and spawning sites (Allouse 1960, 1961; Georgae and Vielliard 1970; Carp 1975; Scott and Carp 1982). The 2006 monitoring of Iraq's restored southern marshes indicates that they still retain their original ability to attract migratory birds, mainly Anseriformes. In comparison with the previous monitoring period 2004-2005 in the southern marshes (Table 1.28), there were increases in the number of species and individuals recorded. The number of species increased 1.2 times in Al-Hawizeh, 1.4 times in Suq Al-Shuyukh, and 1.8 times in East Hammar. Considerable incremental increases were recorded in the number of indivuduals– 3 times in Al-Hawizeh, 2.4 times in Suq Al-Shuyukh, and 4.2 times in East Hammar. The total number of individuals in Al-Hawizeh was 6.4 times higher

than Suq Al-Shuyukh and 3.4 times higher than East Hammar. The number of species in Al-Hawizeh was 1.2 times higher than in the two other marshes.

For Anatidae, our latest survey indicates 13, 8, and 7 species of Anseriformes in Al-Hawizeh, Suq Al-Shuyukh, and East Hammar marshes respectively, and in all marshes 14 species of Anseriformes were seen (Table 1.27). The number of ducks in Al-Hawizeh was 16.5 times higher than in Suq Al-Shuyukh and 15.3 times higher than in East Hammar. The total number of recorded species was 74, of which 39 species were common in all marshes, seven species occurring in both Al-Hawizeh and Suq Al-Shuyukh. Five species appeared in both Al-Hawizeh and East Hammar, while four species were seen in both Suq Al-Shuyukh and East Hammar. There were eleven species that were seen only in Al-Hawizeh. There were 27 resident species that occurred more than nine months each year in the marshes. In addition to darter and goliath herons in Al-Hawizeh, certain territorial species appeared, like the pygmy cormorant (which was dominant in Al-Hawizeh), little egret (in Suq Al-Shuyukh), and gulls and terns (mainly whiskered terns) in East Hammar.

Historical surveys of water birds (Table 1.30) recorded the occurrence of 84 species in Hammar marsh and in lower Mesopotamia in winter, as shown by Georg and Viellared (1970), Koning and Dijksen (1973), Carp (1975), Scott and Carp (1982), and Scott (1995), while Allouse (1960, 1961) listed 134 species of water birds. Our current survey recorded 74 species of water birds in the three monitored marshes. Our bird restoration index, based on Scott's historical number of species (1995), was 88% for species and 14.3% for individuals.

Salem (1995) recorded 15 species of Anseriformes in some wetlands in the south of Iraq (Basrah province) during the ducks' migratory season in 1993-1994 (62,228 individuals), and the same researcher recorded 10 species of Anatidae (15,060 individuals) in middle wetlands (Razzaza Lake). Our current survey recorded 14 species of Anseriformes in the monitored marshes, with 6,162 individulals in Al-Hawizeh, 373 in Suq Al-Shuyukh, and 404 in East Hammar. Total numbers of individuals recorded by Salem (1995) were 9 times

higher than our current survey. Salem (1995) also recorded three species of Anseriformes (Goldeneye, Ruddy shelduck, and Mute swan) that were not encountered in the present survey. Our restoration index, according to Salem (1995) and Scott (1995), was 93%. Marbled teal (*Marmonetta angustirostris*) were also known to breed in Mesopotamia (Green 1993). Our current survey and nesting area visits agreed with Green (1993) and confirmed the breeding of this species in the marshes. In addition, other species were breeding in nesting areas in Al-Hawizeh, SuqAl-Shuyukh, and East Hammar, especially terns. Finally, migratory ducks and other water birds play an important economic role as an edible meat for the local people, and many of the species of Anseriformes and other species are again being sold in the local market.

1.5.8 Recovery Status of the Marshes

Although the marshes now cover a vast area—40% of the original area has been flooded (Richardson and Hussain 2006)—the arid weather still dominates southern Iraq. Consequently, the southern marshes are characterized by hot, long summers and short winters with prevailing northwestern winds. The restored marsh ecosystems have retained many of their previous functions from before their desiccation. Biogeochemical processes in winter that contribute to the transformation of nutrients and organic matter in the system have been retained. Processes such as primary productivity, nutrient uptake by algae and aquatic macrophytes, and feeding of zooplankton and fish larvae on phytoplankton in late spring are occurring.

The winter is unique for the marshland ecosystem. As the air and water temperature drop considerably, biological functions slow down or temporarily halt (i.e., primary productivity and decomposition of material slow greatly). Some of the species disappear, whereas cold-adapted species flourish, so the structure of the ecosystem differs from season to season. In winter, accumulation and elevated levels of nutrients occur, but levels are reduced in the spring and summer blooms. Moderately cold winters in the marshes encourage migration of

ducks and geese to the southern marshes from Siberia and northern Asia to feed and rest.

Spring and summer are considered as the seasons of energy generating in wetland. The first bloom of primary productivity happens during the April-May period, and the maximum harvest yield occurs in midsummer. Decomposition increases rapidly, to reach its peak in autumn, when the productivity and decomposition process rates converge. The second bloom of phytoplankton and maximum yield of hornwort occur in the same timeframe, and the peak of decomposition occurs.

When considering the rate and efficiency of wetland ecosystem processes, a higher functional diversity may be more important than just a higher number of species (Bronmark and Hansson 2005). Many studies have shown that species richness changes with increasing productivity of the habitat, but the exact shape of this relationship is still obscure. Most empirical studies in aquatic systems suggest a unimodle (hump-shape). The relationship between species richness and productivity (Bronmark and Hansson 2005) was recognized in Iraq's restored marshes. Huge increases in the number of individuals, accompanied by a slow recovery of species, led to biological indices that did not reflect the total image of the restored wetland. In general, the restoration of Iraqi wetlands is progressing rapidly, according to data collected during the last 24 months. One major question that remains is related to macroinvertebrates, since there are limited historical data for comparison with our current surveys.

1.5.9 Overall Percentage of Similarity Among Marshes

The highest similarity was between flora and fauna populations of Suq Al-Shuyukh and East Hammar marshes (Table 1.31), with values ranging from 73.7% for macroinvertebrates to 84.3 % for birds. Fish assemblages were more similar between Al-Hawizeh and Suq Al-Shuyukh marshes, because both contain only freshwater species. East Hammar and Al-Hawizeh were the least similar.

1.5.10 Overall Recovery Index

In general, there was an improvement in the overall recovery index in each trophic level in 2006, when compared to 2005 values (Table 1.32, Figure 1.72). Certain trophic levels approached a very high percentage of recovery, as in the case of phytoplankton and macroinvertebrates (100%). Other groups scored high to medium levels, like aquatic macrophytes, water birds, and fish, especially in 2006. East Hammar showed the lowest rate of recovery for most groups. However, the overall increase from 2005 to 2006 clearly demonstrates a dramatic recovery rate for most functional groups in the marshes.

Table 1.31. Percent similarity of the major groups of flora and fauna among the three restored marshes

Trophic Group	Hawizeh & Shuyukh	Hammar & Shuyukh	Hammar & Hawizeh
Fish	80.9	66.6	55.5
Macroinvertebrates	64	73.7	69.2
Macrophytes	62	63.6	55.9
Birds	76.7	84.3	73.3
Phytoplankton	67.2	68.5	67.9
Zooplankton	68.6	84.2	67.5

Table 1.32. A comparison of recovery index of major groups in three restored marshes between 2005 and 2006

Marsh	**Al-Hawizeh**		**Suq Al-Shuyukh**		**Hammar**	
Year	**2005**	**2006**	**2005**	**2006**	**2005**	**2006**
Phytoplankton	65.9	91.0	69	94.9	45.5	100.7
Macrophytes	65.9	73.8	69.0	100.0	45.1	71.4
Macroinvertebrates	--------	---------	100.0	120.6	100.0	120.6
Fish	57.1	64	60.7	71	55.5	64.2
Birds	61.9	73.8	44.1	63.1	34.5	63.1

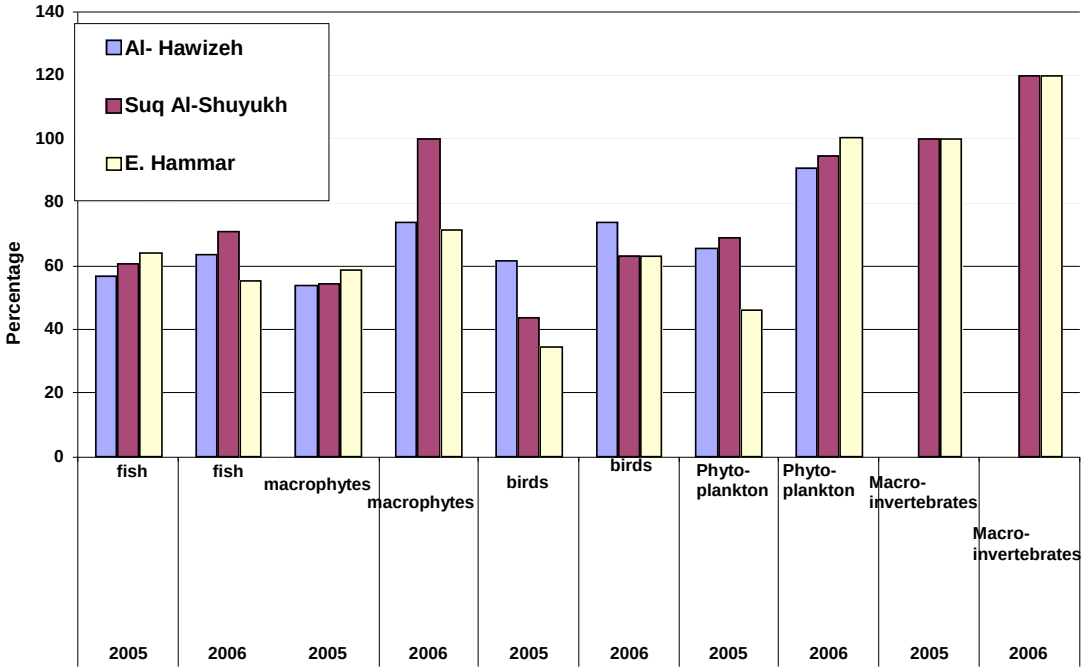


Figure 1.72 A comparison of the recovery index (%) of major groups in three restored marshes between 2005 and 2006.

1.6 Summary and Conclusions

1.6.1 Water Quality

The Iraq marshlands can be classified generally as oligohaline. The water quality values of each marsh depend on the water sources of the Tigris, Euphrates, or Shatt Al-Arab Rivers. Water temperature exhibited large seasonal variations, with lowest temperatures in winter about 10 ^{o}C and higher than 30 $^{\circ}$C in summer; typical of the arid climate of southern Iraq. Water currents in the marshland played a substantial role, affecting light penetration through resuspension of the fine sediments.

All water parameters were found to be in ranges to support growth of the historic main marsh species. The water of restored marshes exhibited nearly the same quality as recorded in historical times, except for higher nutrients and slightly elevated sodium at some locations. Water parameters of the monitored marshes showed the same seasonal variation as previous studies. Monitored marshes retained their role as a sedimentation sink, due to slow water currents. Water transparency remained high, but not as good as in historic times. Higher nutrients support the restoration process of the marshes and improve primary productivity. ,Water leaving the monitored marshes was characterized by lower nutrients, indicating uptake by bacteria, phytoplankton, and macrophytes. Specific findings are as follows:

- The marsh waters were always well oxygenated, i.e. above 5 mg/l (above the fish-critical level).
- Hypoxia was rare except in certain areas with heavy vegetation. Low BOD values indicate that limited organic pollution occurred in the restored marshes.
- Moderate to low levels of NO_3-N and total N suggest the importance of nitrate as a limiting factor for growth of phytoplankton. Decomposition processes in the marshes were illustrated by higher fall, spring, and summer ammonia levels in contrast to low winter levels of ammonia.

- The pH of the three restored marshes was slightly alkaline, indicating availability of bicarbonates and a slight increase in free CO_2 in water. Iraq marshland's waters are regarded as hard.

- Sulphate concentrations in marshlands closely correspond to water composition values of the input values of Tigris, Euphrates, and Shatt Al-Arab rivers.

- Sodium values showed the influence of the Persian Gulf on the marshes, as in the case of East Hammar marsh where higher salinity values were found.

- High levels of water column oxygenation were found in both restored and natural marshes.

1.6.2 Phytoplankton

Primary productivity as expressed by chlorophyll-a showed two peaks, the biggest in the spring and the other in autumn. This was the same pattern found in the historic studies. The number of phytoplankton cells showed a dual mode seasonal pattern, also previously found in historical records. Diatoms were the dominant algal group in all monitored marshes, the same as was recorded in Iraqi rivers and lakes. An inverse relationship existed between chlorophyll-a, number of cells of phytoplankton, and nutrients as shown by most past studies. Specific findings were:

- The number of species of phytoplankton in East Hammer was higher than in the other marshes, and approached historic levels.

- Bascillariophyta (Diatoms) were the dominant group of phytoplankton in all marshes, resembling other Iraqi water bodies.

- Maximum levels of chlorophyll-a and total number of phytoplankton cells in the East Hammer Marsh were higher than found in other restored marshes.

- Recovery indices of phytoplankton species were 91%, 95%, and 100% in Al-Hawizeh, Suq Al-Shuyukh, and East Hammer marshes, respectively.

- Values of primary productivity were high in comparison to historical data.

1.6.3 Zooplankton

Rotifera, Copepoda, Cladocera, and free Nematodes were the dominant orders of zooplankton populations, the same as were recorded previously in Iraqi rivers and lakes, which indicates that restoration is taking place. Peak zooplankton counts were recorded in the spring, the same trend as before marsh desiccation. Specific findings are:

- A double seasonal peak occurs in zooplankton populations with the first peak in the spring (bigger) and the second in the fall (smaller).
- The lowest number of individuals seems to occur in summer.
- There was a significant increase in the number of zooplankton counts in 2006, compared with 2005.
- Composition of zooplankton groups (orders) and densities were similar to those of other Iraqi water bodies.
- Spatial and temporal differences exist in zooplankton taxa in the monitored marshes.

1.6.4 Aquatic Macrophytes

Plant restoration in the monitored marshes was well under way, as noted by the number of recorded species, seasonal variations in species, and percent cover, density, and frequency. Historically dominant species were dominant once again, as noted by high densities of *Phragmites australis* and *Ceratophyllum demersum.* Other species like cattail (*Typha domingensis*), and rush (*Schoenoplectus litoralis*) were present but in low density. Water lilies, which historically were recorded in the area, are still absent from most of the monitored marshes. Specific findings are:

- There was an increase in the number of plant species recorded in 2006, in comparison to 2005.
- The plant species restoration index of the marshes reached 100% in Suq Al-Shuyukh and 71% in East Hammer. No historical records were available for comparison for Al-Hawizeh marsh.

- Plant restoration is progressing in the monitored marshes, as indicated by the reoccurrence of species, spatial and temporal increases in densities, percentage of cover, frequency, and increased productivity harvests.

- Historical species are appearing again, with the dominance of common reeds (*P. australis)* and Hornwort (*C. demersum*). Other species occurred like cattail (*T. domengensis*) and rush (*S. litoralis).*

- The difference in aquatic plant communities in the three monitored marshes could be due to water regime, salinity of substratum, and physical and chemical characteristics of the water.

1.6.5 Macroinvertebrates

The recovery in species composition was good, especially for snails, shrimp, and crabs, but other species were low in numbers and apparently need more recovery time. Numbers of individuals were low in all groups in the restored marshes, except for shrimp. Aquatic plants maintained their previous role as a host for macroinvertebrates. Clear relationships existed between the types of aquatic plants and species of macroinvertebrates. Restoration of the bottom fauna was slow, partly due to the hardness of the bottom (former desiccated marsh soils), which hinders recolonization of bivalves, Annelids, and crustaceans. Seasonal increases in abundance of different groups of macroinvertebrates suggest that restoration is taking place for this trophic level. Specific findings are:

- Improvement in the number of species of macroinvertebrates groups indicates that the restored marshes have a suitable environment for recolonization.

- Huge increases in the number of individuals of macroinvertebrate taxa imply that the restored marshes are a suitable area for reproduction.

- Increases in diversity, evenness, and richness of the major group of macroinvertebrates further demonstrate restoration.

- Al-Hawizeh marsh showed better improvement in number of species and their densities than did other restored marshes.

- High similarity existed between Suq Al-Shuyukh and East Hammar, and could be due to the fact they have the same source of water.

- Improvement in insect populations is a positive sign, since they form a major food item for fish and birds, and they also constitute a major part of the macroinvertebrates population in a healthy natural wetland.

- Recurrence of marine shrimp (*Metapeanus affinis*) in East Hammar marsh indicated the return of this commercial shrimp, a source of food to the marsh inhabitants and other local peoples.

1.6.6 Fish

Restoration of fish assemblages in Al-Hawizeh marsh was more complete than was found in Suq-Al Shuyukh and East Hammar. Higher fish catches in Al-Hawizeh were another indication that restoration was further advanced at this site than in Suq Al-Shuyukh and East Hammar. Al-Hawizeh was a better environment for economic species such as *B. sharpeyi.*

Silurus triostegus, a predator species, constituted a high percentage of the fish biomass in Suq Al-Shuyukh and East Hammar. This has upset the normal food pyramid in these marshes. Collection of ichthyoplankton, juveniles of *Barbus spp.,* and other native species gave clear indication that the southern marshes have retained their original role as a spawning ground, nursery site, feeding area, and refuge for fish. Specific findings are:

- Immature sbour (*T. ilisha*), shabbot (*Barbus=Tor grypus)* and *Gara rufa* were recorded in Suq Al-Shuyukh marshlands during 2006.

- Silver molly (*Poecilia mollienesia velifera*) was recorded in Suq Al-Shuyukh and East Hammar marshes during 2006.

- *L. abu* was the dominant species in Al-Hawizeh and Suq Al-Shuyukh marshes and *C. carassius* was more abundant in East Hammar.

- *Grass carp (C. idella*) and silver molly (*Poecilia mollienesia velifera*) have invaded the restored marshes.

- Ecological indices (Richness, Diversity, and Evenness) in general show an incremental increase from 2004 to 2006, except for East Hammar.

- The similarity index for fish was higher (81%) between Al-Hawizeh and Suq Al-Shuyukh than between East Hammar and Suq-Shuyukh (67%).

- Fish catch per unit time by using electro fishing was as follows:
  - Al Hawizeh < Suq Al-Shuyukh < East Hammar
  - 17.16 kg/h < 9.75 kg/h < 4.45 kg/h

- The marsh fish community was affected by a number of factors mainly water level, catch per unit effort (CPUE).

- The fish restoration index scored 71% in Suq Al-Shuyukh and East Hammar and 64% in Al-Hawizeh.

1.6.7 Water birds

Our discovery of numerous breeding and nesting sites was an obvious indication that bird habitat restoration is in progress, but numbers of birds are still low compared to the previous natural environment bird counts.

A return of winter visitors like ducks, geese, and coots is another indication that the southern reflooded marshes have retained their previous role as wintering grounds. Recovery of resident species was a good sign, reaching 60% less than two years after reflooding. Recovery on the anatidae was more than 80%. Specific findings are:

- Seventy-four species were recorded in all the monitored marshes. Sixty-two species were recorded in Al-Hawizeh marsh, and fifty-three species in both Suq Al-Shuyukh and East Hammar marshes.

- The total numbers of individual birds recorded were 28,331 in Al-Hawizeh, 4,443 in Suq Al-Shuyukh, and 8,465 in East Hammar. The species composition greatly increased from 2004 to 2006, reaching historical levels in certain general groups.

- Species similarity in the monitored marshes was closest between Suq Al-Shuyukh and East Hammar.

1.6.8 Ecosystem Recovery

Various indices were used to assess ecosystem recovery. Assessments were made for all trophic levels, and comparisons with historical records provided a basis for determining recovery rates.

- The percentage of recovery was different for various trophic levels, but in general the percentage was more than 60%. In some cases organism recovery, in terms of species numbers or plant biomass, etc. reached more than 100% of historical values.

- The species composition was highly improved from 2004 to 2006, reaching historic records in certain groups.

- Species similarity in tha monitored marshes was closest between Suq Al-Shuyukh and East Hammar.

- The number of individuals within many groups is still behind the historical data. In some areas, bird populations were 10% to 15% of historical counts.

- Biodiversity shifts are taking place in the restored marshes. Seasonal changes in numbers of species and individuals occur, or some species disappear, as a result of decreased temperature or water level changes.

- Ecosystem functions were returning, as shown by increases in primary productivity, bimonthly peaks in zooplankton biomass, aquatic macrophyte cover and biomass, increases in fish numbers and sizes, and increases in bird numbers and species richness.

- Decomposition of organic material and oxidation and reduction of minerals are taking place in the bottom sediments of the reflooded marshes, and indicate the return of normal biogeochemical processes.

1.7 Recommendations

1.7.1 Water Quality

The following recommendations are made based on three years of monitoring in the marshes. It is clear that continued monitoring is needed to see if the marshes will continue to recover and progress towards normal ecosystem functions on the landscape. Specific recommendations are:

- A separate and adequate water quota for the marshes is needed to maintain at least the present level of recovery.

- A continuous monitoring program is needed for the restored marshes, to be sure that restoration continues to progress and that serious problems of water quality or soil pollution are not occurring.

- Creation of marsh sanctuaries is needed to provide for high-quality water habitat to protect rare and endangered species.

1.7.2 Phytoplankton

- An expansion of open water areas (reducing density of *Phragmities* or dense vegetation in some locations) is needed due to the importance of open water areas to fishery life cycle requirements and to increase landscape diversity.

- Detailed study of phytoplankton blooms and dominant species is needed to assess food chain dynamics for fish.

- Measurement of the primary production of phytoplankton in marshes is needed to assess recovery and growth rates in the future.

1.7.3 Aquatic Macrophytes

- Reintroduction of rare species, which were previously recorded in the marshes, is essential for ecosystem diversity (e.g. water lilies).

- A fixed water quota (maintain historic hydroperiod conditions) for southern marshes is needed to maintain the plant communities that are vital to restoration.

- The use of some aquatic plants, which are present in high biomass, is encouraged for animal food or crafts. Historical cutting by marsh dwellers also maintained open water areas for fish

1.7.4 Macroinvertebrates

- Continuous monitoring of species composition in the southern marshes for important species like mussels is needed. Set up a mussel watch program to assess future pollution problems.

- Complete an investigation of the dispersal of rare species found in this study, such as snail *Pila ovatus*, Caddis fly, and crab *Sesarma spp*.

- More detailed studies of the biology, ecology, and culturing of giant shrimp *Macrobrachium spp.* are needed, due to it's high commercial value.

- Detailed studies are needed of different macroinvertebrates that live on submerged plants, to determine their importance as food sources.

- We recommend that swimming in the marshes be avoided, owing to the presence of the first intermediate host (the snail *Bulinus truncatus*) of bloody urine disease (Bilharzias).

1.7.5 Fish

- A marsh release of fingerlings of *B. sharpeyi, B. xanthopterous* and *Ctenopharyngodon idella* is needed to improve the fishing stock.
- Release silver carp to use the phytoplankton biomass.
- Form sanctuaries for fish to maintain fish stock.
- Details studies should be done of icthioplankton and spawning and nursery grounds, to better assess future fishing stocks and harvesting potential.
- Apply fishing laws and regulations.

1.7.6 Ecosystem Recovery

- Continue to monitor key ecosystem functions (productivity, biogeochemistry, hydrology, decomposition, community habitat) to assess recovery success.
- Develop an overall restoration model to assess recovery.
- Expand monitoring program, especially in the Central marsh area.
- Develop and support a network of scientists to continue research in the marshes.
- Develop a new field station for research in the marshes.
- Work with the Iraq Agricultural and Water Ministries to establish a water regulation plan for sustaining the marshes.

1.7.7 General Recommendations

- Encourage tourism and bird watching in the future as a source of local income.
- Restart the pulp factory, using common reeds, to provide local employment.

- Develop aquaculture programs in the marshes to help support the local marsh dweller populations, which would provide food and income–and in turn, stability–to the region.

1.8 Acknowledgments

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APPENDICES

Appendix 1. Spatial occurrence of phytoplankton species identified in the three restored southern marshes

TAXA	Al- Hawizeh	Suq Al-Shuyukh	East Hammar
Cyanophyta			
Anabaena affinis	+	+	+
Chroococcus dispersus	+	+	+
Gloeotrichia natans	+		
Lyngbya aerugineo-coerulea	+	+	+
L.contorta			+
Merismopedia glauca	+		+
Microcoleus laustris		+	
Nodularia paludosum		+	
Nostoc paludosum.	+		+
Oscillatoria agardhii	+		
O. angusta		+	
O. limosa	+	+	+
O. tenuis	+	+	+
Phormidium ambiguum	+		+
P. retzi	+	+	
Rivularia globiceps			+
R. habasgirgii	+		
Scytonema alatum			+
Spirulina major	+	+	+
S. princes	+	+	+
S. supsalsa	+		+
Chlorophyta			
Actinastrum angustus	+	+	+
A. grasillimum	+	+	
Chlorella vulgaris	+	+	+
Cladophora fracta	+	+	+
C. glomerata		+	
Closterium depressum	+	+	+
C. lunula	+		+
Coelastrum microsporum	+		+

TAXA	Al- Hawizeh	Suq Al-Shuyukh	East Hammar
Cosmarium cucumis	+	+	+
Cylindrocapsa geminella	+		
Microspora floccosa	+	+	
Mougoetia viridis.	+	+	
Oedogonium cripsum	+	+	
O .nanum		+	+
Oocystis borgei			+
Pandorina morum		+	+
Pediastrum duplix	+	+	+
Rhizoclonium crassipellitum	+	+	+
Scenedesmus armatus	+	+	+
S. bijuga	+	+	+
Sphaerocystis plactonica		+	
Spirogyra affinis	+	+	+
S. porticalis	+		
S. subsalina		+	+
S. ionia	+		
Volvox africanus		+	+
Ulothrix tenerrima	+	+	+
U. variabilis.	+	+	
Euglenophyta			
Euglena acus		+	+
E. elasica	+		+
Phacus pleuronectus	+	+	+
Trachelomonas crebea	+	+	+
Chrysophyta			
Dinobryon sertolaria	+	+	+
D. stipitatum	+		+
Rhodophyta			
Compsopogon coeruleus		+	+
Bacillariophyta			
Achnanthes inflata			+
Achnanthes lanceolata		+	+
Amphiprora alata	+	+	

TAXA	Al- Hawizeh	Suq Al-Shuyukh	East Hammar
Amphiprora plndosa	+		+
Amphora ovalis		+	+
Bacillaria paradoxa	+	+	+
B. paxillifer	+	+	+
Campylodiscus noricus		+	
Coccneis placentula	+		+
C. placentula var.eugypta	+	+	+
C. pediculus	+		
Cyclotella atomus	+		
C. striata			+
C. meneghiniana	+	+	+
C. pseudostelligera	+	+	
Cylindrotneca gracilis		+	+
Cymbella affinis	+	+	+
C. cistula	+	+	+
C. prostrata			+
C. turgida	+		+
C. ventricosa		+	
Diatoma vulgare	+	+	+
Diploneis ovalis	+		+
Epithema argus		+	+
E. sorex	+	+	
E. zebra		+	+
Fragilaria argus		+	+
Fragilaria capucina	+		+
F. crotonensis	+	+	+
F. pinnata		+	
F. pirescens Var. capitata	+		
F. vaucheriae	+	+	+
Gomphonema acuminatum		+	
Gomphonema constrictum	+	+	+
G. olivaceum	+	+	+
G. vibrio		+	

TAXA	Al- Hawizeh	Suq Al-Shuyukh	East Hammar
Gyrosigma fasciola	+		
G. attenuatum	+	+	
Mastogloia braunii		+	+
Mastogloia grevillei	+	+	
Melosira italica	+		+
Melosira varians	+	+	+
Navicula cryptocephala	+	+	+
N. cuspidata	+	+	+
N. lanceolata		+	+
N. mutica		+	+
N. parva	+	+	+
N. perrotettii			+
N. placetula	+	+	+
N. salinarum			+
N. spicula	+		+
Nitzschia aciclaris		+	+
N. (Nitzschiellae) aciclaris		+	
N. amphibia	+		+
N. apiculata	+		+
N. dissipata		+	+
N. fasciolata		+	+
N. frustulum		+	+
N. longissima	+	+	+
N. linearis		+	+
N. obtusa	+	+	+
N. palea	+	+	+
N. paleacea			+
N. philipinarum	+	+	
N. punctata var.coarctata		+	
N. sigma		+	
N. viridula	+		+
Neidium affine			+
Pinnularia major		+	+
P. viridis	+	+	

TAXA	Al- Hawizeh	Suq Al-Shuyukh	East Hammar
Pleursigma delicatulum	+	+	
Rhoicosphenia curvata	+	+	+
Rhopalodia gibba	+	+	+
R. gibba var.ventricosa	+		+
R. rhopala			+
Surirella biseriata	+		+
Surirella robusta		+	+
Synedra capitata	+	+	+
S. fasciolculata	+	+	+
S. ulna	+	+	+
Tabellaria fenestrata	+	+	+
TOTAL SPECIES RECORDED	**94**	**98**	**104**

Appendix 2. Seasonal occurrence of phytoplankton species in the monitored Iraqi marshes. H=Al-Hawizeh. S=Suq Al-Shuyukh. E=East Hammar.

Taxa	Autumn	Winter	Spring	Summer	Sum
Cyanophyta					
Anabaena affinis		HSE	HE	HE	HSE
Chroococcus dispersus	HSE	HSE	HSE	HSE	HSE
Gloeotrichia natans			H	H	H
Lyngbya aerugineo-coerulea	E	SE	HSE	HSE	HSE
L.contorta			E	E	E
Merismopedia glauca	E	E	HE	HE	HE
Microcoleus laustris	S		S	S	S
Nodularia paludosum	S	S	S	S	S
Nostoc paludosum.			HE	HE	HE
Oscillatoria agardhii	H	H	H	H	H
O. angusta			S	S	S
O. limosa	HSE	HSE	SE	SE	HSE
O.tenuis	HS	HSE	HSE	HE	HSE
Phormidium ambiguum			HE	H	HE
P. retzi	HS	S	H	H	HS
Rivularia globiceps			E		E
R.habasgirgii			H		H
Scytonema alatum			E		E
Spirulina major	HSE	HSE	SE	SE	HSE
S.princes	HE	HE	HS	HSE	HSE
S.supsalsa	E	E	HE	E	HE
Chlorophyta					
Actinastrum angustus	SE		HS	H	HSE
A. grasillimum	H		S	S	HS
Chlorella vulgaris	HS	HSE	HSE	HE	HSE
Cladophora fracta	HSE	HSE	HSE	HSE	HSE
C.glomerata			S		S
Closterium depressum	HS	HSE	HS	HS	HSE
C.lunula	H		HE	HE	HE

Taxa	Autumn	Winter	Spring	Summer	Sum
Coelastrum microsporum	HE	HE	H	E	HE
Cosmarium cucumis	HE	HSE	HE	E	HSE
Cylindrocapsa geminella	H		H		H
Microspora floccosa	HS	HS	HS	HS	HS
Mougoetia viridis.	H		S	S	HS
Oedogonium cripsum	HS	HS	HS	HS	HS
O.nanum			SE	E	SE
Oocystis borgei			E		E
Pandorina morum	SE	SE	SE	SE	SE
Pediastrum duplix	HE	HSE	SE	SE	HSE
Rhizoclonium crassipellitum	HS	HS	HS	HS	HS
Scenedesmus armatus	HSE	HSE	HSE	HSE	HSE
S. bijuga	HSE	HSE	HS	HS	HSE
Sphaerocystis plactonica	S		SE	E	SE
Spirogyra affinis	HS	HSE	HS	HE	HSE
S. porticalis	H		H		H
S.subsalina	S		SE	E	SE
S. ionia	H	H	H	H	H
Volvox africanus	S	S	SE	E	SE
Ulothrix tenerrima	S	SE	S		SE
U. variabilis.	HS	HS	HS	S	HS
Euglenophyta					
Euglena acus	SE	SE	S	S	SE
E. elasica	H	H	HE	E	HE
Phacus pleuronectus	HSE	HSE	E	E	HSE
Trachelomonas crebea			HSE	HE	HSE
Chrysophyta					
Dinobryon sertolaria	HE	HSE	H	E	HSE
D.stipitatum	H	H	E		HE
Rhodophyta					
Compsopogon coeruleus	SE	SE	SE	E	SE
Bacillariophyta					
Achnanthes inflata	E	E	E		E

Taxa	Autumn	Winter	Spring	Summer	Sum
Achnanthes lanceolata	SE	SE	S	E	SE
Amphiprora alata	HE	HSE	H	E	HSE
Amphiprora plndosa	E		HE		HE
Amphora ovalis	SE	SE	SE	E	SE
Bacillaria paradoxa	HSE	HSE	SE	SE	HSE
B. paxillifer	HSE	HSE	HSE	HSE	HSE
Campylodiscus noricus	S		S		S
Coccneis placentula	HE	HE	HE	HE	HE
C. placentula var.eugypta	HSE	HE	HS	HS	HSE
C. pediculus	H	H	E	E	HE
Cyclotella atomus	H	H	H	H	H
C. striata			E		E
C. meneghiniana		HSE	HE	H	HSE
C. pseudostelligera	H		HS	H	HS
Cylindrotneca gracilis			SE	S	SE
Cymbella affinis	HSE	HSE	HSE	HSE	HSE
C. cistula	HSE	HSE	SE	SE	HSE
C. prostrata	E	E	E	E	E
C. turgida	H	HE	H	H	HE
C. ventricosa	HSE	HSE	SE	E	HSE
Diatoma vulgare	H	H	HE	H	HE
Diploneis ovalis	SE	SE	S	S	SE
Epithema argus	HS	HE	H	H	HSE
E. sorex	SE	SE	SE	E	SE
E. zebra	HE	HE	E	E	HE
Fragilaria argus	HSE	HSE	HSE	HSE	HSE
Fragilaria capucina	E	E	SE	E	SE
F. crotonensis	H		H		H
F. pinnata	HE	E	HE		HE
F. pirescens Var. capitata	E		SE	E	SE
F. vaucheriae	HSE	HSE	HSE	HSE	HSE
Gomphonema acuminatum	HSE	HSE	H	H	HSE
Gomphonema constrictum	S		S		S

Taxa	Autumn	Winter	Spring	Summer	Sum
G. olivaceum	H	H	H	H	H
G. vibrio	HS	H	HS	H	HS
Gyrosigma fasciola	S	S	SE	S	SE
G. attenuatum	S	S	HS	S	HS
Mastogloia braunii	H		E		HE
Mastogloia grevillei	HSE	HSE	HSE	HSE	HSE
Melosira italica	HSE	HSE	HS	HS	HSE
Melosira varians	HSE	HSE	HSE	HSE	HSE
Navicula cryptocephala			SE	E	SE
N. cuspidata	HSE	HSE		E	HSE
N. lanceolata	HSE	HS	HS	HS	HSE
N. mutica			E		E
N. parva	HSE	HSE	HSE	HSE	HSE
N. perrotettii			E		E
N. placetula	HE	H	HE	E	HE
N. salinarum	SE	S	SE	S	SE
N. spicula			S		S
Nitzschia aciclaris			HE	E	HE
N. (Nitzschiellae) aciclaris			HE	H	HE
N. amphibia			SE	E	SE
N. apiculata	SE	E	SE	SE	SE
N. dissipata			SE	E	SE
N. fasciolata	HE	H	HSE	HSE	HSE
N. frustulum			SE	S	SE
N. longissima	HSE	HSE	HSE	HSE	HSE
N. linearis	HSE	HSE	HSE	HSE	HSE
N. obtusa			E		E
N. palea			HS	H	HS
N. paleacea	SE		SE	E	SE
N. philipinarum	S		S		S
N. punctata var.coarctata			HE		HE
N. sigma			E		E
N. viridula			SE		SE

Taxa	Autumn	Winter	Spring	Summer	Sum
Neidium affine	HS		HS	H	HS
Pinnularia major	HSE	HS	HS	HS	HSE
P. viridis	HSE	HSE	HSE	HSE	HSE
Pleursigma delicatulum	HSE	HSE	SE	SE	HSE
Rhoicosphenia curvata	HE		HE		HE
Rhopalodia gibba	E		E		E
R. gibba var.ventricosa	H	H	HE	H	HE
R. rhopala	SE	SE	S	S	SE
Surirella biseriata	HSE	HSE	SE		HSE
Surirella robusta	SE		HSE	E	HSE
Synedra capitata	HSE	HS	HSE	HSE	HSE
S. fasciolculata	HSE	HSE	HSE	HSE	HSE

Appendix 3. Comparison of total number (individuals/M^3) of zooplankton between 2005 and 2006 in all marshes

East Hammar		Al-Hawizeh		Suq Al-Shuyukh		
2006	**2005**	**2006**	**2005**	**2006**	**2005**	Yr. / mo.
60950	**(no data)**	4940	4830	24010	2350	**Sept.**
63625	**(no data)**	48370	21250	26880	3435	**Oct.**
68600	**(no data)**	26720	4125	24005	3450	**Nov.**
82460	3915	20545	6945	9675	18435	**Dec.**
60145	74335	17405	101390	26435	27420	**Jan.**
49560	50590	20890	**(no data)**	11960	16935	**Feb.**
108585	102810	43410	45575	49870	71925	**Mar.**
45515	47470	98350	124630	34470	31290	**Apr.**
60100	59960	27850	45710	31700	30800	**May**
32400	28650	24450	22350	26025	23125	**June**
22475	19925	18700	16550	8400	7740	**July**
(no data)	21170	**(no data)**	4860	**(no data)**	14025	**Aug.**

Appendix 4. Spatial occurrence of macroinvertebrate species in three restored marshes (H:Al-Hawizeh, S: Suq Al-Shuyukh and E: East Hammar) in 2006

Species	Group	Marsh
Agrion sp.	**Insect**	**H**
Aschnidae	**Insect**	**H, E, S**
Belostoma sp.	**Insect**	**E**
Blue dragon adult	**Insect**	**H, E, S**
Brachythemis fuscopalliata adult	**Insect**	**H, E, S**
Chironomidae	**Insect**	**H, E, S**
Coleoptera (brown)	**Insect**	**H, E, S**
Coleoptera (gold)	**Insect**	**H**
Coleoptera (green)	**Insect**	**H S**
Coleoptera (grey)	**Insect**	**H**
Coleoptera (yellow)	**Insect**	**H, E, S**
Coleoptera Larvae	**Insect**	**H**
Corixidae	**Insect**	**H, E, S**
Damselfly (blue)	**Insect**	**H, E, S**
Damselfly (pink)	**Insect**	**H**
Damselfly (orange)	**Insect**	**E**
Diptera epifauna	**Insect**	**E**
Diptera 1	**Insect**	**H, E, S**
Diptera 2	**Insect**	**H E**
Diptera 3	**Insect**	**S**
Diptera 4	**Insect**	**H**
Diptera black	**Insect**	**H**
Diptera grey	**Insect**	**S**
Diptera long legs	**Insect**	**H S**
Dragon adult	**Insect**	**H S**
Dragon fly nymph	**Insect**	**H**
Dytsidae	**Insect**	**H, E, S**
Gerris sp.	**Insect**	**E S**
Green dragon adult	**Insect**	**S**
Hemiptera	**Insect**	**H, E, S**

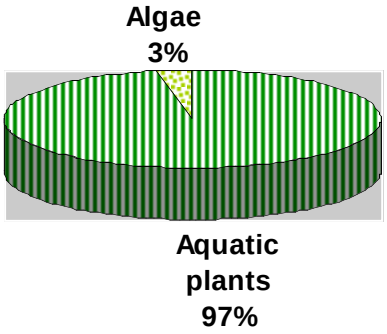
Species	Group	Marsh
Hydrophilidae	**Insect**	**H**
Insect larvae (Diptera)	**Insect**	**H**
Insect larvae 1	**Insect**	**H, E, S**
Ischnura sp.1	**Insect**	**H, E, S**
Ischnura sp.2	**Insect**	**H, E, S**
Ischnura sp.3	**Insect**	**H, E,S**
Large dragon nymph	**Insect**	**H, E, S**
Libellulidae 1	**Insect**	**H, E, S**
Libellulidae 2	**Insect**	**H, E, S**
Marsh grasshopper	**Insect**	**S**
May fly	**Insect**	**H**
Mosquito	**Insect**	**H E**
Old women needle	**Insect**	**S**
Orange dragon adult	**Insect**	**H**
Plecoptera	**Insect**	**H, E, S**
Predator insect	**Insect**	**H E**
Unidentified insect 1	**Insect**	**S**
Unidentified insect (orange)	**Insect**	**H**
Bellamya bengalensis	**Snail**	**H, E, S**
Bellamya unicolor	**Snail**	**H, E, S**
Bulinus truncatus	**Snail**	**H, E, S**
Gyraulus costulatus	**Snail**	**H, E, S**
Lymnaea auricularia	**Snail**	**H, E, S**
Lymnaea gedrosiana	**Snail**	**H, E, S**
Lymnaea natalensis (arabica)	**Snail**	**H, E, S**
Melanoides tuberculata	**Snail**	**E S**
Melanopsis nodosa	**Snail**	**E S**
Melanopsis praemorsa	**Snail**	**H, E, S**
Physa acuta	**Snail**	**H, E, S**
Theodoxus niloticus (jordani)	**Snail**	**H, E, S**

Species	Group	Marsh
Ataephyra desmarsti mesopotamica	**Shrimp**	**H, E, S**
Caridinia baboulti basrensis	**Shrimp**	**H, E, S**
Macrobrachium equidens	**Shrimp**	**H, E, S**
Macrobrachium rude	**Shrimp**	**E**
Metapenaeus affinis	**Shrimp**	**E**
Lumbricus sp.	**Annelida**	**H S**
Oligochaet 1	**Annelida**	**H, E, S**
Oligochaet 2	**Annelida**	**H E**
Polychaet	**Annelida**	**H E**
Aranidae 1	**Spider**	**H, E, S**
Aranidae 2	**Spider**	**H E**
Aranidae 3	**Spider**	**H E**
Aranidae 4	**Spider**	**H**
Aranidae 5	**Spider**	**H E**
Elamenopsis kempi	**Crab**	**E S**
Sesarma boulangeri	**Crab**	**H, E, S**
Sesarma sp.	**Crab**	**S**
Corbicula fluminaea	**Mussel**	**H, E, S**
Corbicula fluminalis	**Mussel**	**H, E, S**
Unio tigridis	**Mussel**	**S**
Paryhale basrensis	**Amphipod**	**H, E, S**
Sphaeroma ananndelli	**Isopoda**	**E S**
Balanus amphitrite	**Cirripedia**	**E**

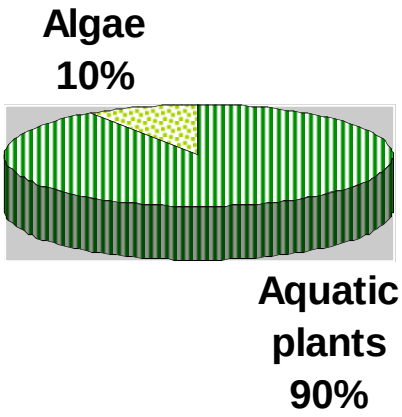
Appendix 5. Food sources for the major fish species in the monitored marshes are shown below. These data support the food pyramid diagrams (1.58, 1.59, and 1.60) shown in the main text, Section 1.47.

Figure 1. Diet composition of *B.sharpeyi* in restored marshes

(Fig.1a)*: B. sharpeyi* in Suq Al-Shuyukh



(Fig.1b)*: B. sharpeyi* in Al-Hawizeh



(Fig. 1c)*: B.sharpeyi* in East Hammar

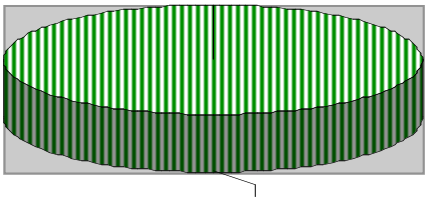
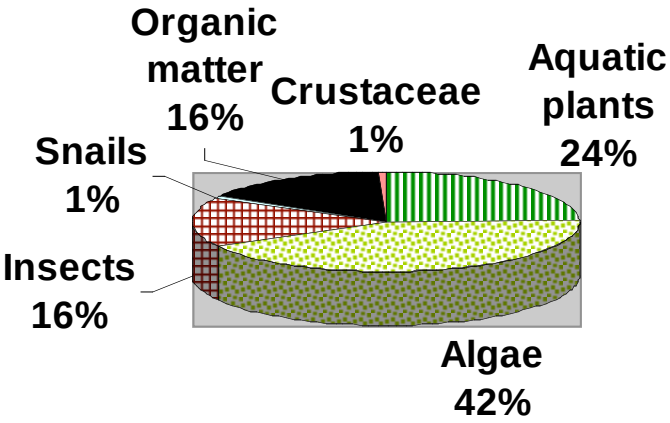
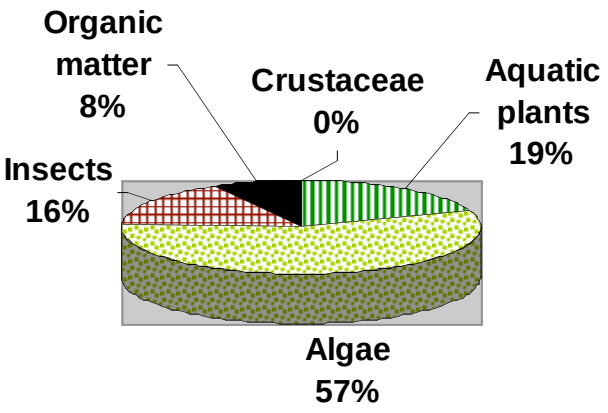


Figure 2. Diet composition of *C. carassius* in restored marshes

(Fig. 2a*) : C. carassius* in Suq Al-Shuyukh



(Fig. 2b)*: C. carassius* in Al-Hawizeh



(Fig. 2c)*: C. carassius* in East Hammar

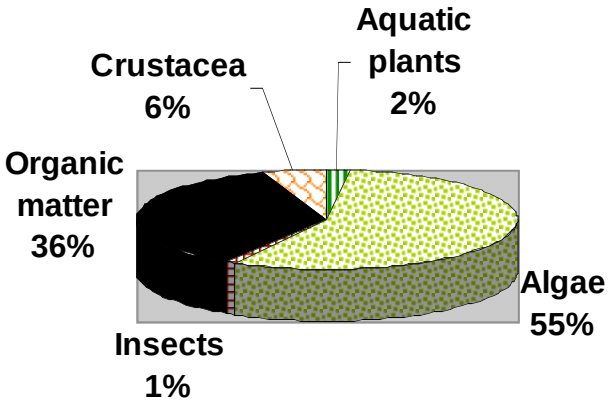
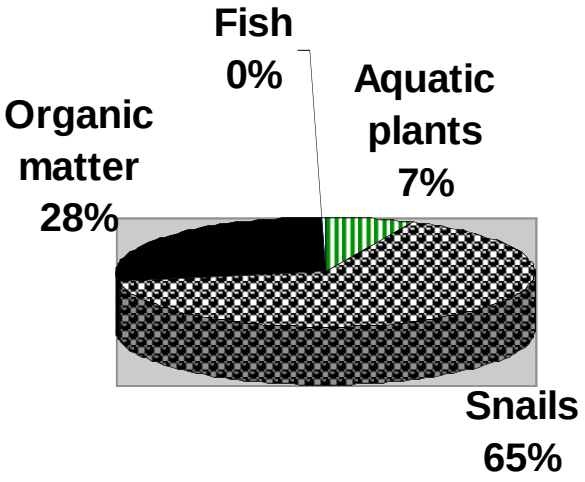
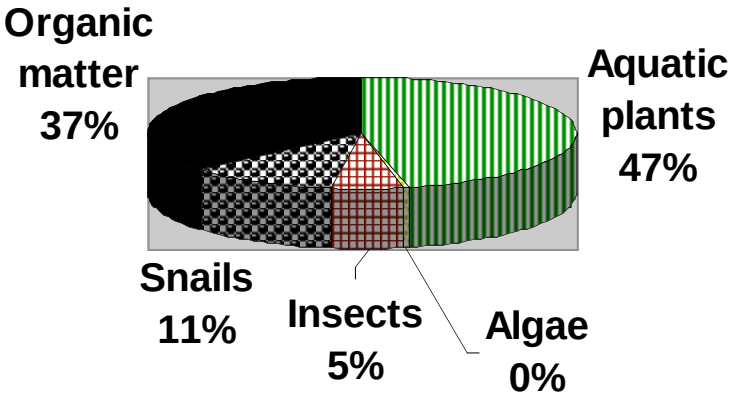


Figure 3. Diet composition of *C. carpio* in restored marshes

(Fig. 3a) :*C. carpio* in Suq Al-Shuyukh



(Fig. 3b):*C. carpio in Al-Hawizeh*



(Fig. 3c)*: C. carpio* in East Hammar

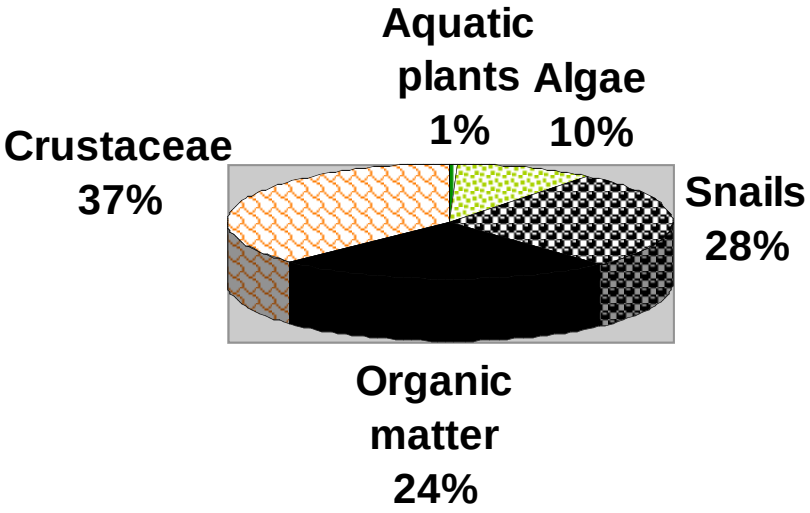
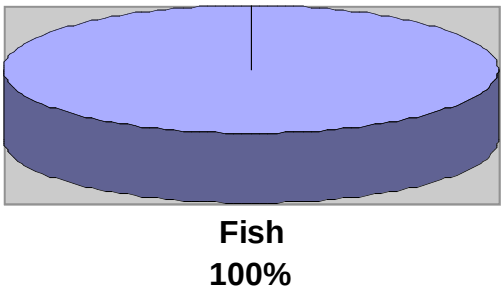
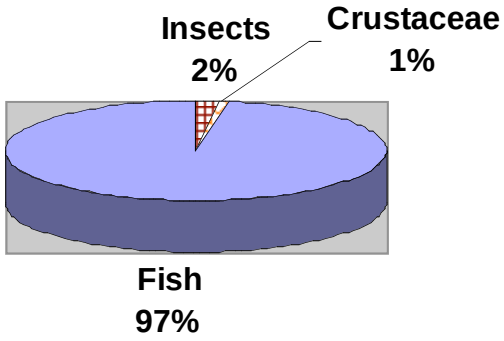


Figure 4. Diet composition of *A. vorax* in restored marshes

(Fig. 4a)*: A.vorax* in Suq Al-Shuyukh



(Fig. 4b): *A. vorax* in Al-Hawizeh



(Fig. 4c): *A.vorax* in East Hammar

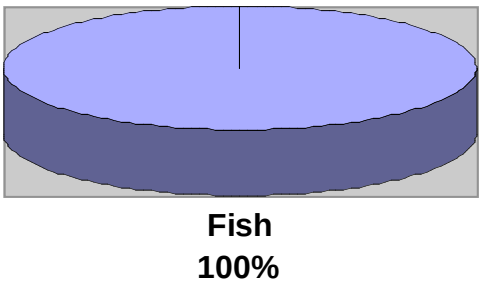
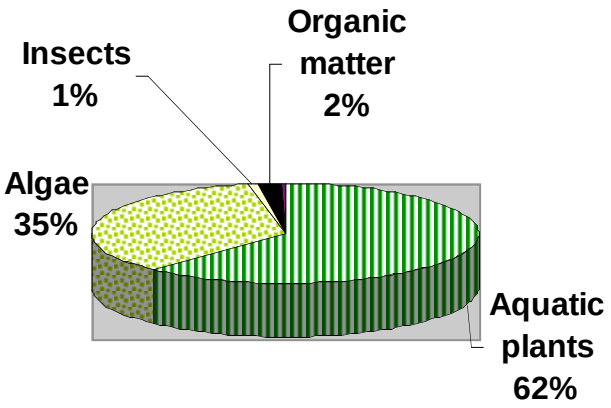
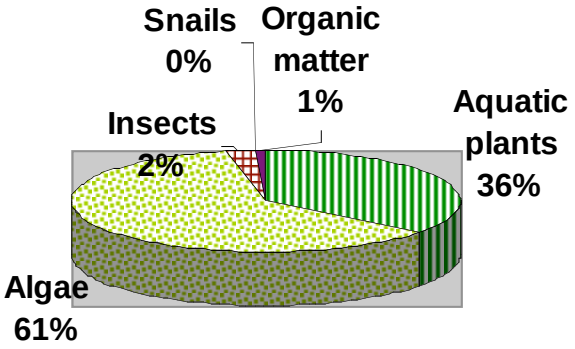


Figure 5. Diet composition of *B. luteus* in restored marshes

(Fig. 5a)*: B. luteus* in Suq Al-Shuyukh



(Fig. 5b)*: B. luteus* in Al-Hawizeh



(Fig.5 c): *B. luteus* in East Hammar

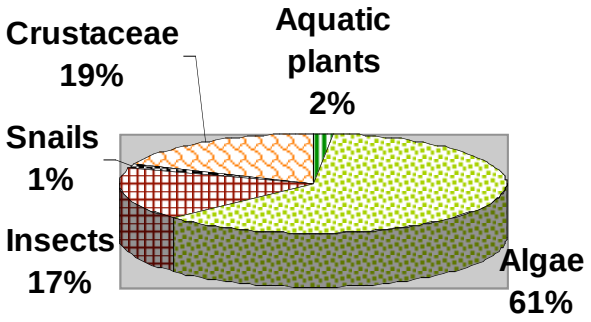
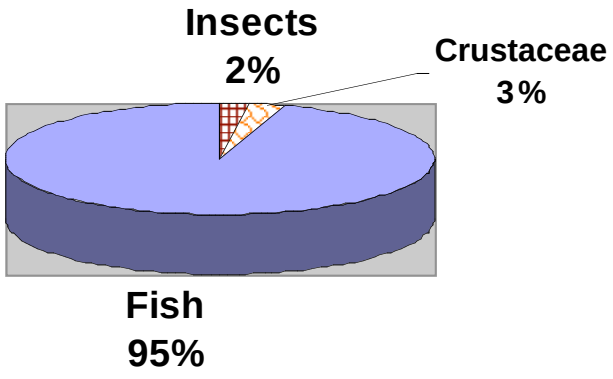
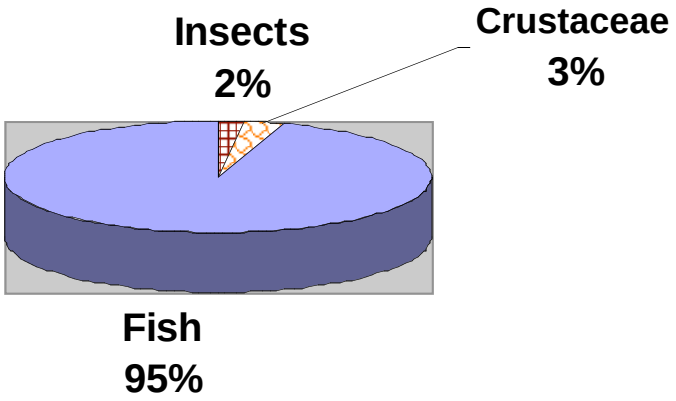


Figure 6. Diet composition of *S.triostegus* in restored marshes

(Fig. 6a)*: S. triostegus* in Suq Al-Shuyukh



(Fig. 6b)*: S. triostegus* in Al-Hawizeh



(Fig. 6c)*: S. triostegus* in East Hammar

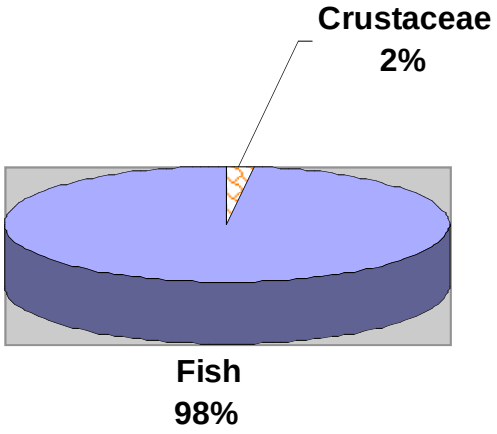
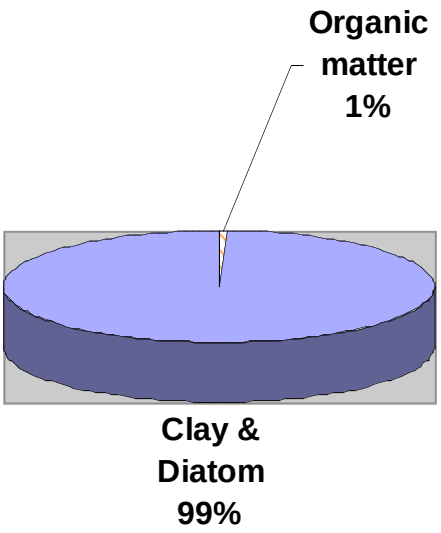
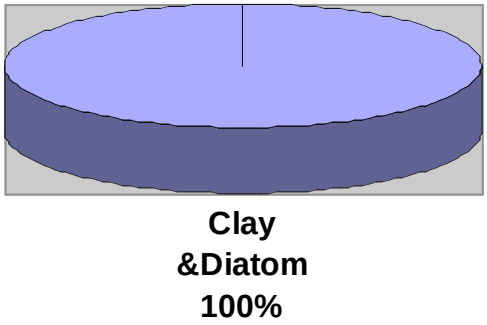


Figure 7. Diet composition of *L.abu* in restored marshes

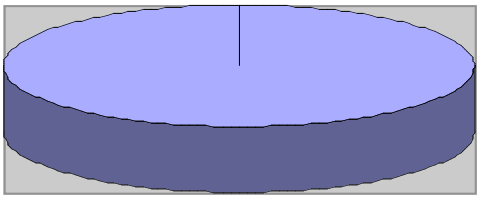
(Fig. 7a)*: L.abu* in Suq Al-Shuyukh



(Fig. 7b): *L. abu* in Al-Hawiyzeh



(Fig. 7c): *L. abu* in East Hammar



Clay
&Diatom
100%

Appendix 6. Methods

Water Quality

Field measurement:

Parameter	Methods/Instrument
Air Temp.	YSI 556MPS
Water Temp.	“ “ “
Conductivity	“ “ “
Salinity	“ “ “
pH	“ “ “
TDS	“ “ “
DO	“ “ “
Flow rate	Sontek (Flow Tracker)
Transparency	Secchi disc
Depth	Sontek (Flow Tracker)

Water Chemistry Analysis:

Phosphate	Parsons et al. 1984
Nitrate	“ “ “
Na	Standard Methods 1975
SO_4-S	“ “ “
NH_4-N	“ “ “
Total N	“ “ “
BOD	“ “ “
CO_3	“ “ “

Phytoplankton

QUALITATIVE STUDY/ FIELD	Plankton net at 20 µm mesh/15 min
IN THE LABORATORY	Hickman and Klarer 1974
QUANTITAVE STUDY	Maulood and Boney 1980
Chlorophyll-a	Vollenweider 1974
Identification	Smith 1950, Prescott 1970, Al-Handal et al. 1989, Hadi et al. 1984

Zooplankton

QUANTITATIVE MEASUREMENTS	Hundred liters of water & filter net of mesh size of 60 µm
QUALITATIVE MEASUREMENTS	plankton net of 60 µm mesh size was dragged for about ½ hr.
LABORATORY MEASURMENTS	numbers of individuals counted then the average was calculated for 100 liters
Abundance =	no. of species n / total no. of species) X 100

Aquatic Macrophytes

Field collection	Transect perpendicular at 20 m intervals. Vegetation was evaluated in ($1m^2$) quadrate. Biomass according to Lind 1979
Estimation cover	Braun-Blanquet method (1965)
Calculations n	Frequency = total number of quadrats in which species occurs / total number of quadrats. Density = number of individual sampled per quadrat / total number of quadrats

Macroinvertebrates

Field procedure	Wooden quadrate $625cm^2$ with aquatic plants and with bottom sediments. Small conical hand net (mesh size 1mm), mouth diameter 220mm. Ekman dredge (30x15x15) cm
Laboratory procedure	Clay materials laid in aquarium, separated by washing them with plenty of water over sieve (mesh 0.4-0.6 mm)
Identification	Sultan 1987, Hameed 1989, Abdul-Sahib 1989, Edmondson 1959.

Fish

Field work	Different mesh size nets and electrical fishing device.
Identification	Khalaf 1961, Beckman 1962, Coad1990
Laboratory examinations	Frequency and point methods for food analysis Hynes1950. Diet items Edmondson 1959, Schmitt 1950, Smith 1971, Macan 1972, Piplein et al. 1977
Ecological calculations	Similarity-Jaccard 1908, Abundance-Odum 1979, Richness-Margalef 1968, Diversity-Shannon & Weaver 1949, Evenness-Pielou 1966

Water Birds

Field work	Watching by binocular and census individuals
Identification	Porter et al. 1996
Ecological calculations	Similarity-Jaccard 1908, Abundance-Odum 1979, Richness-Margalef 1968, Diversity-Shannon & Weaver 1949 Evenness-Pielou 1966