AN ASSESSMENT OF THE LOWER MOULOUYA IRRIGATION PROJECT

by

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Introduction

In May 1978 a contract was signed between USAID and the University of Minnesota to carry out an assessment of the economic and social effects of the Lower Moulouya Irrigation Project in Northeast Morocco. The research team was directed by Professor Robert T. Holt of the University of Minnesota and the field research was directed by Dr. David Seddon of the Overseas Development Group at the University of East Anglia in the United Kingdom.

USAID's association with the development of the Lower Moulouya project started at the beginning of the 1960's with an agreement to provide a loan of approximately 23 million dollars for the construction of storage dam and major irrigation facilities such as the dead head and main canals. A second loan was provided in 1975 for the enlargement of the irrigation perimeter on the right bank of the Moulouya River to include an area above the main canal known as the Triffa high service.

During the 1960's the major thrust of international aid policy and of the national policy in a significant number of underdeveloped countries was towards the rapid economic development of selected areas primarily through major capital investment project such as dams and irrigation works. The objective was to maximize economic growth with little attention being paid to equity matters such as income distribution. Such an approach has characterized Moroccan policies for agricultural development up until the present, in large part as result of advice given through the 1960's by such agencies as USAID and the World Bank.

In the 1970's, however, donor agencies such as USAID and the World Bank have questioned the approach which was so dominant in the 1960's. The

new orientation was as concerned with poverty as with growth, and stated broadly: "The new development strategy must reject the thesis that poverty can be attacked indirectly through the growth rates filtering down to the masses. It must be based on the premise that poverty must be attacked directly" (Mahbub ul Haq, Director of the Policy Planning Department in the World Bank, April 1972). This has led to a growing interest in investment programs aimed primarily at the small farmers and landless laborers who constitute the vast majority of rural producers. In so far as the majority of the rural work force live in areas outside the immediate orbit of large scale development projects such as irrigation perimeters it has become the conventional wisdom to regard this new strategy as inevitably to be associated with improved dry land farming.

While the approach taken in the 1960's has come under serious criticism in the 1970's there have been very few analyses of the large capital projects of the earlier type to determine exactly what their socio-economic impact has been. This assessment is an attempt to begin to overcome that deficiency. The contract provided that the evaluation was to consist of four major elements; 1) an analysis of variations in production and productivity as a result of the irrigation project, 2) a financial benefit-cost analysis; 3) an extended economic and social analysis of the effects of the irrigation project and 4) a set of conclusions and recommendations. There are four plains that are irrigated through the project: The Triffa on the right bank of the Moulouya and the Sebra, Bou Areg and Gareb on the right bank. The contrast explicitly excluded the Gareb from the study.

The analysis of variations in production and productivity was according to the contract to include two types of study 1) a longitudinal study to compare production and productivity before and after irrigation and 2) a cross-comparison of present day production and productivity in land under irrigation including a comparison with land in the region that is not presently irrigated. Chapter Two of this report is intended to deal with these provisions of the contract.

The cost benefit analysis was to focus largely on those variables that are relatively easy to quantify. The cost of the project in this part of the study were the expenditures for basic construction, the operating and maintenance cost of ORMVAM and the cost of production. The benefits considered are those that accrue to farm managers, land owners, and agricultural labor. The cost benefit analysis and its results are reported in Chapter Three.

The extended economic and social impact analysis (an extended cost benefit analysis) follows from the stated concerns of USAID with the consequences of large scale capital intensive projects and their equity and distributional implications. In this context the contract asks for an extensive study of the impact of the irrigation project on different socio-economic groups with particular reference to changing access to resources and to social facilities, and also to income distribution. It was suggested in the contract that specific attention be paid to the condition of small farmers and landless laborers and to the relationship between irrigation and labor migration. Chapter Four reports this extended economic and social analysis.

The conclusions and recommendations are contained in Chapter Six.

In order for the reader to understand the analysis we have undertaken it is necessary to have some familiarity with the region and its developmental history. Chapter one is devoted to that purpose.

To readers interested in the methodology of the project, a separate paper is available from AID/Washington. A very detailed case study on change on the Sebra plain is also available under separate cover. As these two topics have a much more limited, interested audience than the main report, they are being circulated separately.

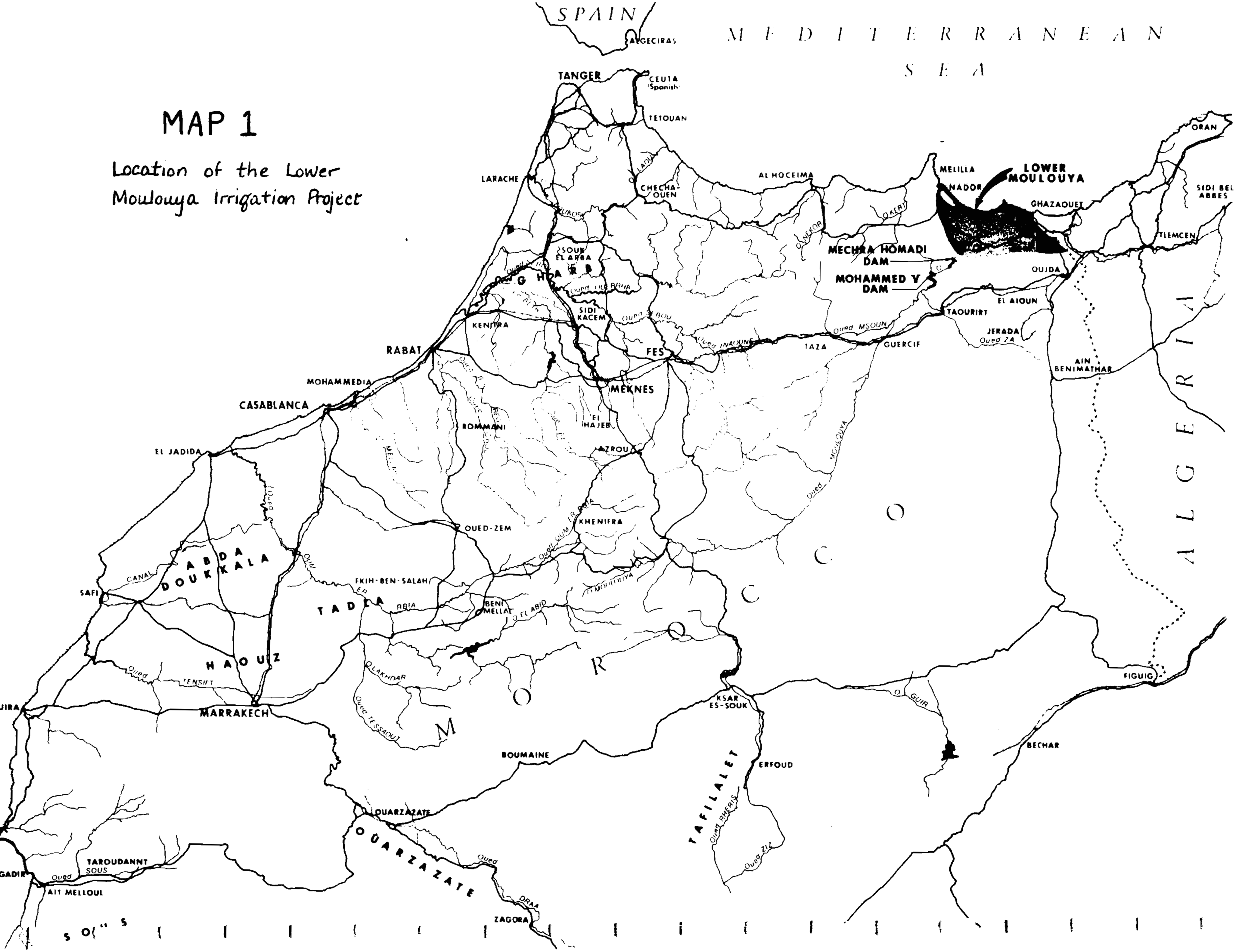
There were some problems encountered during the period of field work that prevented the research team from following its original research design and forced it to exclude some things from the study. Permission by the Minister of the Interior to do field research was delayed in reaching the Provincial governors and no survey work could be undertaken on two of the three plains until just three weeks before the team departed from Morocco. This also impeded collecting locally available data on the state farms. In order to partially overcome this delay the team stayed in the field somewhat longer than anticipated and did not spend enough time in Rabat and Casablanca to collect data on available only in these places on electricity generation and on state farms.

Some members of the team had expected to go to Morocco to discuss the draft report submitted in 1980. Arrangements were made to collect some missing data and check out some major discrepancies in data collected on state farm production. This trip was cancelled over our objections. One consequence of the delay in getting the required permission to do field work

and to travel to Morocco after the completion of the draft report is that we have not been able to include any analysis of the state farms in this report.

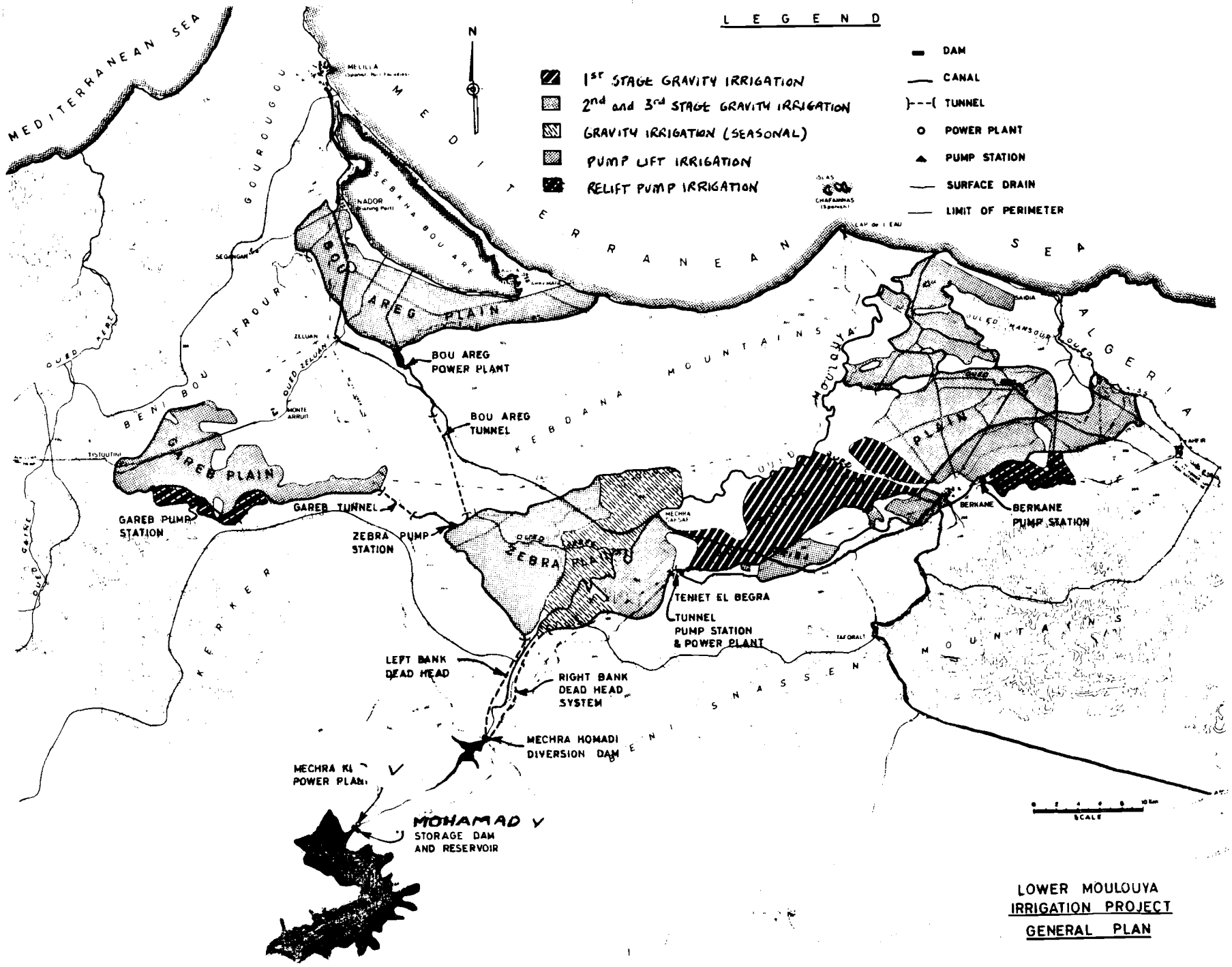
In addition to Professor Robert Holt and Dr. David Seddon who served as director of the project and director of field research respectively, the project team consisted of Dr. Piers Blaikie from the Overseas Development Group, Professors Malcolm Purvis and Terry Roe and Mr. Tewfik Ben Redgeb and Mr. Robert Deuson from the University of Minnesota and Monsieur Amane M'Barek from the Agricultural Institute in Rabat Morocco. In addition Mr. Richard Frankel worked briefly with the field team.

The research team accumulated a large number of debts during the research period. As is typical in research projects we cannot repay these debts but only acknowledge them. We would like to thank M. Abderrazak El Allani, Director of ORMVAM for the cooperation he showed our research team. It is not always comfortable to be in the position of the director of a project that is to be evaluated by a group of outsiders from foreign countries but if he were uncomfortable M. El Allani never displayed it. The entire staff at ORMVAM was very cooperative with us in all of our investigations. They all showed the easy confidence of the members of an organization who know they are doing an important job and doing it well.



MAP 1

Location of the Lower Moulouya Irrigation Project



LOWER MOULOUYA
IRRIGATION PROJECT
GENERAL PLAN

MAP 2

CHAPTER ONE

The Lower Moulouya Region Before the Advent of Irrigation

The lower Moulouya region lies in the extreme northeast of the Kingdom of Morocco. (See Maps 1 and 2.) It is bounded on the north by the Mediterranean Sea, on the West by the eastern outcroppings of the Rif Mountains (called the Kerker, the Beni Bou Ifrour and the Gorrougou), on the southwest by a range of hills and ridges that build to the high plateau that lies east of the Taza gap, and on the south and east by the Beni Snassen Mountains. The northeast corner touches the Algerian Border. The center of the area in the northern part is punctuated by a small range of hills called the Kebdana Mountains.

The Moulouya River divides the region. On the right bank the Triffa Plain (60,000 ha.) stretches about 50 kilometers from the southern edge of the perimeter northeast to the Mediterranean Sea and the Algerian border. On the left bank there are three plains. The Sebra in the South (20,000 ha.), the Bou Areg on the Northwest edge of the region (17,000 ha.) and the Gareb on the West (25,000 ha.).

Over half of the irrigable land (43,000 ha.) within the perimeter is on the Triffa plain, but the Triffa is also the most heterogeneous. The southern part extending north to the Cherraa River is sheltered from the maritime influences of the Mediterranean by the Kebdana mountains. The average rainfall is about 250 mm, but the annual variation is high. The plain to the north of Cherraa benefits from more rainfall and a higher water table. French settlers engaged in extensive pump irrigation in this region before the advent of Moulouya project. The northern most area near the mouth of the Moulouya is quite marshy and historically was not cultivated.

The Sebra plain with 8,600 irrigable hectares lies on the southern edge of the perimeter. It is the driest of the plains being sheltered like the southern part of the Triffa from the Mediterranean by the Kebdana and being more exposed to the hot winds from the south. It has no water table. The Bou Areg is a crescent shaped region that lies on the coast of a shallow, salt water lagoon that opens to the Mediterranean. While rainfall is more plentiful in this area, the plain has little elevation or relief. Ground waters tend to be brackish and drainage can be a problem. 12,300 hectares are irrigable.

The Gareb is in the western part of the region. It will not be irrigated until 1980 and was explicitly excluded from this study.

The Moulouya is not only of geographical importance in the region; it also has political and administrative significance. Historically, it marked the boundary in the northeast between the Spanish and French zones of occupation. Today it is the dividing line between the Province of Oujda on the right bank and the Province of Nador on the left. For administrative purposes Moroccan provinces divided up into districts or "circles". The area under irrigation on the right bank is in the Circle of Berkane. The situation on the left bank is more complicated. The Sebra is in the Circle of Louta, the Bou Areg in the Guelaia and the Gareb in the Rif. These administrative districts are important in this study because certain statistics are collected at the level of the Province and others at the level of the Circle. As the boundaries of the irrigation perimeter are not coincidental with the administrative regions, certain extrapolations will have to be drawn from administrative regions to the command area of the irrigation project.

Within the perimeter there are two major towns. Berkane on the right bank lying at the edge of the Beni Snassen Mountains had a population in 1980 of about 50,000.[1] The headquarters of the irrigation project, the Office Regional de Mise en Valuer de la Moulouya (ORMVAM), are located here. On the left bank on the northwest edge of the Bou Areg Plain is Nador, capital of the province of the same name. Its population in 1980 was approximately 35,000.

Seven large villages are now prominent in the region; Segangan and Selwan on the Bou Areg (population 8,000 and 3,000 respectively); Zaio on the Sebra (population 5,000); Monte Aruit and Tistoutine on the Gareb; and Afhir and Saidia on the Triffa (population 15,000 and 3,000 respectively). Saidia is a tourist resort on the Mediterranean coast and is blessed with thousands of meters of beautiful sand beaches.

There are two cities just outside the perimeter. Oujda, the capital of the provinces with the same name, lies 60 kilometers east of Berkane. Situated at the eastern terminus of the major west-east transportation arteries (both rail and highway), it is the metropolis of eastern Morocco with a population of 300,000. Twenty kilometers north of Nador is the Spanish enclave city of Melilla. Captured by the Spanish from the Moors in the 1490's, it was the base from which the Eastern Rif was dominated by Spain in the beginning of the twentieth century. These two cities are major markets for the agricultural produce of the lower Moulouya and a foci for much commercial activity.

230 kilometers to the southwest of Nador is Taza (population 100,000) and on the same highway 120 kilometers further is Fez, one of the major

centers of Moroccan culture (population 400,000). On the Mediterranean coast about 150 kilometers west of Nador is Al Hocema. The major cities of Western Morocco, Tetuan and Tangiers in the north and Rabat, Casablanca and Meknes in the center are far away.

While for the past two decades the political tensions between Morocco and Algeria have greatly restricted commercial and cultural interchange, historically the contacts with western Algeria were very significant. Oran was a more important urban center for the region than were the great cities on the Atlantic coast that now are so dominant in Moroccan economic and political life.

The main transportation artery in the basin is an excellent hard surfaced highway that runs from Melilla in the North through Nador, across the river to Berkane in the Southwest and on to Oujda. Two highways run south and intersect with the main Fez-Oujda west east highway - one on each side of the river. The eastern route running south from Berkane winds through the Beni Snassen Mountains in a series of spectacular hairpin turns. The highway on the left bank does not go through such tortuous terrain but it does twist and turn enough to slow down heavy goods transport. The only through route to the west winds through the rugged Rif Mountains touching Al Hocema on the coast and going on to Tetuan and Tangiers. There are no rail lines that connect the region to the rest of Morocco.

Largely for reasons of terrain and distance, the lower Moulouya region has been remote from the centers of Moroccan culture, political life and economic activity. It has not however, been isolated from the outside

world. Indeed, for millennia it has been in contact with the commercial and cultural life of the Mediterranean. Melilla was the Phoenician City of Rusidir. From classical times into the modern era the region has been a northern terminus for a trans-Saharan trade route. For over 100 years the proximity of two borders, the Spanish at Melilla and the Algerian has facilitated commercial exchange-some of it illicit, as smugglers rose to the challenge of potential profits to be made from vagaries of tariff boundaries.

While the region is not large, it manifests great diversity. Name the dimension--topography, climate, culture, history, politics--and even a superficial survey will uncover significant heterogeneity. The land varies from what can only be called near desert at the southern edge of the Sebra plain to cedar groves in the Beni Snassen and Rif Mountains to marshy swamp land near the mouth of the river where not many decades ago the malarial mosquito lurked. Rainfall varies from about 250 millimeters a year to over 400 in some of the mountain areas, but the annual variation is high. A year or more may go by in the driest parts with no significant precipitation.

Seven different tribes identify some area within the basin as a part of their homeland. Two colonial powers, France on the right bank and Spain on the left, pursued quite different colonial policies in the region throughout the first half of the twentieth century.

In the mid 1950s as independence came to Morocco, irrigation from the dammed waters of the Moulouya came to the Northeast. While discussions about a Franco-Spanish project to harness the river dated from the early years of the protectorate, firm agreements were not reached until after

World War II. Construction on the right bank canal system began in 1947. In 1952 work on a diversion dam was undertaken and by 1956 this dam, the right bank dead head canal and the southern portion of the Triffa main canal were completed and irrigated cultivation with waters from the Moulouya was initiated. By that time Morocco had been independent for almost a year and there were problems confronting the newly independent state that meant that developments on the lower Moulouya could not receive much attention. In 1960, however, the Moroccan government obtained a $23,000,000 loan from the U.S. Development Loan Fund. Work began immediately on a large storage dam (originally called the Mechra Klila, but changed later to Mohamad V), the Sebra main canal, the Bou Areg tunnel and the remainder of the Triffa main canal. Construction on the dam was seriously delayed in 1963 when an unusually severe food hit the area and the dam was not completed until 1969. By that time the entire Triffa, with the exception of the high land above the main canal was under irrigation and the following year irrigated agriculture began on the left bank. In late 1975 detailed planning began on the next phase of the scheme--irrigation of the high Triffa. Irrigation in that area began in 1978 and the entire high Triffa should be under irrigated production in 1980.

The final extension of the project is in the Gareb plain. Work began in the late 1970s and the Gareb should be under irrigation by the end of 1980.

Our task is to assess the impact of the dam and irrigation works. It is no easy endeavor. It involves not the relatively simple task of comparing the region in the late 1970s to what it was like before the

project in the early 1950s, but the far more difficult challenge of assessing what it was like in the late 1970s and will be into the next century, with what it would have been in the absence of the project. By defining the problem in this manner three central questions begin to emerge. The first concern is the kind of evolutionary trends that were present in the region before the advent of the irrigation project and which would have continued to change the region even in the absence of the project.

In the popular western mind there exists an image of a sleepy traditional community, changeless for centuries and relatively isolated from the dynamic forces of the outside world. It is unlikely that this image is accurate for any but a small minority of regions in the developing world. It is certainly a false picture of the Lower Moulouya Basin in the first half of the Twentieth Century. But recognizing that the region was in a state of flux before the project is not enough. There are certain important changes that could have been induced by the project but also may have been underway long before the beginnings of irrigation. Population growth is an example of this kind of change. The great increase of financial resources in the region and the increased food production that resulted from the irrigation project could have stimulated increased population growth rate. Alternatively growth rates could have already been high and were relatively unaffected by the project. Only by undertaking some historical analysis can the impact of the project be sorted out from the development that would have occurred in its absence.

The second question concerns the effects of other events that were taking place coincidentally with the irrigation project. The year the water first flowed from the Moulouya onto the southern part of the Triffa plain was the year that Morocco become independent. This dramatic political event affected the northeast in many ways and it is important not to confuse the consequences of independence wih the effect of the irrigation project.

Another important development in the region was the massive labor migration to Europe that began in the 1960s. This had a far reaching economic and social impact but only if we can see this immigration in historical perspective can we sort out the effects of immigration from the effects of the project.

The third question is in many ways the most intriguing. Certain developments that took place during the period of colonial rule would have remained relatively unconsequential to the economic life of the region had there been no project. With the project however they took on new significance. The transfers of land which occurred immediately after the protectorate was established are a good example. Had there been no project and the land had remained in its relatively unproductive state, the conflicts that originated in these transfers would have been of little economic significance. But with the changes that came with irrigation the stakes were raised and the conflict took on a new economic significance.

In order to gain some insight into these problems we turn to a brief historical review of the region.

THE MOULOUYA BASIN IN PRE-COLONIAL TIMES

The 19th century was the twilight of the great Moorish kingdom of Western Islam. At the height of its power it controlled not only vast territories in northwest Africa but also a good share of the Iberian peninsula. By the end of the 19th century, however, the central government institutions were badly weakened. Part of the territory that was nominally under their control were, in fact, relatively independent of direct governing from the capital of the kingdom. The Lower Moulouya Basin was a region that was on the periphery of central government control. As a brief background to the assessment let us look at the people that inhabited it and their means of livelihood.

The Land and Its People

The great geographical and climatalogical divesity of the Moulouya basin contributed to considerable differences in land exploitation. These differences were accentuated by the fact that different tribal peoples speaking different languages occupied the area.

Two major tribes occupied the Triffa plain and its surrounding hills and mountains. The Beni Snassen Mountains were the traditional homeland of a tribe by the same name. These people were settled agriculturalists who grew cereals and some vegetables and tree crops on the cleared mountain slopes that received more rainfall than the adjacent plains and the Beni Snassen developed small scale irrigation using rain fed streams and springs

as a source of water. They kept some livestock, mainly goats, and the southern portion of the Triffa plain was used largely for grazing purposes.

The northern part of the Triffa was occupied by the Triffa, an Arabic speaking tribe. Here the hills are less rugged than in the south and the plain is better watered. Households engaged in more extensive cereal cultivation and also grazed livestock.

The economy and way of life on the Sebra was quite different than on the other two plains. The people of the Ulad Stut, an Arabic speaking tribe that lived in this region, were transhumant herders. They lived in tents and followed their herds of sheep and goats, living in the hills in the hot, dry summer and moving on to the plain in the winter as seasonal rains created some grazing possibility. They cultivated very little if any land. This pattern remained well into the 20th century. As late the 1960's it was still possible to see a few households living in skin tents and moving with the rhythm of the seasons.

The Berber tribes living on and around the Bou Areg, the Beni bou Ifrour and the Kebdana had developed an economy much like that of the Beni Snassen. Cereals and vegetables were grown on the hills, sometimes with miniature irrigation facilities. The Bou Areg was largely used for grazing but it could be cultivated more successfully than the southern Triffa or Sebra because of higher rainfall.

The region as a whole fell under the jurisdiction of the governor of Oudja, the local representative of the Moroccan central government. The maintenance of law and order and the extraction of taxes from the local tribes was the responsibility of the governor and his agents, the Quaids. These latter, although appointed by the state (makhzen) tended to be local

leaders with a major following among the tribesmen. All too often, however, they were themselves embroiled in local feuds and fractional politics and used their official recognition by the state to increase their local power base and achieve the status of petty lord or tyrant. The remoteness of the region from the heartlands of the Moroccan state made the tasks of the governor unusually difficult given the limited troops at his disposal and the distance any larger expeditionary force from Fez or elsewhere to the west would have to come to put down local rebellion or resistance. At the same time the proximity of Algeria and the openness of the region to the Mediterranean made it hard to control illegal transactions including the smuggling of arms. Despite the nature of the climate and the general poverty of argicultural production all of the product was not locally consumed. Some was collected in taxes by the Quaids and the Makhzen, and despite the armed power of the locals it would appear that in most years taxes were paid. There was apparently sufficient over and above that consumed or taxed to take to the markets which existed throughout the region. Evidence suggests that at least by the beginning of the 19th century grain and livestock were being sold for export from the region and that imported goods, including manufactured commodities and certain food stuffs--notably sugar and tea--were increasingly available in the tribal markets of the northeast.

By the end of the 19th century the region began to feel the pressures of the European colonial expansion. French settlers from Algeria agitated to push the borders with Morocco further west. A few began to develop land holdings on the northern Triffa plain. In the first few years of the 20th

century French troops penetrated the borders of Morocco to discourage raiders from the Angad plains and the Beni Snassen mountains to the west of Oudja and perhaps also to extend the area under colonial occupation. During 1907 and 1908, while French forces elsewhere were occupying Casablanca and subjectuating the Sawiyya tribe, Oudja was occupied by French forces stationed on the frontier and a "band of security" was created around the town, the western limit of which was the Moulouya river. In 1908 the small town of Berkane was laid out near a military post as a market center for French settlers, who had already taken over parts of the northern Triffa plain.

On the other side of the Moulouya river the late 19th century saw growing competition among the European powers to establish a foothold on the coast. But it was the Spanish with their long standing physical presence in the town of Melilla who began around the turn of the century to extend first their economic influence and subsequently their military power over the hinterland of Moulouya in the area that is now Nador Province and further afield. In 1904 a Franco-Spanish agreement defined the area in northern Morocco over which Spain migh have jurisdiction in any annexation of Morocco and from this time on Spanish involvement in the northeast increased rapidly.

A local rebellion lead by the notorious Bu Hmara broke out in the region between 1903 and 1907. The Spanish unofficially assisted the rebel leader and private Spanish businessmen obtained concessions for mining rights in the coastal hills and contracts for substantial arms shipments.

The Moroccan forces crushed the rebellion but the Spanish invented reasons to stay in the region. Expeditionary forces occupied areas in the interior to the west of the Moulouya beyond the limits of Spanish jurisdiction and in 1909 large scale fighting broke out between local tribes and Spanish troops. When the tribes sued for peace, garrisons were set up throughout the penetrated area which included the Guelaia and Kebdana mountains and a limited form of military occupation took place. In 1911 growing resistance to Spanish incrusions among the tribes of the central and eastern Rif and fears of an expansion of French occupation across the Moulouya on to the left bank led the new governor of Melilla to undertake extensive operations to safeguard the newly occupied territory. By the end of the year the Spanish were in direct control of virtually all of the territory to the south and southeast of Melilla as far as the Moulouya river including the Bou Areg and Sebra plains.

The defacto occupation of both the Spanish and the French was formally ratified in 1912 with the signing of the treaty which made Morocco a protectorate under French and Spanish rule. The kindom of Morocco fell under colonial domination of two European powers which was to last almost a half a century.

THE NORTHEAST UNDER COLONIAL RULE

The colonial experience was quite different on the two sides of the river. The French, largely because of the proximity of Algeria and the military forces based there, passified the northeast quickly and colon

settlements on the northern Triffa, which had begun before the formal establishment of the protectorate increased in number. Large farms devoted largely to cereal production were established. Beginning in the 1930s, however, large scale investment changed the nature of agricultural production. The swamps of the Madagh were drained and pump irrigation was introduced in many areas. Citrus, vegetables and vineyards begun to displace cereals as the major crop. The colon community grew in size and influence. A good local road network was developed and Berkane which was established in 1908 became a fair sized market town with a population of over 3,000, about half of whom were Europeans.

Resistance to Spanish occupation continued on the left bank and before 1920 a full scale rebellion had broken out. The Spanish were badly defeated in a number of encounters. But by 1926, with the support of the French and the consolidation of Spanish forces under an unknown Col. Franco, the rebellion was suppressed.

Even with pacification, however, the eastern part of the Spanish protectorate was never attractive to the kind of large scale colonization that developed in the French zone. Some private companies obtained land on the Gareb, Sebra and Bou Areg plains and settled Spanish small holders on it. Some limited small scale pump irrigation was developed and cotton was introduced as a commercial crop, but large scale commercial agriculture with the infra-structure of roads and markets it demands did not develop. The majority of Spanish in the region lived in the towns. Villa Nador had a population of over 3,000 in the 1930s, the vast majority of whom were Spanish with a significant Jewish minority.

As the 1950s, the decade of independence for Morocco, approached the different manifestations of the two colonial experiences were deeply etched on the countryside. The commercial colonial agriculture and its large plantations with extensive pump irrigation came to dominate the northern Triffa. A good road network was in place and commercial ties with Oudja and with Oran and western Algeria were developed.

The small scale Spanish colonization on the left bank had made little mark on agriculture. Spanish investment was limited. Infra-structure development was inconsequential. The countryside languished in poverty.

There are four characteristics of the region in the 50-75 years before independence that are of consequence in the evolution and impact of the irrigation project. They are land ownership and transfers, population growth, labor utilization and migration, and dry land agricultural production.

Land Ownership and Transfer

In the pre-colonial period there were basically two types of land ownership. Individual households had rights of cultivation, inheritance and limited allienation on specific plots of land with "melk" titles. This type of "ownership" was particularly prominent on the cultivated land in the hills among the Beni Snassen, the Berber tribes around the Bou Areg and among the Triffa. The grazing land which was largely on the plains that later were to be irrigated were generally tribal or collectively held. All families in the appropriate collectivity had use rights on this land. For neither type was there a formal system of land registration and transfer.

Immediately after the establishment of the protectorate both colonial powers took steps to formalize the record of land ownership and to regularize land transfers. The Spanish published a decree in 1912 forbidding the transfer of collective land among private individuals. In 1914 another decree established a system of land registration through which formal titles could be obtained. In 1916 a further edict was issued reinforcing that of 1912.

The French introduced a formal system of land registration very soon after the signing of the treaty of 1912 and prohibited the outright purchase of collective lands unless they had been previously registered. Leasing of collective lands was permissable. However, if a tenure of over 3 years was involved the explicit approval of the Director of Native Affairs was required.

While the motivation behind these decrees may have been innocent, they created the potential for a great deal of mischief. Pressure for the development of a market in land came not on a hills were melk property had prodominated in pre-colonial times and where there was a good understanding of private property, but on the plains which was where the Europeans had an interest in settling and farming. As pointed out above large French colon estates developed on the northern Triffa and were farmed under French control right up until independence. Although title to some of the land may have been obtained in an underhanded fashion, the colons' rights soon became firmly established in law and practice.

The situation was more complicated on the left bank and the legacy of problems created in the early years of the protectorate inhibited

agricultural development into the 1970s. Eastern Spanish Morocco was never very attractive to European settlement and it developed only on a limited scale. The Spanish, however, were very suspicious of French expansionary desires across the Moulouya and sought to get ownership of land in the vulnerable area directly across the Moulouya from French occupied territories formally registered in the name of Spanish nationals -- either individuals or firms--or in the name of completely loyal natives. Without going into the labyrinthan details of any specific case the problem in general can be explicated. Some individuals from the Sebra with close ties to Spanish authorities registered collectively owned land in their own names under the edicts of 1912 and 1916. Some of this land was later sold to Spanish development companies. The drier parts of the Sebra, close to the river, however, could not be effectively cultivated without irrigation. The Spanish did not settle on it and it continued to be used by the local population, first as grazing land and later for limited cereal cultivation. The fact that formally the land titles had changed hands made little difference.

Some disputes over the ownership of this collective land that had illegally passed into private hands emerged in the 1930s. But the conflicts did not fully mature until irrigation became eminent and the land values soared and individual owners began to exercise their legal rights. The problem was taken into the courts which could not, however, resolve the question. Eventually the government had to take control and impose a solution. Effective exploitation of the irrigated land, however, was delayed and even by the late 1970s it was not farmed as effectively as land

which had not been in disputed title. More details will be supplied in latter chapters in the section in land reform and redistribution. It is enough to point out here that the events on the early period of the protectorate had a depressing effect on land exploitation 60 years later.

Population in the 20th Century

Population growth in the northeast since the beginning of the Moulouya irrigation project has been great. (see Table 1.1).

From 1960 through 1974 the population growth of Oudja province increased 62.52% from 438,020 to 700,600; that of Nador 66.2% from 343,626 to 515,800. These figures, of course, include a large area that is outside the irrigation perimeter. We do not have for the 1970's the population figures for the circles that lie within the project. From 1960 to 1968, however, population of the Berkane circle increased 29.3%, Rif circle 27.3%, Louta circle 26.5% and Guelaia circle 30.0%. Growth rates remained high throughout the 1970s.

While it is difficult to say how much the irrigation project contributed to population growth, we can give some perspective on the problem, however, by looking at population growth over the previous half century.

Specific census data from the pre-colonial period do not exist. European travelers in the area in the late 19th and early 20th century, however, commented on the high population density in the hills and mountains. One observer estimated that there may have been as many as 50-70 persons per square kilometer in the coastal hills. All the reports

TABLE 1.1

POPULATION GROWTH IN NORTHEAST MOROCCO

Change from 1960 to 1968 by Province and District

	1960	1968	% increase
Oujda Province	438,020	595,000	35.8%
Figuig district	38,447	54,000	40.4%
Taourirt district	76,036	98,000	28.9%
Beni Snassen/Berkane district	140,771	182,000	29.3%
Oujda suburbs	92,151	123,000	33.5%
Oujda municipality	90,615	138,000	52.3%
Nador province	343,026	440,000	28.3%
Rif district	137,433	175,000	27.3%
Louta district	82,996	105,000	26.5%
Gelaia district	107,889	127,000	30.0%
Nador town	14,708	23,000	56.4%

Estimated Change From 1971 to 1975 by Province

year	Oujda population	pop. density	Nador population	pop. density
1971	633,828	14.9	480,517	78.4
1972	645,000	15.2	496,000	80.9
1973	679,400	16.0	501,300	81.8
1974	700,600	16.5	515,800	84.1
1975	669,700*	32.4*	531,300	86.7

*The area of Oujda was cut from 42,400 square kilometres to 20,700 with the establishment of Figuig as a separate province in 1975.

indicate that the plains further inland, probably the Sebra, Gareb, and southern Triffa were sparsely inhabited.

Scanty data on population do exist for the 1930s. While we could not find any figures that give actual numbers of people in the specific regions for which we are concerned Table 1.2 shows the change in population density for areas that are quite comparable to three circles, Guelaia, Rif, and Louta that are included within the irrigation perimeter on the left bank. The increases are spectacular. The Ulad Stut who occupied the Sebra increased in population by 78.6%. The Beni Bu Ifrour, a dominant tribe on the Bou Areg, increasd by 147.1%. The bulk of the increase occured in the countryside; the urban population on the left bank remained very small. In 1936 Villa Nador had a population of just over 3,000, Segangen 221, Monte Arruit 51, and Zaio about 50. The population in the towns was predominently Spanish and thus are not reflected in the density figures in Table 1.2 which cover only the native population.

TABLE 1.2

Changes in Population Density on the Left Bank
(People per Km^2)

Area/tribe	1931-2	1940	% increase
(Guelaia)			
Beni bu Gafar	69	145.6	111.0
Mazuja	88	143.6	63.2
Beni Shicar	75	134.1	78.8
Beni bu Ifrur	49	121.1	147.1
Beni Snidel	40	86.2	115.5
(Rif)			
Tafersit	86	103.8	20.7
Beni Ulishek	69	83.7	21.3
Temsaman	66	71.3	8.0
Beni Said	50	55.4	10.8
Beni Tuzin	34	54.4	60.0
(Louta)			
Kebdana	31	47.3	52.6
Ulad Stut	14	25.0	78.6
Metalsa	9	19.2	113.3
Beni bu Yahi	11	16.1	46.7

Comparable statistics for the right bank are not available but there is indirect evidence that it was also experiencing rapid population growth. Before the second World War there was a general labor shortage in the French zone and policies were pursued to alleviate it by such things as a restriction on labor emigration. The northeast, however, was excluded from these restrictions. This suggests a plentiful supply of labor and therefore a relatively large and probably a growing population. The number of labor emigrants to Algeria from the Beni Snassen region during the 1930s also suggests a good size population. (These data will be reviewed below.) Berkane in 1936 had a population of nearly 3,500, about half of whom were Moroccans.

The high rates of population growth continued after the second World War and persist right up to the present. In a study of the rural population of Morocco based largely on the 1960 census but also on some more recent data, Noin[2] suggests that while the national average growth rate was about 2.5%, in the rural areas, what he called the "Mediterranean regions of the Northeast" and those of the "Moulouya in the North" showed average rates of growth of 3.6% and 3.1% respectively. Included within these regions, are areas inhabited by the Beni Bu Ifrour, the Beni Bu Yahi and Kebdana (in Nador province) as well as the Beni Snassen (Oujda province). In these regions he suggests that children under 15 constituted an average 49% of the total population with the proportion rising to 52% in some rural communes. Between 1960 and 1964 the population of Nador province grew by about 8.7% and pressures on the land continued to rise as population density increased. Figures taken from the Plan Quinquenal for 1968-1972 suggest that the rural population density in 1960 was 53.5 per square kilometer while the figure per cultivable square kilometer was 231.

Nador town grew rapidly from the mid 1930s to until 1950 but declined in population from 22,841 in 1951-52 to 17,583 in 1960 reflecting the exodus of Spanish Nationals following independence. In 1960 only 5.5% of the population of Nador province lived in towns (urban population 19,367: rural population 330,192). 91% of the urban population lived in Nador town.

The urban population on the right bank has grown rapidly from the 1930s right up to the present. Table 1.3 shows the growth of population in some major towns on the Moulouya right bank.

TABLE 1.3

POPULATION OF URBAN CENTER ON THE RIGHT BANK

Table

urban centre	1942	1951	1960	1971
Oujda	34,523	80,546	128,645	172,470
Berkane	3,464	8,399	20,496	38,636
Ahfir	2,569	4,249	10,794	12,491
Saidia	NA	NA	1,102	2,623

In spite of this enormous urban growth on the right bank the countryside was not being emptied of population. In 1953 the rural population in the five rural communes within the perimeter on the right bank was 79,266. We do not have data for the identical region for an earlier date but figures for a somewhat larger area which includes these five communes, shows a doubling of the rural population since the late 1930s. The population within the irrigation perimeter on the right bank would have increased by about that same amount.

By the mid 1960s the rural population density within the perimeter on the right bank was 55 per square kilometer. On the left bank it was 45 per square kilometer. It must be remembered that at that time virtually the whole right bank was being irrigated while water from the Moulouya was not yet going to the left bank. Considering the poverty of agricultural resources in the plains on the left bank, 45 people per square kilometer is an impressively high figure.

Thus, we can see that the northern Mediterranean coastal area of Morocco most likely had a relatively dense population in the hills and mountains and a sparse population on the plain in the late 19th century and

that the population has grown steadily and rapidly since that time. In this context the problem of assessing the impact of the irrigation project is not that of examining its effect on population growth rates, but understanding the significance of the great increase in the intensity of the land use possible under conditions of irrigation in a region that had a high population density and high growth rate at the time the project was planned and executed. This understanding depends in turn on knowing about the nature of the local economy and its changes in the period before irrigation.

The Pre-Irrigation Economy and Its Problems

The traditional rural economy was based on a pattern of agricultural exploitation which involved a fairly intensive cultivation in the hills where rainfall was heavier and more reliable than in the plains which were used largely for grazing. This pattern dominated well into the 20th century. But the rapid population growth was putting pressure on the traditional modes of agriculture as early as the end of the 19th century. A number of adjustments and accommodations occurred over a 50 to 60 year period.

There developed first a form of what Geertz has termed "agricultural involution"-- a kind of ever increasing intensity of the hill cultivation to bring every square meter of available land under cultivation and to wring every potential out of the soil. Second, there was a decline in animal husbandry as attempts were made to bring the grazing lands of the plain under cereal cultivation. Third, thousands from both banks of the river sought seasonal agricultural employment on the colon farms in Algeria. Fourth, in the Spanish zone thousands joined the Spanish army and

went to Spain in the 1930s to fight with Franco in the Civil War. Fifth, a small number of rural residents got involved in small scale trade and commerce, to supplement income from agricultural pursuits. Finally, as irrigated agriculture began on the colon farms in the northern Triffa in the 1930s, employment opportunities in agriculture were created for the indigenous population. Some of these developments, particularly the labor immigration we will look at in some detail, but first we will examine some scanty evidence in the agricultural production record of the colonial period.

The expansion of cultivation to less desirable areas in the hills and on to the plains brought more marginal land into production and output became more affected by the fickle climate. Specific data on yields for the years before the Second World War are not available but general reports indicates that there were severe problems. 1934, 35, and 36 were years of low rainfall and poor harvests. 1937 was even worse and we can use the word famine advisedly to describe the conditions on the left bank at that time.

1945 and 1947, especially the former, were also miserable years for agriculture. From September 1944 through August 1945 less than 25 mm of rain fell in Nador; for the same period in 1946-47 there was less than 75 mm. Table 1.4 shows cereal production and animal population on the left bank for the years 1944 through 1947. While in the good year of 1944 over a million hectares of cereals were harvested with an average yield of over 7 quintals per hectare, in 1945 only about 30,000 hectares were harvested with a yield of .2 to .3 quitals per hectare. Massive imports of wheat and barley came into the area (211,000 quintals of barley compared with the usual 30,000 quintals and 250 quintals of wheat compared to the normal 52,000 quintals).

TABLE 1.4

Production on the Left Bank, 1944-47

year	wheat area	wheat yield	barley area	barley yield	sheep	goats	cattle	donkeys
1944	44,459	7.2	918,665	8.6	248,600	295,100	35,900	19,600
1945	935	0.2	29,339	0.3	177,600	158,200	37,600	18,900
1946	19,582	6.4	255,216	5.6	51,000	72,000	20,600	6,800
1947	8,575	3.3	104,578	2.4	82,000	108,600	20,300	7,400

source: R. Bossard, Mouvements Migratoires dans le Rif oriental, doctoral thesis Universite Paul Valery, Montpellier, 1978, p. 49.

By June of 1945 approximately 30,000 people had left the central and eastern Rif, mainly for western Morocco. An observer reported that the immigrants --25,000 to 30,000 — came barefoot and half starved into Tangiers. Traces of the disasters show up in the population pyramid of the 1960 and 1971 censuses. 1947 was not quite as bad but the reduction in animal population following the draught of 1945 removed some of the cushion that had been available to meet the crisis in 1945.

Comparative figures on crop yields of Oudja and Nador provience and the rest of Morocco indicate how disadvantaged these two provinces are. The figures in table 1.5 for the 1960s indicate an average yield in Nador for cereals, legumes and vines are significantly below the national averages. The average for cereals in Oudja is below the national figure; the higher figures for vines and legumes probably reflect the irrigated production in the Moulouya basin.

The pattern is clear. The Moulouya basin is a risky place for dry land agriculture. With a growing population in a region already relatively

TABLE 1.5

Comparative Yields for Three Types of Crop (qx/ha)

	Nador	Oujda	Morocco
cereals	5.4	5.9	6.3
legumes	4.4	6.0	5.5
vines	1.3	7.4	5.6

densely populated the people have pursued livelihoods both outside agriculture and outside the region. With almost no industry in the area and with a work force with few marketable skills, it requires enormous motivation and effort to find alternative employment. In order to get some perspective on how the region might have evolved with out the irrigation project, however, we must look at the evolution of patterns of employment over a period of some years.

The great increases in population in the region during the colonial period made the inadequacies of agricultural resources in the region obvious and exacerbated the need for alternative sources of livelihood. Significant numbers sought temporary employment outside the region.

Even during the second half of the 19th century there was considerable seasonal labor to Algeria. Abun Nasr has observed, "In addition to the small French farmers working in the Algerian country side there emerged (from 1870 onward) the large estates owned by capitalist class of landowners who viewed agriculture as a business enterprise and relied on Spanish, Maltse and Moslum labor for the cultivation of their land."[3] A growing portion of the Moslum labor was provided by men from northeast Morocco. Increasingly, the Northeast was drawn into the colonial eonomy of Algeria.

For the 1930s scattered data on labor immigration to Algeria exists. They indicate that many thousand were involved. A report done in the early 1930s on immigration from the left bank for the period May 1930 through April 1932 shows that about 60,000 went to work in Algeria over that 24 month period. As employment was seasonable a number of the same individuals probably made several trips during the period but even so, roughly 10% of the active male population in the region went to Algeria to work.

Very similar numbers immigrated from the right bank. By the end of 1930s it was estimated that 30,000 men from the Beni Snassen tribe were leaving for Algeria each season.

These figures reflect not only the general absence of employment opportunities in agiculture for the large population of the Moulouya basin but also the shift in land use patterns. As the plains came under cultivation and the relative importance of grazing declined, men were freed from the daily attention to livestock to seasonal employment in crop production. They were freed in some months to seek employment outside the region.

Significant seasonal immigration to Algeria continued particularly for the right bank population right up to the independence of Morocco in the mid 1950s.

The development of the infrastructure -- roads, irrigation facilities, etc. -- provided some employment opportunities for locals on the right bank in the 1930s. The absence of much investment on the Spanish side of the river meant that there was little similar opportunity. There was, however, an alternative. Franco was very impressed with the fighting qualities of the Moroccans that had been displayed in the Rif wars of the teens and

twenties and recruited thousands into his army in the 1930s. By 1937 some 35,000 Moroccan regulars had crossed into Spain to fight with Franco. By 1938 this figure had risen to between 50,000 and 60,000. Moroccans made up over 10% of the front line troops fighting for the rebels. A large proportion of the Moroccan soldiers in Spain came from the central and eastern Rif.

Non-Argicultural Employment of the Rural Population

There is also other evidence of the inadequacy of the agricultural economy, particularly on the left bank, to meet the needs of the local population before the irrigation project. While the data come from the 1960s, they obviously reflect patterns that developed many years before.

It was pointed out above that the urban population on the left bank was very small in the colonial period. The 1960 census revealed that in Nador province only 5.5% of the population lived in towns and villages. However, only 75% of the population was involved in farming, just over 5% in mining and nearly 20% in commerce, "service" and government employment. This indicates that a remarkably high proportion of the rural portion of the population was engaged in commerce -- higher than in any other province in Morocco. The Service Central des Statistique in commenting on the figures stated "Nador has an exceptionally high population [involved in commerce] for a predominantely rural area. This may well be explained by the proximity of Melilla. Furthermore, it is a fact that in certain districts near the town of Nador, population density is well over 150 inhabitants per square kilometer. This is a high figure in a region where natural

resources are poor and the local population is forced to become involved in petty commerce to provide an income. Agriculture itself is very poor and the equally undeveloped cottage industries are not sufficient to support such a concentration of population."

The figures from the 1960 census and the conclusion drawn from them were supported by the Avant Projet which reported 75.5% of the population on the Sebra, Bou Areg and Gareb plains were involved in agriculture either as farmers or laborers, while 8.5% were traders or artisians.

The situation on the right bank was quite different. In Oujda province, 40% of the population was classified as Urban. 65% of the population was engaged in agriculture, 12% in industry and mining and 23% in commerce, "service" and government employment. The high percentage living in towns and villages reflects the large population of the City of Oujda. These data also suggest that almost all the rural population was engaged in agriculture. Data from the Advant Projet confirm this conclusion. Table 1.6 shows that from 2% to 4% of the population in the three areas on the right bank were traders and/or artisans; for the left bank the figure is 8.5%. It should be noted that unemployment is also higher on the left bank.

While the data is scanty, they all point to the same conclusion: by the nineteen fifties--the decade of both independence and the coming of irrigation--there were serious problems in the northeast. The population was large, dense and more importantly, rapidly growing. Given the resourse base and level of technology, agriculture was pressed to the limit and was more vulnerable to the exigencies of the weather than it had been 50 years earlier. 1945 and 1947 indicated that a bad year could ravage the

TABLE 1.6

Percent of Population in Various Occupations

	OUJDA PROVINCE			NADOR PROVINCE
Stated Occupation	Beni Snassen mts	Triffa Plain	Berkane Area	Sebra/Bou Areg/Gareb
farmer/agric. labourer	89.4%	85.7%	79.0%	75.5%
trader/artisan	2.0%	3.2%	4.0%	8.5%
official	2.1%	2.1%	4.0%	4.0%
unemployed	5.5%	9.0%	13.0%	12.0%

Source: Avant Projet, 1964

population. Thousands of people were directly dependent on employment outside not only the region, but outside the country as well and the local economy was aided significantly by the money they brought back. While the right bank benefited from French investment, the economy of the rural areas on the left bank where almost all the native population lives was little affected by the colonial occupation.

Independence brought with it opportunities; it also created problems. It is to some of the events and developments of the independence period that are important to the economy of the region that we now turn.

AN INDEPENDENT MOROCCO AND DEVELOPMENT IN THE NORTHEAST

In the northeast, the first four years of independence were a time of considerable economic and social hardship and of significant political turmoil. On the left bank of the Moulouya the withdrawal of the Spanish

led rapidly to unemployment and economic crisis. During the autumn of 1956, emergency allocations were made for needy families in the north, and a national drive began under the Committee of Aid for the North to raise funds for the people of the northern zone. But the effort was not commensurate with the magnitude of the task, and in the autumn 1957, after a poor harvest, a second relief drive was held and funds once again distributed in the north. When monetary integration between the two former colonies was achieved in 1958, the area on the left bank along with the rest of the old Spanish zone suffered from the removal of protective tariffs and new demands in the form of taxes. Within a month of fiscal integration with the more developed south, there were petitions for further relief in the north and for special controls to keep down the cost of living, which had soared. One of the first measures to be taken was to fix the price of bread. This may have helped the urban populations but it hurt the farmers. The economy declined, workers were laid off, strikes followed and the mass of the population suffered.

By the autumn of 1956 the situation had become extremely precarious and there were frequent reports of impending violence. Towards the end of the year the King Mohamed V, made his first visit to the province. One of the major official reasons for so doing was to open the now completed Mechra Homadi dam. The King's speech at the official welcoming ceremonies recognized the highly volatile situation in the region and the difficulties associated with its proximity to Algeria. He praised those members of the Liberation Army (which had been particularly active in Oujda and in Nador) who had accepted integration into the Moroccan army and promised land and jobs to those who returned to their villages. In this context, the

distribution of irrigated land in the Triffa to a limited number of small peasants and landless labourers, was an astute political geture.

During 1958, as tension mounted over the future of Algeria (of major concern to many in the northeast, given their close ties over the previous decades), and as independence brought with it problems of administration in several provinces, trouble broke out in Nador and Oujda, and also in the adjacent provinces of Taza and Al Hoceima. By October 1958 there were indications of serious trouble to come in the provinces of Taza, Al Hoceima and Nador, but the most serious incidents occurred in Oujda. The Minister of National defense was given full powers to investigate the situation in the region. Violence broke out around the towns of Al Hoceima and Nador and a Royal Commission was set up to investigate in detail the grievances of the local population. The tension appeared to ease, but when the Commission presented its findings in December 1958, it conveyed a general sense of intense frustration and resentment that independence had not brought the region the benefits hoped for. There were serious problems of unemployment, a lack of hospitals, roads, schools and agricultural credit. All of these problems were particularly acute in the former Spanish territory. While the grievances were being reported in Rabat, demonstrations of protest and violence erupted in the northeast, particularly in the central Rif and the area directly to the north of Taza. Early in January the dissidents were issued with an ultimatum by the Palace to cease their activities; a significant number in the area around Al Hoceima refused and during January the army was sent in to pacify the region. 20,000 men were required to suppress the uprising.

The economic problems of the region were exacerbated by the drastic reduction in labor emigration to Algeria after 1956. It was totally cut off following the frontier war between Algeria and Morocco in 1963 when the border was effectively closed. During 1961, however, the West Germans began to recruit Moroccan labor for various kinds of industrial employment and by the end of that year 7,000 men from Nador province were working in Germany, the vast majority of them from Nador. Economic expansion in Western Europe during the first half of the 1960s led other countries also to look to the Mediterranean for sources of what was, by European standards, cheap labor. Agreements with France, Belgium and Holland during the years 1963 to 1965 led to a massive increase in employment opportunities for Moroccan workers in Europe, and a very substantial proportion of all Moroccan migrants--particularly of those going to the highest paying countries of West Germany, Holland and Belgium came from the Northeast. Thus the traditional pattern of men from the northeast leaving the country for work reemerges in the 1960s after a hiatus of about five years.

The numbers involved are impressive. Bossard[4] provides figures on the number of workers leaving Nador from 1956 through 1975. (See Table 1.7). The number increases steadily through the 1960 peaking at 18,000 - 22,000 from 1968-1971 and declines sharply in the 1970s. Between 1968 and 1974 over 14,000 left Oujda province for Western Europe according to official sources; the actual number is probably higher because there was considerale "unofficial emigration."[5]

By the mid 1970s about 100,000 men from Nador and Oujda were laboring in Western Europe. At that time Bossard estimated that of the 370,000 Moroccans working in France 22% came from Oujda and Taza and 7% from Nador

and Al Hoceima.[6] At the same time Baroudi estimated that half of the Moroccans working in West Germany, Holland and Belgium came from the Central and Eastern Rif (12,500 out of 25,000 in Germany; 22,000 out of 45,000 in Holland; 30,000 out of 60,000 in Belgium.[7]

TABLE 1.7

Number of Workers Leaving Nador Province for Western Europe from 1956 through 1975

Period	Number Leaving Nador
1956-1959	1,500 - 2,500
1960-1963	7,000 - 10,000
1964-1967	16,000 - 20,000
1968-1971	18,000 - 22,000
1972-1975	4,000 - 6,000

Source: Bossard 1978; p. 20.

While this emigration can be looked upon as a continuation of the practices that began decades before in the movement to Algeria, there were significant differences. The agricultural work in Algeria was seasonal, men stayed away for several months. They typically spent years in Western Europe. The workers, of course, could command much higher wages in Western Europe than they could in seasonal agricultural employment, and thus could return much more money to the local economy in remittances and in the savings they brought back. Table 1.8 shows the estimated wages, expenditures and savings from workers in Germany, Holland, Belgium and France in 1974. West Germany tops the list and France is at the bottom.

TABLE 1.8

Wages, Expenditures, and Savings of Moroccan Workers in Four Western European Countries

	Germany	Holland	Belgium	France
wages(Dh)	1,912	1,518	1,464	1,070
expenditure(Dh)	846	639	804	517
'savings'(Dh)	1,066	879	660	553

Source: Bossard 1978; 180-181

The volume of remittances and accumulated savings and their value to the regional economy has been substantial. In 1966 Noin estimated that a migrant worker would save about 5,000 dirhams a year.[8] In 1969 an investigation in one area of the Rif district of Nador province suggested that workers sent back between 1,000 and 1,500 dirhams during the year, and brought back an additional 1,000 to 3,000 dirhams when they returned on vacation. Bossard esimates that in 1973 and 1974 average annual transfers to the region were 7,500 dirhams and 9,500 dirhams respectively.[9] While there are considerable differences in these estimates, even the lower figures suggest a significant impact on the local economy.

Aggregate data confirm this conculsion. In the second six-monthly report for 1975, produced by the provincial administration of Nador, it was reported that deposits received in Nador banks that semester were around 9 million dirhams, and that "a good proportion of those funds emanated from Moroccan workers abroad, now estimated at around 50,000." In 1976 remittances from foreign migrants from all Morocco for the first time out-valued earnings from the sale of phosphates, producing an inflow of 2,417 million dirhams (compared with 2,190 million from phosphate sales).

In Nador province in 1976 more than 390 million dirhams entered the area as a result of foreign earnings by labour migrants. The Banque Populaie (which is the bank most frequently used by migrants for transfers and savings) transferred 303 million and about 85 million came through the post office (mandates and postal orders). These figures, which probably under estimates the total sum entering the province, represents 16% of all remittances from Morocan workers in Europe in that year.

This massive labor migration and funds returned to the region must rank with the Moulouya irrigation project as the two most significant economic events in the region in the first two decades of independence. The impact of the two on the region are not independent. The exodus of workers certainly had an impact on the labor market at a time when demand for agricultural workers was increasing as a new land came under irrigation. The influx of funds certainly increased the demand for consumer goods including the products produced from irrigated agricultue. But the interrelationships are not simple. In the Chapters that follow referemces will be made to how the labor migration must be taken into account in assessing the import of the irrigation project.

SUMMARY AND CONCLUSIONS

We have reviewed some of the historical developments in the lower Moulouya region from the late 19th century. What aspects of that developmental history are relevant to assessing the impact of the irrigation project?

1. Given the resources of the region there is a relatively dense population that has been growing rapidly. About half the population was under 15. An enormous number of individuals enter the work force each year. There is an ever increasing number of mouths to feed.

2. From late in the 19th century many men from the area were forced to seek employment outside the region. Under the colonial regime tens of thousands sought work in Algeria and/or (in the 1930s) enlisted in the Spanish Army. The many thousands who went to Europe in the 1960s and 70s must be viewed not as a new phenomenon but as a resumption of the practice which had been broken only temporarily from 1956 to the early 1960s. The local economy was greatly stimulated by the remittances from 1965 to 1978 but it must be remembered that significant amounts of money had historically been returned to the economy from migrant workers and soldiers. The situation of the local economy as it existed in 1956 had been heavily influenced by a half century of emigration and remittances.

3. Agriculture, except in the northern Triffa where extensive pump irrigation prevailed, was a risky venture. Major crop failures occurred two or three years in every decade.

Again with the exception of the Northern Triffa, there had been a steady trend in the 20th century to bring more marginal lands that were

more vulnerable to the vagaries of the weather, under cultivation. These lands were by and large in the plains that were to come under irrigation from the Moulouya. The real famine in 1945 followed by the major crop failure of 1947 indicate how precarious the dependence on traditional dry land agriculture was. Agriculture was more vulnerable in 1955 than it had been fifty years earlier.

4. Fifty years of colonial domination by France and Spain left quite different marks on the countryside. A flourishing colonial agriculture existed on the right bank with a well developed infrastructure of road and market to support it. While the major beneficiaries were the French, the native agricultural workers did develop experiences over 20 years with modern irrigated production. As we shall argue below, this resevoir of experienced workers greatly facilitated the adopted of the techniques of irrigated productions.

Little investment in agriculture took place on the left bank. The Spanish left the countryside little changed from the way they found it.

5. The northeast was particularly hard hit by the necessary concomitants of independence. It was the part of the country which relied most on employment in Algeria and with the Spanish state. The pains associated with economic integrations of the two years of occupation after 1956 were particularly felt in the Central and Eastern Rif.

In 1956 it would have been difficult to have been optimistic about the future of the Lower Moulouya region. Perhaps the only bright spot was the beginnings of irrigation from the Moulouya. But when the colonial powers left, construction had not even started on the major storage dam or on the capital structures on the left bank. Much work remained to be done.

Chapter One

Footnotes

1. The population figures for villages, towns and cities for 1980 given in this section are estimates. The last census was in 1971 and with the rapidly growing population, there is much margin for error.
2. D. Noin, La Population rurale de Maroc. Presses Universitaires de France, Paris 1970.
3. J.M. Abun Nasr, A History of the Maghrib, Cambridge University Press, 1971. p. 256.
4. R. Bossard, Movements migrationes dans le Rif oriental, doctoral thesis, Université Paul Valeny, Montpellier 1978, p. 20.
5. A. Baroudi, Maroc: Impérealisme et émigrations, Le Sycomore, Paris, 1978, p. 130.
6. Bossard, p. 40.
7. Baroudi, p. 32.
8. Noin, p. 234.
9. Bossard, p. 129.

CHAPTER TWO

VARIATIONS IN PRODUCTION AND PRODUCTIVITY

The verbal imagery used by advocates of an irrigation project often verge on the poetic. "Making the desert bloom" has been employed so frequently it has become a cliche. But for one who has had the opportunity to stand on a hill side and overlook a plain on a hot summer afternoon both before and after the advent of a successful irrigation project, the phrase elicits a specific image. Before irrigation a few blades of withered grass poke through the reddish, parched soil and some small bushes and cacti punctuate the barren landscape. A rock lined draw cuts deeply through a gentle slope as eloquent testimony to the rain which may be infrequent, but which can devastate the land in torrents when it comes. A few sheep and goats search diligently for some skimpy piece of nutritious vegetation.

After irrigation the change is dramatic. The land has been leveled and destoned. Irrigation canals impose a regular grid on the landscape and one can hear the gentle flow of sweet water. But most impressively, the dominant color has changed from reddish brown to deep green particularly where the cropping pattern is dominated by orchards.

For one who saw the southern Triffa plain before and after irrigation this stereotype assumes reality. There are other places in the basin, however, where the irrigation lands are under exploited and the change is not nearly so striking.

AGRICULTURAL LAND USE: PRE AND POST IRRIGATION

The visual impression does not present an adequate picture of the change. For this we need to have numbers which provide the details of agricultural land use both before and after irrigation. To get numbers on land use before irrigation in which one can have some confidence is no easy matter.

The Pre-Irrigation Land Use Pattern

The first problem is that there is no single year that one can take as a before-irrigation base line because the land was phased into irrigation in parcels from 1956 to 1979. For the southern Triffa plain 1954 is an immediate pre-irrigation year; for the northern Triffa where pump irrigation was supplanted by water from the Moulouya the early 1960's would be a desirable base point. The Sebra and Bou Areg were first irrigated in the early 1970's so 1968 or 1969 represent an immediate pre-irrigation period. For the High Triffa the mid nineteen seventies mark the period before irrigation.

Even if data were available for these years (or preferably averages over a several year period) for the specific areas presently under irrigation, there would be problems of interpretation. When part of the right bank came under irrigation in 1956 and the international boundary between the left and right banks was eliminated, the cropping patterns on the not yet irrigated left bank probably changed. The relative price of market vegetables probably fell as those from the newly irrigated land came on to the market. Some land devoted to high cost vegetable production particularly on the BouAreg was probably shifted to other crops. Thus irrigation in one part of the basin affected land use in another part even before water flowed to the latter.

Let us look more specifically at the precise problem we face in reporting the change in production from the pre to the post irrigation period. In 1977-78 there were about 72,000 hectares within the total command area. This included, of course, both the high Triffa and the Gareb which were not yet irrigated plus a great deal of land that lies outside

the canal system and will never be irrigated. Slightly over 50,000 hectares were actually dominated by the canals and potentially irrigatable. We would like to get data that represented land use on the average during the period 1950-54 for precisely that land that was irrigated in 1977-78 in order to get the pre-irrigation cropping pattern. We would then compare this pattern with the cropping pattern on the irrigated land in 1977-78. Unfortunately the data for this pre-irrigated period do not exist. It is unlikely that they were ever collected.

We have attempted to reconstruct the pre-irrigation land use on the land irrigated in 1977-78 from two studies. The Avant Projet undertaken in the early 1960's developed some data on agricultural land use for 29,700 hectares of the right bank for 1954 and for 27,870 hectares on the left bank for 1962. These data were reviewed and reported in the Hydrotechnic report of 1965.[1] The data from this study are reported on Table 2.1.

On the right bank in 1954 almost half of the land was committed to cereal production. Presumably a goodly portion of this was left fallow in any one year given the customary methods of cultivation in the area. The preferred rotation was to plant wheat one year, barley a second, and leave the land fallow the third. A run of excessively dry or wet years, however, could upset this rotation pattern. As population pressure on the land increased, land was left fallow less frequently. One year fallow in four or five became more frequent than one in three.

Pasture land accounted for the next highest use (29.3%). Citrus, vegetables, and grapes were grown with pump irrigation in the North. But cereal production and pastures still accounted for over 75% of the total area.

Table 2.1

Agricultural Land Use Before Irrigation

Right bank (Situation 1954)				Left bank (Situation 1962)			
Crops	Area (Ha)	% Total Area	% Cropped Area	Crops	Area (Ha)	% Total Area	% Cropped Area
Citrus	1500	5	7.1	Cereals	15,000	53.8	90.5
Market crops	1500	5	7.1	Market & cash crops	1,100	3.9	6.6
Wine grapes	4000	13.5	19.0	Olives - figs	460	1.7	2.8
Cereals	14000	47.1	66.7	Pasture	11,300	40.5	-
Pastures	8700	29.3	-				
Total	29,700				27,870		

Source: Avant Projet

The data for the left bank in 1962 (which include the Gareb plain) indicate that cereals were even more dominant than on the right bank. About 54% of the land covered by the study and 90% of that under cultivation was devoted to cereal production. 40% of the land was in pasture. Market and cash crops and miscellaneous tree crops (figs, olives, almonds) together accounted for less than 6% of the total area, and less than 10% of the total cultivated area.

There are, however, certain problems with these data. The total area included on the right bank (29,700 hectares) obviously does not include the entire Triffa plain which covers about 60,000 hectares, 36,000 which were

equipped for irrigation in 1978. We do not know precisely what land was covered in the 1954 study but it seemed reasonable to assume that it included parts of the Triffa scheduled for eventual irrigation, but certainly not all. The total area of 27,870 hectares covered in the 1962 survey of the left bank raises even more difficult prolems of interpretation. Again this is only about half of the total area in the three plains, but since it covers three plains, one of which is not included in this study we cannot draw any firm conclusions about pre-irrigation land use on the Zebra and the BouAreg from this study alone.

There are, however, some data from another study which when interpreted in the light of figures from the Avant Projet increase our confidence in reconstructing a general picture of pre-irrigation cropping patterns. During the development of plans for the extension of the project a French team (SERESA) reconstructed the cropping patterns for 1957-58 (see Table 2.2). This team did not report data by plain or even by bank, and its report covers a year in which water from the Moulouya was being used in the southern part of the Triffa plain. Some patterns emerge, however, that are consistant with those reported in the Avant Projet. 73,120 hectares were covered in the study which is more than will ever be equipped for irrigation. About 50% of the total area was in cereals (or left fallow presumably for cereal cultivation the following year). This is very close to the comparable figures reported by the Avant Projet if one combines the 1954 right bank figures with those from the left bank for 1962.

The SERESA survey shows only 10,000 hectares in pasture and 1,200 hectares in waste land compared to 20,000 hectares in pasture in the Avant

Table 2.2

Agricultural Land Use in 1958

Crops	Area (Ha)	% of Total Area	% of Cropped Area	Average Yields Tons/Ha	Observations
Irrigated Crops: (Total)	(14,600)	20.0	25.6		60% of the crops were irrigated by sources other than The Moulouya
Vegetables	3,900				
Wine grapes	3,700			11	
Citrus	2,500			4	
Beans	4,500			1	
Annual Crops: European & traditional	(28,925)	39.6	50.8		European annual crops had better yields than traditional crops because of the quality of the land, cultural practices, seeds, etc.
Hard wheat	12,500			1	
Soft wheat	2,400			1.4	
Barley, oats, corn	13,125			1.0	
Broad Beans	250			0.8	
Chick peas	650			0.7	
Arboriculture (Total)	(2,600)	3.6	4.6		
Olives	200			3	
Grapes	1,700			4	
Misc., figs...	300				
Almonds	400			0.8	
Fallow	(10,800)	14.8	19.0		
Pastures	(10,000)	13.7			
Forests	(5,000)	6.8			
Waste lands	(1,200)	1.6			
Total Area	73,125				
Cropped Area with fallow	56,925				

Source: SERESA Survey

Projet study. While this latter study does not identify by name any irrigated area, from the crops reported one could assume that a total of 6,000-8,000 hectares were irrigated on the right bank in 1954 and on the left bank in 1962 mainly with pumps. By 1958 when the SERESA study was undertaken, 14,500 hectares were being irrigated--about 8,000 with pumps and an additional 6,000 hectares on the Southern Triffa with water from Moulouya. Assuming that in 1954 a high proportion of that land on the Southern Triffa had been in pasture (a reasonable assumption given the low rainfall in the southern Triffa) the figures in the two reports are not so far apart. We can add close to 6,000 hectares to pasture and waste land reported by the SERESA team and the total would be almost 17,200 hectares--close to the figure report by the Avant Projet. This interpretation of the percentage of land devoted to various uses before irrigation would make the two studies quite consistent with one another.

The SERESA study also reports 36,000 sheep, 35,000 goats and 4,000 head of cattle. We have no figures from the Avant Projet for comparison.

If from these studies and from some of the general historical evidence reported in the previous chapter we were to reconstruct the use pattern of the land equipped for irrigation from the Moulouya in 1978 it would look as follows: On the Triffa 36,000 hectares were equipped for irrigation in 1978. In 1954 about 7,000-8,000 hectares of land in the northern part of the plain were irrigated with ground water and produced largely citrus, grapes and market vegetables. This land was almost exclusively controlled by Europeans. Another 12,000 to 15,000 hectares in the north were largely in cereals (including fallow) and pastures with the former predominating. In the southern Triffa 12,000-14,000 hectares were devoted to cereal

cultivation (including fallow) and pastures with the latter predominating. A few miscellaneous tree crops would be grown. Some of the land in the area, of course, would have been devoted to non-agricultural uses.

In 1978, 5,700 hectares in the Sebra were equipped for irrigation. Before 1970 about 90% of this would probably have been grazing land with the remaining land in cereals. A few hectares were in miscellaneous tree crops. (The higher elevations of the Sebra where a higher percentage of the land was in cereals in the 1960s will not be equipped for irrigation.) Before irrigation the Sebra was a miserable place to farm, suffering not only from lack of rain but also from lower quality soils. In the absence of irrigation water it was best suited for grazing in the traditional manner developed by the transhumant herder. But in dry years even the sheep and goats had to be diligent to eke out a bit of nourishment from that harsh land.

The 10,200 hectares on the Bou Areg equipped for irrigation in 1978 were probably largely devoted to cereals and grazing land before 1970 although some market vegetables were grown, particularly where there was pump irrigation.

If one looked back to the pre-irrigation period at the approximately 52,000 hectares on the three plains that are presently equipped for irrigation, one would probably find 9,000 to 11,000 hectares of citrus, grapes and vegetables (about 8,000 of which were irrigated), 15,000-17,000 in pasture, 20,000-25,000 in cereals (of which up to one-third would be fallow in any one year) and a small amount of land in miscellaneous tree crops. Thus in any given year only 28,000-30,000 hectares would have been planted.

Cropping Patterns in 1978

There has, of course, been a dramatic, planned change in the cropping patterns. The details of the cropping pattern on the irrigated land in 1978 are shown in Table 2.3. 9,355 hectares were in citrus, 75% of which were clementines (tangerines); 2/3 of these were seedless varieties. 25% were in oranges, 3/4 of which were navel oranges. The area in grapes has decreased in the irrigation period to a total of about 2,800 hectares and table grapes were becoming more important than wine grapes.

About 12,300 hectares were planted in vegetables in 1978. (Where two crops are planted in one year on the same land the area is reported twice.) Dry beans and potatoes are the dominant vegetables making up together about 60% of those grown. Something less than 9,000 hectares of cereals were planted in irrigated regions in 1978 of which about 15% was hard wheat, 37.5% soft wheat and 47.5% barley and other cereals.

One of the most significant changes in production has been the development of industrial crops. In 1978 about 7,000 hectares were devoted to industrial crops. Traditionally in the area a small amount of cotton had been grown mostly on the Gareb and Bou Areg plains, and Niora (red pepper) had been cultivated. By 1978 cotton had not been planted in the region for 6 years and sugar beets had emerged as the most significant industrial crop, accounting for 56% of the industrial crops grown. Niora remained important.

While pasture lands had virtually disappeared within the irrigated area in 1978, over 1,000 hectares were planted in forage, almost all of which was alfalfa. A small but significant herd of dairy cattle, 20,000 head of milk cows had also been developed by 1978. Surprisingly, ORMVAM reports a

Table 2.3

Cropping Pattern 1978

	Triffa		Bou Areg		Sebra		Total
	ha.	Percent	ha.	Percent	ha.	Percent	
Citrus							
1-4 years	765	89%	20	2%	75	9%	860
5-9 years	710	57%	65	5%	470	38%	1245
Mature	7250	100%	0	0%	0	0%	7250
Total	8725	93%	85	1%	545	6%	9355
Grapes							
Wine	1100	100%	0	0%	0	0%	1100
Table	1640	94%	60	4%	35	2%	1735
Total	2740	97%	60	2%	35	1%	2835
Vegetables							
Potatoes	3075	84%	320	9%	255	7%	3650
Beans	3025	82%	415	11%	260	7%	3700
Artichoke	510	62%	90	11%	220	27%	820
Melons	770	47%	690	42%	180	11%	1640
Tomatoes	155	27%	355	62%	60	11%	570
Misc. veg.	945	49%	645	34%	335	17%	1925
Total	8480	69%	2515	20%	1310	11%	12,305
Cereals							
Hard Wheat	990	75%	115	9%	215	16%	1320
Soft Wheat	2070	63%	920	28%	315	9%	3305
Oats & Barley	2150	51%	1260	30%	775	19%	4185
Total	5210	59%	2295	26%	1305	15%	8810
Industrial Crops							
Sugar Beets	1560	39%	1990	50%	440	11%	3990
Sugar Cane	0	0%	570	74%	204	26%	774
Niona	560	39%	525	37%	335	24%	1420
Mix	250	28%	610	70%	15	2%	875
Total	2370	34%	3695	52%	994	14%	7059
Forages	630	55%	315	28%	200	17%	1145

great increase in the number of sheep and goats within the perimeter. They are not, however, on the irrigated land.

As can be seen from Table 2.3 there are some significant differences in the cropping patterns on the three plains. About 70% of the land under cultivation was on the Triffa plain in 1978, about 10% was on the Sebra and 20% on the Bou Areg. Over 90% of the citrus and vines are on the Triffa. The industrial crops (sugar beets and cane, and niora) are predominantly grown on the left bank. While most of the cereals and vegetables are grown on the right bank (about 60% and 70% respectively) the percentage of land on the three plains in cereals and in vegetables are about the same.

The pattern of change in production is clear: pasture land has virtually disappeared; the amount of land devoted to cereals has been reduced by two-thirds; vegetables, citrus, and industrial crops now account for most of the land under irrigation. Dairy cattle are becoming important. Sheep and goats have virtually disappeared from the irrigated land, but have actually increased within the total perimeter.

There has also been an increase in the amount of land that is neither cultivated nor used for grazing. As the population increased and the soil became more productive, more land was occupied by houses and there was an expansion of the road network. About 10,000 hectares of land dominated by the canals are occupied by roads, houses, etc. This is slightly more than the 15% that was planned for such use in the early stages of the project.

CHANGES IN PRODUCTIVITY: PRE AND POST IRRIGATION

It can be seen that there have been major shifts in agricultural land use following the advent of irrigation. A change, of course, is to be expected. Of more interest are increases in productivity as measured by output per hectare. We have analyzed changes in productivity in two ways. First, we have examined the yields for those crops that were grown before and after irrigation. Secondly, we have estimated net returns per hectare in value terms before and after irrigation. The first set of figures present only a partial picture because they cannot take into account any of the crops that were grown only before or only after irrigation. The second set are affected not only by changes in yield but also by changing prices.

Changes in Yields

The best data we have on productivity in quantitative terms before irrigation is found in the SERESA study. These data along with our estimates for 1960 and 1978 based largely on ORMVAM data are reported on Table 2.4. It can be seen that the output per hectare of cereals increased by about two and one-half times between 1958 and 1978. For beans, the increase is one and one-half times, for wine grapes two and one-half times, for citrus about three times. The changes in these last three crops require some comment. In 1958 most beans and all of the citrus were probably grown on irrigated land. The dramatic increase in the latter probably represents new varieties and improved farming techniques. There probably had been less change in the technology of bean cultiation. The

increase can probably be attributed to higher fertilizer use. The area in wine grapes has greatly decreased during the last 12 years; over that period productivity remained unchanged.

TABLE 2.4

YIELDS BEFORE AND AFTER IRRIGATION (Tons/Hectare)

Year / Crop	1958 Before irrig. (S.E.R.E.S.A.)	1960	1978	Increase 1960 to 1978
Hard Wheat	0.8	1.8	2.2	1.9
Soft Wheat	1.0	2.0	2.5	2.1
Barley	1.0	2.5	2.5	2.5
Beans	1	1.3	1.5	1.4
Grapes (wine)	4	14	10	12
Citrus	4	7.4	11.9	10

These figures for cereals and beans greatly underestimate the increase in output per hectare. Before irrigation fields planted in cereals had to be left fallow at regular intervals. Such a practice is not necessary in irrigated production if proper cultivation techniques are used. Thus the average output over a 3 or 4 year period for a given hectarage planted in cereals would be 3.5 to 5 times more in 1978 than before the advent of

irrigation. In 1978 a crop of beans and a crop of potatoes were commonly grown on a single plot in a given year. Thus just reporting the bean yield in 1978 underestimates the annual output of a hectare by the yield of a potato crop and vice versa.

Changes in Net Returns Per Hectare

One should not jump to any conclusions about the value of the irrigation project from these figures on yield increase. They only cover a few of the many crops now grown and which occupy less than one half of the irrigated area and do not take into account the higher cost of production for irrigated farming. The increase in the net value of production per hectare would be more a meaningful statistic if one wishes to examine changes in productivity. It is, however, more difficult to compute, for in addition to getting data on output per hectare at two different time periods we need data on prices for the product and cost of production per hectare.

Net annual return per hectare was estimated in the Avant Projet at 292 dirhams for the Triffa plain in 1954. For the left bank returns were very low because there was little pump irrigation. The net return was estimated at only 11 dirhams per hectare in 1962 in the Sebra, Bou Areg and Gareb plains. Using the SERESA survey for 1957-58 it was possible to calculate the gross returns per hectare for the whole perimeter before surface irrigation. The average annual value of total production for 1957-59 was about 35,000,000 dirhams which works out to 519 dirhams per hectare. Operating costs were estimated at 220 dirhams per hectare. Labor costs were not dealt with in the survey. By using the techniques worked out by

TABLE 2.5

CROP RETURNS 1958

Crops	Area (Ha)	Value of Total Production 1000 DH	Operating Costs 1000 DH	Labor Costs 1000 DH	Net Returns 1000 DH
Irrigated crops (Total) with ORMVAM's	14,600	24,535	12,265	6,302	5,878
Irrigated crops without ORMVAM's. (5800 Ha dry)	14,600	20,521	10,259	4,995	5,267
Annual crops (dryland Ag.)	28,925	9,203	2,760	1,884	4,559
Arboriculture	2,600	3,440	1,720	416	1,304
Fallow	10,800	972	-	-	972
Pasture	10,000	600	-	-	600
Total with area irrigated by ORMVAM in dry land	66,925	34,736	14,739	7,295	12,702
Per hectare	-	519	220	109	190

TABLE 2.6

PRE-IRRIGATION NET CROP RETURNS (Dirhams/Hectares)

	Hydrotechnic, ONI, Report		Estimates using S.E.R.E.S.A. Survey (1958
	Right Bank (1954)	Left Bank (1962)	
Total Value of Production DH/Ha	837	216	519
Operating Costs DH/Ha	395	85	220
Labor Costs DH/Ha	150	120	109
Net Crop Returns DH/Ha	292	11	190

ORMVAM in the early 1970s we calculated the total man days for an area of 66,925 hectares to be 1,824,000, i.e., 27.2 man days per hectare as an average for the whole area. Using 4 dirhams a day as the wage rate labour costs would be 109 dirhams per hectare. This would place net crop returns for 1957-58 at 190 dirhams per hectare. This is about 20 dirhams per hectare higher than the average for the whole region one would obtain from the Avant Project. Since some land was irrigated with water from the Moulouya at the time of the SERESA study we would expect a higher average. Thus the two studies give raise to similar conclusions about net revenues per hectare before irrigation. (See tables 2.5 and 2.6.)

To get the gross returns per hectare for 1978 we took the yield for each crop times the price received. (See Table 2.7 for price data)

An ORMVAM study on costs of production of various crops in 1978 (which updated a 1972 report) was used to estimate input costs -- seeds, pesticides, etc., with the exception of labor. Estimates were made on the labor input for each crop per hectare using both ORMVAM data and results of our survey. The value of labor was computed using both a minimum agricultural wage and the average agricultural wage for the region.

In 1978 costs were approximately 1,630 dirhams per hectare for the whole irrigated area. Land cost for seeds, fertilizers, machinery, pesticides, etc., averaged 65 dirhams per hectare. Rent and water costs averaged 190 dirhams per hectare and labor costs were 900 dirhams per hectare (minimum wage) or 1,300 dirhams per hectare (Average wage). Net returns were 2,185 dirhams per hectare (minimum wage) and 1,785 dirhams per hectare (average wage).

TABLE 2.7

PRICES OF CROPS FOR SELECTED YEARS (Dirhams/ton)

	1960	1968	1970	1972	1974	1976	1978
Hard Wheat	40	47	47	50	63	63	85
Soft Wheat	35	40	40	50	60	60	85
Barley	23	25	25	30	40	40	65
Cirtus-Full prod.	30	45	45	50	60	80	70
Grapes (wine)	12	18	20	20	30	35	35
Potatoes	70	40	40	30	45	65	60
Cucurbitacae	12	25	25	40	35	25	40
Dry Beans	90	100	110	105	170	140	250
Niora	180	200	200	235	205	250	350
Sugar Beets	--	--	--	6	6.6	9.6	11.5
Sugar Cane	--	--	--	--	6.5	6.5	9
Forages	0.23/UF	0.25/UF	0.25/UF	0.30/UF	0.35/UF	0.40/UF	0.50/UF
Artichokes	25	35	50	50	55	55	60
Tomatoes	12	20	25	25	45	50	50

These figures indicate a 9 to 13 fold increase in net returns per hectare. As the cost of living something more than doubled, the increase in constant dirham would be approximately 4 to 6 fold. This is certainly an impressive increase in land productivity in value terms. But we must remember that these figures do not take into account any of the capital costs of the dams, the canals and the tunnels. In the following chapter, the benefit cost analysis, one gets a better estimate of the economic worth of the project, and the way in which it evolved from 1960 to 1978. In that chapter we will be more precise about the economic benefits. The data reported above provide an initial gross estimate of the increases in productivity in monetary terms to provide the reader with a general idea of the change that has occurred.

VARIATIONS IN PRODUCTION AND PRODUCTIVITY BY FARM SIZE

It is part of the folklore, if not of the theory of farm management, that cropping patterns and productivity will vary by size of unit and by type of management. Economies of scale and different incentives, among other factors, should effect what is grown and how it is produced. There is in the lower Moulouya great variation in size of farms but much less variation in the type of management. The vast majority of the farms are small, owner operated units. But a fair amount of the land is in large state farms. (For reasons stated in the introduction, state farms are not included in this study.)

TABLE 2.8

SIZE OF LAND HOLDINGS (OWNED, RENTED AND IN ASSOCIATION)

		0 - 25	>2.5-5	>5-10	>10-15	>15-20	>20-50	>50-100	>100 Ha	TOTAL
BOUARG	Number of Farmers	5	9	9	5	6	5	2	0	41
	% of Farmers	12.21	22	22	12.2	14.6	12.2	4.9		100
	Total Ha	7.45	31.50	67.14	69	103	163.85	168	0	609.94
	Ha/ farmers	1.49	3.50	7.46	13.80	17.17	32.77	84	0	14.85
SEBRA	Number of Farmers	2	18	6	2	1	1	0	0	30
	% of Farmers	6.67	60	20	6.67	3.33	3.33			100
	Total Ha	2	67.75	38.79	26	15.24	30	0	0	179.78
	Ha/ farmers	1	3.76	6.47	13	15.24	30	0	0	5.99
TRIFFA	Number of Farmers	38	26	22	5	1	1	1	1	95
	% of Farmers	41	26.3	23.2	5.3	1	1	1	1	100
	Total Ha	48.38	94.11	164.57	63.8	16	27	100	395	908.86
	Ha/ farmers	1.27	3.62	7.48	12.76	16	27	100	395	9.57
TOTAL	Number of Farmers	45	54	36	12	8	7	3	1	166
	% of Farmers	27	32	22	7	5	4	2	1	100
	Total Ha	57.83	193.36	270.50	158.80	134.24	220.85	268	395	1698.58
	Ha/ farmers	1.29	3.58	7.51	13.23	16.78	31.55	89.33	395	10.23

Size of Farms

Table 2.8 shows the distribution of size of farms in each size category based on data generated by our survey. Virtually all the farms are owner managed. Only one farmer in the survey rented all the land he farmed. A few rented a part of the land they farmed and some land was jointly owned and farmed "in association."

27% of the sample operated farms of 2.5 hectares or less; 32.5% from over 2.5 to 5 hectares; 21.6% from over 5 to 10 hectares; 7.2% from over 10 to 15 hectares and 9% from over 15 to 50 hectares. There are, of course, some significant differences among the three plains. The Triffa plain has the largest percentage of farms with 2.5 hectares or less (41%), followed by the Bou Areg (12%) and the Sebra (6.67%). If we look at the percent of farms of 5 hectares or less we see a somewhat different pattern. Two-thirds of the farms on the Triffa and Sebra are five hectares or less, while on the Bou Areg only one-third fell into that category. By contrast almost one-third of the operations on the Bou Areg are over 15 hectares. Only two farmers in our sample on the Sebra and four on the Triffa farm over 15 hectares.

Cropping Patterns and Size of Farms

Tables 2.9 through 2.15 show the major crops grown on the three plains by size of farm. They show that cropping patterns differ significantly both among the plains and among farmers with different size farms. In this chapter we are not primarily concerned about the direct welfare implications of these differences in size of farm. These issues

will be raised in Chapter Five. In this section we are concerned with the relationship between the size of farm and the crops grown and their yields to discover if there are any systematic patterns. Do the small farmers grow the same crop as large farmers? If they grow the same crops, do they have similar yields? On the tables that follow we will use essentially the same size categories as used on Table 2.8. In order to interpret these tables, however, it it necessary to call attention to certain features of the data. It can be seen in Table 2.8 that only one farmer operates more than 100 hectares. He farms 395 hectares on the Triffa plain. He is a real outlier in our sample, farming over 40% of the total amount of land operated by the 95 farmers in our sample on the Triffa. We have dropped him from the analysis because to include him distorts the aggregate picture rather badly.

It will also be noted from Table 2.8 that there are in the total sample 19 farmers with more than 15 hectares -- 18 if we drop the farmer with more than 100 hectares. 13 of the 18, however, are on the Bou Areg plain; only 2 on the Sebra and 3 on the Triffa. On the later two plains there is only one farmer in each of these large size categories. A case could be made to collapse all the size categories above 15 hectares into one category. There is, however, a good deal of variance on some variables among the 18 farmers and aggregate figures difficult to interpret. In the sections that follow we will report data on the large farmers for farm sizes of 15-20 hectares, 20-50 hectares and 50-100 hectares. It must be remembered the figures are meaningful only for the Bou Areg plain and that the total for the region are heavily influenced by those data. It should also be pointed out that these data are based upon our sample of private

TABLE 2.9

CITRUS

	Ha	0-2.5	>2.2.5	>5-10	>10-15	>15-20	>20-50	>50-100	TOTAL
BOUARG	% of farmers	--	--	--	--	16.7	--	--	2.4%
	% of total area	--	--	--	--	3.88	--	--	.66%
SEBRA	% of farmers	--	11.1	33.3	50	100	100	--	23.3%
	% of total area	--	1.3	6.8	8.7	59.1	11.7	--	10.2%
TRIFFA	% of farmers	52.6	46.2	86.4	60	100	100	100	60.6%
	% of total area	50.8	15.8	61.0	37.6	12.5	63	86	52.4%
TOTAL	% of farmers	44.4	25.9	58.3	33.3	37.5	28.6	33.3	39%
	% of total area	42.5	8.2	38.1	16.5	11.2	9.2	32.1	22.3%

farmers. The state farms are excluded. The figures on the percentage of land on each plain devoted to the various crops thus differ from those summarized earlier in this chapter which are based on ORMVAM data, and includes the state farms. (See the appendix to this chapter of a discussion of these differences.)

We can begin examining the pattern by looking at citrus which was the glamour crop of the 1950s and 1960s. (Table 2.9) Virtually all citrus is grown in the right bank. Only one farmer from our sample in the Bou Areg raised citrus; 23% of those on the Sebra had citrus orchards. On the Triffa, however, 61% had planted citrus and 47% of the total area on the plain was in citrus in 1978. Over half the farms with 2.5 hectares or less on the Triffa had citrus and about one half of the land on the farms of this size was in citrus. All of the farmers with more than 15 hectares on the Triffa grew citrus but there are only three in our sample.

For the irrigated region as a whole, 39% of the farmers grew citrus and 22% of the land area was in that crop. In terms of area planted it is the most important crop for private farmers in the region.

The second highest percentage of land (19%) is devoted to vegetables. (See Table 2.10). About the same percentage of land on each of the three plains is devoted to vegetables, 17.7%, 16.5%, 20.3% on the Bou Areg, Sebra and Triffa respectively. The only surprising data on vegetable production is that none of the smallest farmers on the Bou Areg grow any vegetables while over half of the farmers in virtually all other size categories on all three plains grow vegetables. But even on the Triffa and the Sebra the smallest percentage of farmers in the smallest category (2.5 hectares or less) raised vegetables.

TABLE 2.10

VEGETABLES

	Ha	0-2.5	>2.25-5	>5-10	>10-15	>15-20	>20-50	>50-100	TOTAL
BOUAREG	% of farmers	--	66.7	77.8	80	83.3	100	100	70.7%
	% of total area	--	27.6	17.8	29.1	16.0	15.0	15.5	17.7
SEBRA	% of farmers	50	77.8	66.7	100	100	--	--	73.3
	% of total area	30	22.4	22.7	16.2	6.6	--	--	16.5
TRIFFA	% of farmers	55.3	88.5	81.8	100	100	--	--	72.3
	% of total area	52.8	65.9	30.0	34.6	43.8	--	--	32.1
TOTAL	% of farmers	48.9	79.6	80.6	91.7	87.5	71.4	66.7	72.1
	% of total area	45.2	44.4	26.0	29.2	18.3	11.1	9.7	76.5

TABLE 2.11

INDUSTRIAL CROPS

	Ha	0-2.5	>2-2.5	>5-10	>10-15	>15-20	>20-50	>50-100	TOTAL
BOUARG	% of farmers	20	66.7	100	100	100	100	100	82.9%
	% of total area	23.5	20.2	37.9	28.6	24.7	30.8	16.8	25.5%
SEBRA	% of farmers	50	94.4	83.3	100	100	100	--	90%
	% of total area	50	41.9	28.7	19.4	66	13	--	28.1%
TRIFFA	% of farmers	26.3	73.1	36.4	40	100	--	--	43.2%
	% of total area	12.4	20.2	7.0	3.1	12.5	--	--	5.6%
TOTAL	% of farmers	26.7	77.8	61.1	75	100	85.7	66.7	61.4%
	% of total area	15.1	27.8	17.8	16.8	28.9	24.6	10.6	15.8%

61% of the operators who responded to our survey grew industrial crops (sugar beets, cane and niora) but production was concentrated on the left bank where just over 25% of each plain is in these crops compared to only 5.6% on the Triffa. On the Sebra industrial crops are particularly popular with the smaller farmers. Among industrial crops niora is most significant with this group. (See Table 2.11.)

Cereals account for about 14% of the land area. (Table 2.12) They are, however, more important on the left bank where 25% of the land is in cereal production. Less than 4% of the Triffa, by contrast, is devoted to these crops. On all the plains the smaller the farmer the higher percentage of his land is in cereals. It should be pointed out that while none of the farmers with 2.5 or less hectares on the Bou Areg grew vegetables, they all grew cereals.

Tree crops other than citrus and forages are the two crop categories we have yet to deal with. Both are relatively insignificant in terms of land area. 5.3% and 2.7% respectively. While the area in forages is small these crops play an important role in the livestock production in the region and will be discussed below in the section dealing with that topic. (See Tables 2.13 and 2.14)

There are several clear patterns that emerge from these tables. It is striking that citrus is predominently grown on the right bank while industrial crops (especially sugar beets) and cane are grown largely on the right bank. Central government agricultural policy is largely responsible for both of these patterns. In the late 1950s almost every land owner dreamed of getting rich from citrus production and the government saw its

TABLE 2.12

CEREALS

	Ha	0-2.5	>2-2.5	>5-10	>10-15	>15-20	>20-50	>50-100	TOTAL
BOU AREG	% of farmers	100	77.8	88.9	60	83.3	80	100	82.9%
	% of total area	51.5	47.6	46.8	23.2	19.9	20.1	20.8	25.4%
SEBRA	% of farmers	50	83.3	100	100	100	100	--	86.7%
	% of total area	50	34.2	33.3	13.5	13.1	10	--	25.3%
TRIFFA	% of farmers	26.3	50	36.4	20	--	--	--	33.7%
	% of total area	12.2	12.3	8.2	3.1	--	--	--	3.6%
TOTAL	% of farmers	35.6	64.8	61.1	50	75	71.4	66.7	55.4%
	% of total area	18.6	25.7	21.4	13.5	16.8	16.3	13.1	13.7%

TABLE 2.13

OTHER TREES

	Ha	0-2.5	>2.25-5	>5-10	>10-15	>15-20	>20-50	>50-100	TOTAL
BOUAREG	% of farmers	--	11.1	33.3	--	--	40	50	17.1%
	% of total area	--	3.2	4.3	--	--	4.3	1.1	2.1%
SEBRA	% of farmers	--	22.2	33.3	50	--	100	--	26.7%
	% of total area	--	3.7	3.6	6.5	--	11.7	--	5.1%
TRIFFA	% of farmers	18.4	30.8	36.4	20	100	--	100	27.6%
	% of total area	4.8	3.0	4.4	1.7	3.1	--	14	5.4%
TOTAL	% of farmers	15.6	24.1	36.1	16.7	12.5	42.9	66.7	24.8%
	% of total area	4.0	3.3	4.2	1.8	0.4	4.8	5.9	3.7%

TABLE 2.14

FORAGES

	Ha	0-2.5	>2-2.5	>5-10	>10-15	>15-20	>20-50	>50-100	TOTAL
BOUAREG	% of farmers	--	22.2	44.4	20	16.7	60	100	31.7%
	% of total area	--	4.8	3.0	0.7	0.5	9.5	6.0	4.9%
SEBRA	% of farmers	--	27.8	83.3	--	--	--	--	33.3%
	% of total area	--	3.3	9.0	--	--	--	--	3.2%
TRIFFA	% of farmers	5.3	19.2	36.4	40	100	--	--	18.9%
	% of total area	1.1	1.6	3.3	1.2	6.3	--	--	1.0%
TOTAL	% of farmers	4.4	22.2	47.2	25	25	42.9	66.7	24.7%
	% of total area	1.0	2.7	4.0	0.8	1.1	7.0	3.7	2.7%

foreign currency coffers enriched by the export of the golden fruit. But in the late 1950s and through the 1960s citrus production expanded rapidly through the Mediterranean world. The threat of overproduction and low prices loomed and a decree was issued in 1972 to prevent the expansion of citrus. Without special dispensation new citrus could be planted only to replace old trees. Citrus was at that time already widely cultivated on the right bank but as the left bank was just coming into irrigated production there were few trees and no more could legally be added without special permission; thus there is little citrus on the left bank today.

The fact that over 11% of the land is in sugar beets and cane with most of the production on the left bank is also largely due to government policy. Morocco has one of the highest per capita consumptions of sugar in the world. The government fostered the building of a sugar factory just outside Zaio on the left bank as part of an import substitution strategy. ORMVAM encourages farmers to grow sugar beets, particularly on the left bank where transportation costs to the factory are lower and a cash crop was more needed than on the right where citrus was already important.

There is also a difference in the data generated by our survey in the percent of land devoted to cereals on the three plains. About 25% of the land on the left bank but only 4% on the right is in cereals. There is no simple explanation for this difference. It appears to be related to the pattern of cropping among farmers with different sized units on the two sides of the river. On all three plains the smaller farmers (those with 10 hectares of land or less) devote the largest percentage of land to cereal production. The figures on the Bou Areg are particularly striking. All of the farmers with less than 2.5 hectares of land grew cereal and

have over 50% of their land in small grain. By contrast none of them grew any vegetables. The data we have on marketing show that none of these small farmers market any cereal. The small farmers on the other plains who grow cereal generally market only a small amount of what they produce. Thus the smaller farmers are obviously growing cereals largely for home consumption.

In northeast Morocco cereals are almost literally "the staff of life". One can speculate that the memory of pre-irrigation agriculture when drought meant soaring prices for cereals and at times near starvation, lives in the mind of the small farmers. Cereals store easily. To the small farmer they represent a hedge against an uncertain future. Other crops might generate more cash immediately but provide little safety for a large household if shortages in food in the near future drive prices high. We will explore these issues further in Chapter 5 when we address the impact of the project on the welfare of the household.

This still does not explain why cereals are much more popular on the left bank than on the right and more prominent on the Bou Areg than on the Sebra. A part of the difference between the two areas might be explained by the number of years the various regions have been under irrigation. By 1978 most of the land on the Triffa had been irrigated for over 20 years while the left bank had been under irrigation only 8 years. It takes a period of time for farmers to learn how to grow the new crops that can be grown when water becomes available. Farmers on the left bank may still be adjusting to irrigated agriculture. They keep a high percentage of their land in traditional crops that they know how to grow while experimenting on a part of their land with new crops.

If this factor were of major importance, however, we would expect a higher percentage of land on the Sebra than on the Bou Areg to be in cereals. Before irrigation cultivated land on the Sebra was almost exclusively devoted to cereals. Cereals also dominated the Bou Areg. The farmers on the Sebra are older and less well educated than those on the other plains. If the time involved in learning to grow new crops was of major significance we would expect a higher portion of the land on the Sebra to be devoted to cereal production. There are obviously other factors involved. As will be pointed out in Chapter 5 many of the small farmers on the Bou Areg are parttime farmers. They have other occupations that they pursue in town. If the marginal returns to their labor are higher in the alternative occupation, they will grow crops with the lowest labor input -- namely cereals. They farm largely to supply the household with a staple than can easily be stored.

Productivity: Output Per Hectare

The success of an irrigation project is dependent not simply on the introduction of new crops which can take advantage of the abundance of water, but also on improved farming practices. As pointed out above returns per hectare in the aggregate have increased dramatically since the advent of irrigation. It is now time to examine variations in yields by the size of farm operation. Before looking at yields for specific crops it is useful to look at the intensity of land use. Table 2.15 shows the percent of land under a farmers control which is actually cultivated. There is a clear pattern. Small farmers farm more intensively than larger farmers. On the Triffa and the Bou Areg farmers with 2.5 hectares or less

TABLE 2.15

INTENSITY OF LAND USE

(Percent of land under cultivation by size category)

	Ha	0-2.5	>2-2.5	>5-10	>10-15	>15-20	>20-50	>50-100	TOTAL
BOUAREG	% of farmers								
	% of total area	75.0	103.4	109.8	81.6	65.0	79.7	60.2	76.3%
SEBRA	% of farmers								
	% of total area	130.0	106.8	104.1	64.3	144.8	46.9	--	88.4%
TRIFFA	% of farmers								
	% of total area	134.1	118.8	113.9	80.6	78.2	63.0	100.0	85.4%
TOTAL	% of farmers								
	% of total area	126.4	112.1	111.5	78.6	74.8	73.1	75.1	83.1%

cultivate about 130% of their land. This figure falls off dramatically as farm size increases. Farmers with more than 15 hectares cultivate in a given year only about 75% of their land. (It must be remembered that there are so few cases of farmers with more than 15 hectares on the Sebra and Triffa that no inferences can be made from these data about the larger farmers on those two plains.) Small farmers are obviously double cropping. There are two common practices. One is to grow a crop of beans and a crop of potatoes on the same plot in a given year. Another is to intercrop vegetables among citrus particularly when the latter are immature. This second practice will probably lead to reduced yields of vegetables as they compete with the trees for the sun and nutrients.

The major exception to the generalization that the small farmers cultivate more intensively is the farmers on the Bou Areg with 2.5 hectares or less. They cultivate on the average only 75% of the land. It should be remembered that these are the farmers who devote the highest percentage of their land to cereals and who grow no vegetables. As double cropping invariably involves at least one crop of vegetables it is not surprising that they farm it less intensively than their counterparts on the other two plains and thus underexploit their land.

Tables 2.16 - 2.24 display the yields for major crops grown in the region. A word of caution is necessary in interpreting these data. The number of farmers in any of the cells is very small so one cannot generalize to the population of farmers at a given size for a specific crop. But it would be misleading to aggregate. It is well known that one cannot add apples and oranges; one can also not justifably add wheat and barley or potatoes and beans or clementines and oranges and quote a total figure for

TABLE 2.16

Clementin Yield (quintal/hectare)

Size of holdings Ha. / Plain	0-2.5	>2-2.5	>5-10	>10-15	>15-20	>20-50	>50-100	AVERAGE
Bou Areg	—	--	--	--	--	--	--	--
Zebra	--	6.25 1 farmer	1 1 farmer	--	114.2 2 farmers	--	--	91.69 qx/ha
Triffa	119.2 9 farmers	87.7 4 farmers	159.5 12 farmers	121.4 2 farmers	100 1 farmer	76.5 1 farmer	--	125.59 qx/ha
Total 2 Plains	119.2	71.6	154.9	121.4	111.1	76.5	--	122.29 qx/ha

TABLE 2.17

Orange Yields (quintals/hectare)

Size of holdings Ha. / Plain	0-2.5	>2-2.5	>5-10	>10-15	>15-20	>20-50	>50-100	TOTAL PLAINS
Bou Areg	—	—	—	—	0 1 farmer	—	—	0
Zebra	—	—	0.6 2 farmers	0 1 farmer	300 1 farmer	—	—	61.6 qx/ha
Triffa	77.3 3 farmers	20.1 5 farmers	105.8 8 farmers	—	—	—	—	63.5 qx/ha
Total 2 Plains	77.3	20.1	77.7	0	60	—	—	50.4

TABLE 2.18

OTHER CITRUS YIELDS (quintals/hectare)

Size of holdings Ha. / Plain	0-2.5	>2-2.5	>5-10	>10-15	>15-20	>20-50	>50-100	TOTAL PLAINS
Bou Areg	—	—	—	—	—	—	—	—
Zebra	—	—	—	—	15 1 farmer	—	—	15 qx/ha
Triffa	51 5 farmers	106.8 3 farmers	153.5 7 farmers	—	—	—	—	123.6 qx/ha
Total 2 Plains	51	106.8	153.5	—	15	—	—	119.1 qx/ha

TABLE 2.19

POTATOES YIELDS (quintals/hectare)

Size of holdings Ha. / Plain	0-2.5	>2-2.5	>5-10	>10-15	>15-20	>20-50	>50-100	TOTAL PLAINS
Bou Areg	--	12 1 farmer	44.2 2 farmers	43.2 2 farmers	202 1 farmer	--	--	71.8 qx/ha
Zebra	4 1 farmer	100 3 farmers	28.1 3 farmers	--	--	--	--	42.1 qx/ha
Triffa	144.7 8 farmers	155.8 13 farmers	129.9 11 farmers	185.6 3 farmers	--	--	--	152.6 qx/ha
Total 2 Plains	140	147.2	100.2	146.8	202	--	--	130 qx/ha

TABLE 2.20

SUGAR BEET YIELDS (quintals/hectare)

Size of holdings Ha. / Plain	0-2.5	>2-2.5	>5-10	>10-15	>15-20	>20-50	>50-100	>100	TOTAL
Bou Areg	480	117.8	483.3	344.5	331.1	318.1	459.1	—	383.11
Zebra	—	321.7	400	330.4	250	350	—	—	329.8
Triffa	542.9	418.9	418.9	467.5	—	—	—	346.1	402.16
Total 2 Plains	519.4	345.8	451.5	377.1	326.9	317.8	459.1	346.1	381.30

yields in quantitative terms. One could collapse the size categories but this would conceal one of the most interesting features of the table, namely the great variation in yields for most of the crops. One can legitimately make some comparisons among the plains from the data on these tables and draw attention to some trends in the relationship between size and productivity.

For citrus of all kinds and for potatoes and sugar beets the yields are higher on the Triffa than on the plains on the left bank. But these data must be interpreted with caution. As pointed out above very few farmers on the left bank raised citrus and since all the orchards were planted after 1970 the trees are not yet fully mature; low yields would be expected. While most sugar beets are grown on the left bank we do have 31 in our sample on the Triffa who grow beets. The comparison among the plains is meaningful and the right bank farmers do have the higher yields. The differences in potato yields are striking. The Triffa plain has much higher yields.

The farmers on the Bou Areg plain do markedly better with cereals and marginally better with niora and beans. (See Tables 2.21 - 2.23) For virtually all crops the lowest yields are on the Sebra. For any given crop there are so few farmers from the Sebra in our sample that one can have little confidence in a generalization about the yield on a specific crop. But since the pattern for the Sebra is so consistent we can have more confidence in the general observation that productivity is lower on that plain.

There are a number of possible reasons. The soil on the Sebra is of lower quality and this accounts for some portion of the lower yields. Also

TABLE 2.21

CEREAL YIELDS (quintals/hectares)

		0-2.5	>2-2.5	>5-10	>10-15	>15-20	>20-50	>50-100	TOTAL
BOUAREG	(1) SW	26.6	15.83	20.66	8.21	21.70	30.82	30	19.57 qx/ha
	(2) HW	11.29	—	—	—	—	12	—	11.91 qx/ha
	(3) B	15.71	25	16.78	12.40	23	18.63	24.71	20.72 qx/ha
SEBRA	(1) SW	12	4.96	17.49	12	15	—	—	8.63
	(2) HW	—	—	—	15	—	—	—	15-
	(3) B	—	10.55	14.27	0	16	5	—	10.64
TRIFFA	(1) SW	9.66	12.80	8.07	—	16	—	—	9.73
	(2) HW	2.50	4.17	11.60	—	—	—	—	7.55
	(3) B	11.70	16.90	5.43	—	20	—	—	10.47
TOTAL	(1) SW	15.98	10.19	14.18	8.42	21.07	30.82	30	15.51
	(2) HW	8.09	4.17	11.60	15	—	12	—	10.24
	(3) B	12.80	13.70	12.88	10.85	22.17	16.47	25.71	17.59

TABLE 2.22

NIORA YIELD (quintals/hectare)

	0-2.5	>2-2.5	>5-10	>10-15	>15-20	>20-50	>50-100	TOTAL
Bou Areg	--	30	11.5	15.7	7.8	5	--	12.8
Sebra	4	9.4	11	15	--	7.1	--	9.8
Triffa	9.1	12.1	13.1	--	10	--	--	11.7
Total	6.7	11.8	11.6	15.4	8.5	5.9	--	11.14

TABLE 2.23

SUGAR BEET YIELDS (quintals/hectare)

Size of holdings Ha. / Plain	0-2.5	>2-2.5	>5-10	>10-15	>15-20	>20-50	>50-100	>100	TOTAL PLAINS
Bou Areg	--	22	16	40	--	13.6	10.6	--	14.2 qx/ha
Sebra	--	8 3 farmers	--	12 1 farmer	--	--	--	--	8.8 qx/ha
Triffa	14.4 9 farmers	12.6 16 farmers	12.9 9 farmers	17.2 4 farmers	13.3 1 farmer	--	--	4.4	11.6 qx/ha
Total 2 Plains	14.4	12.5	12.9	20.1	13.3	13.6	10.6	4.4	12.1 qx/ha

TABLE 2.24

SUGAR CANE YIELDS (quintals/hectare)

	0-2.5	>2-2.5	>5-10	>10-15	>15-20	>20-50	>50-100	TOTAL
Bou Areg	640	429.8	631.3	397.9	591.3	480	956.7	557.6
Sebra	—	354.7	321.6	--	--	106.7	--	275.6
Triffa	--	--	—	—	—	--	--	—
Total	640	398	493.9	397.9	591.3	421.1	959.7	508.2

as will be pointed out in Chapter 5 farmers on the Sebra are less well educated than those on the other plains and are somewhat older. These factors probably correlate with lower managerial skill.

We also have some reasonable speculation about some other patterns. Citrus, potatoes and sugar beets--the crops for which the highest yields are on the Triffa could be grown in the region only with irrigation. Niora, cereals and beans are traditional crops in the area. While for reasons pointed out above citrus is a special case it is intereting that farmers on the right bank do better with new crops and those on the left bank do better with old crops grown in 1978 under irrigated conditions. This suggests that there is a learning process that is taking place. Farmers first learn to grow old crops under new conditions and they shift to new crops. It takes some time to get fully accustomed to the new crops and effectively exploit their potential. The worst farmers probably stay with the old crops the longest. The farmers on the right bank who are still growing old crops after 20 years are the least adaptable and progressive; they have low yields. Many farmers on the left bank have learned to grow old crops but have still not mastered completely the growing of new crops under irrigated condition.

While there is some systematic variation in yields among the plains for certain crops, the data reveal no systematic relationship between the size of farm and the output per hectare. The great variation in yields, that shows up in the tables, however, is of interest. We will briefly summarize the data by crop and then explore some of the possible reasons for the variation.

Yields of soft wheat range from less than 5 to over 30 quintals per hectare; hard wheat from 4 to 15; barley from 5½ to over 25 (see Table 2.21).

Tables 2.20 and 2.22 through 2.24 show that for the industrial crops there is no overall relationship between size of farm and output per hectare. The smallest farmers, however, do well with both sugar beets and cane. The highest yield for beets is about 3 times the lowest, but for cane the highest is 9 times the lowest. For Niora there is a 7 fold difference.

Sugar beets is the one crop in which we with data on hand can make a comparison between the productivity of private farmers and the state farms. Table 2.25 shows that private farmers get from 3 to 12 times more tons per hectare than do the state farms. The average is about 8 tons more per hectare, which is between 20 and 25 percent.

For the other crops the cell size gets so small when yields are presented by size of holdings that little can be said about any individual crop. The data, however, on clementines, oranges, other citrus, beans, and potatos, do show the great variation in output per hectare as do the other crops.

Clearly this great variation requires some attention. The number of cases is so small, however, that it is inappropriate to undertake normal statistical analysis.

One of the important factors contributing to the great variation in yields is that not all of the farmers in the sample irrigate all their crops. There are a number of reasons. Six farmers in our sample of farmers within the command area did not have any irrigatable land. Five of

TABLE 2.25

Sugar Beet Yields on Private and State Farms (Tons/Ha)

	Private Farmers	State Farms		
		SODEA	SOCETA	AVERAGE
Right Bank	45.3	32.7	38.1	42.7
Left Bank	41			41
Total Average	43	32.7	38.1	41.9

these were on the Triffa and one on the Sebra. In addition, there were four farmers who could have irrigated but did not irrigate any of their land (three in the Triffa and one in the Sebra). Thus, over 8 percent of our sample from the Triffa produced no crops with irrigated production.

Furthermore, another 27 farmers were not irrigating all of their irrigatable land. If we look at these farmers by plain and size of holding, the following picture merges: there are two on the Bou Areg, each with 5-10 hectares. They state that the reason they do not irrigate all their land is lack of money. On the Sebra there were two in the 2.5-5 hectare category, one in the 5-10 hectare category and one in the 20-50 hectare category. Of the two in the first set, one gave no reason for not irrigating, and the other said that there was not enough labor available and that employment outside agriculture was too profitable to spend all his time farming. The farmer in the second set claimed there was not enough labor and there was not enough water. The last farmer said that his land was not yet cleared of stones.

The pattern on the Triffa where out sample picked up 21 farmers who were not irrigating all their land is more complex. Eleven farmers with less than 2.5 hectares were not irrigating all their land. The reasons given were as follows: not enough water, 5; insufficient labor, 3; lack of money, 2; land not cleared, 1; no reason given, 1. (One farmer gave two reasons.)

There were six farmers in the 2.5-5 hectare category who gave the following reasons for not irrigating all their land: not enough water (or irregular supply), 4; parcel not cleared, 1; no reason given, 1. The one farmer in the 5-hectare category gave as his reason insufficient water. Of the two with 10-15 hectares, one gave no reason and the other had a parcel that was not cleared. One farmer with 15-20 hectares gave insufficient labor as his reason for not irrigating all his land.

We can summarize these data as follows: Seventeen farmers (10%) are not irrigating all or part of their land because of the inavailability of water through problems of design or construction. Eleven (6.6%) give lack of money (including land not being cleared) as a reason. This indicates an absence of credit at an interest rate these farmers calculated would make borrowing to increase productivity through irrigation worthwhile. We do not know if this represents excessive risk aversion, low marginal productivity, or an objection to borrowing on other grounds. In any case, however, if farmers had more money available they could make the capital investments (e.g. clearing their land) or purchase the inputs that would lead to greater productivity.

Ten farmers (6%) gave insufficient labor as a reason for not growing irrigated crops. As there is unemployment in the area, we must assume that

these farmers feel that the marginal productivity of labor is less than the increase in productivity that would result from irrigating their land. It seems unlikely that this could be the case and more reasonable to hypothesize that they do not have the financial resources available to hire the required labor. Again, there would seem to be some problems with the availability and use of credit.

If the land is in production but not being irrigated, it will probably be planted in cereals. Table 2.26 shows the yields for cereals planted inside the perimeter, but not irrigated, with cereals planted in the dry lands outside the perimeter. Note that while there is little difference for soft wheat, much higher yields are achieved on the dry lands outside the perimeter than inside for the other small grains. This reflects the fact that for cereal production depending on just rainfall, the hills around the plains are a better place to farm. It might also indicate that it is the least adequate farmers within the perimeter who do not irrigate and the good farmers who survived in dry land agriculture in the hills.

We will return to the issues of cropping patterns and productivity in Chapter 5 when we look at it from the perspective of the correlates of income for the farm household.

Livestock Production

To complete the picture of the changes in production and productivity since the advent of irrigation, we must review the changes that have occurred in livestock production. The number of livestock within the irrigation perimeter - both on irrigated and non-irrigated land - has been

TABLE 2.26

YIELDS OF CEREALS NOT IRRIGATED

Location / Cereal	Dry inside the perimeter (1)	Dry outside the perimeter (2)
Soft Wheat	2.21 8 farmers	2.07 6 farmers
Hard Wheat	1.40 12 farmers	9.8 9 farmers
Barley	1.89 15 farmers	3.29 10 farmers

increasing and the composition of the herd has been changing. It was reported at the beginning of this chapter that the SERESA study reported 4,000 cattle, 36,000 sheep and 35,000 goats in the region (including the Gareb) in 1958. According to ORMVAM reports, there are currently about 50,000 cattle, 400,000 sheep and 35,000 goats. These figures include the Gareb plain and the dry land lands within the perimeter. Thus the percentage breakdowns given below which are taken from data generated by our survey cannot be applied to these ORMVAM figures.

The most significant change in livestock has been the increase in the cattle population and the introduction of high quality dairy breeds. ORMVAM reports that 32% of the herd is made up of local catle with low milk and moderate meat yields, 24% are pure bred cattle (largely Friesians that have been imported from Europe) and 44% are a cross between local breeds and the imported cattle. (See Table 2.27) The data from our survey show a different pattern, but since it represents such a different population than the ORMVAM data, it should not be used to imply that the ORMVAM figures are incorrect. (See Table 2.28) The data from the survey do confirm the importance of purebred cattle in the region and indicate that they are heavily concentrated on the Bou Areg. The smallest number of cattle are kept on the Sebra. We found no purebred cattle on any of the dry land farms we surveyed.

While the number of cattle have increased dramatically in 20 years and a significant dairy herd has been developed, sheep and goats, particularly the former continue to be important in the region. The data in Table 2.28 show that almost half the farmers on the irrigated land within the region own sheep and/or goats. Ownership of these animals is

TABLE 2.27

Cattle on the perimeter 1978 (Source ORMVAM)

	Number	Percent	Adult Cows	% of Total Adults
Purebred Cattle	12,000	24	6000	30
Local Cattle	16,000	32	6000	30
Crossbred Cattle	22,000	44	8000	40
Total Cattle	50,000	100	20,000	100

TABLE 2.28

Cattle - Number by class and by plain (Source: Survey)

Cattle / Plain	Purebred Cattle adults & Young	Crossbred Cattle Adults & Young	Local Cattle Adults & Young	Total Cattle Adults & Young
Bou Areg	248	46	104	398
Sebra	19	28	37	84
Triffa	48	98	224	370
Total Irrigated Area	315	172	365	852
Dryland Survey	0	10	41	51

TABLE 2.29

Livestock: Survey 1977-1978

	Number of animals of adults & young	Number of farmers with animals	% of total farmers with animals	Average size of herd	Number farmers interviewed
Bou Areg	398	28	68.3	14.2	41
Sebra	84	18	60	4.7	30
Triffa	370	65	68.4	5.7	95
Total	852	111	66.9	7.7	166
Sheep and Goats					
	Number of animals of adults & young	Number of farmers	% of total farmers	Average size of herd	Number farmers interviewed
Bou Areg	1372	24	58.5	57.2	41
Sebra	629	17	56.7	37	30
Triffa	1317	39	41.1	33.8	95
Total	3318	80	48.2	41.5	166
Dryland Farmers					
	Number of animals of	Number of farmers with animals	% of total farmers	Average size of herd	Number farmers interviewed
Cattle	51	11	57.8	4.6	19
Sheep & Goats	777	14	73.7	55.5	19
Mules, Donkeys Horses	30	14	73.7	2.1	19

more important on the left bank where 58.5% and 56.7% of the farmers on the Bou Areg and Sebra than on the Triffa where the comparable figure is 41.1%. The average size herd is also larger on the plains on the left bank.

It is a bit misleading to lump sheep and goats together, because, in fact, there are very few goats left in the area. Our survey turned up only 56 on farms within irrigated land and 49 of those were on the Sebra. Even dry land farmers in the region keep few goats.

The data on animal ownership by size of holding is presented on Tables 2.30 and 2.31. They indicate that the smallest farmers on the Bou Areg and Sebra own very few cattle and that the ownership of pure bred cattle is more prominent among the farmers with 2.5 to 10 hectares and among those with over 20 hectares. The small farmers on the Triffa appear to be moving into cattle production much more significantly than are the small farmers on the left bank. (The reader should note in examining Table 2.31 that the aggregate figures are distorted by the one farmer on the Bou Areg in the 20-50 hectare category who owns about 60% of all the pure bred cattle reported in our survey.)

Table 2.30 also contains the data on the amount of land in forages, and the hectares of forage per head of cattle. Throughout the region the figures are very low.

Table 2.31 contains the data on ownership of sheep and goats by size of holding. These data show that, except on the Triffa, the smallest farmers are not deeply involved in sheep and goat production, but that significant numbers are held by farmers with 2.5 to 5 hectares. The data also show how inconsequential the ownership of goats has become in the region.

TABLE 2.30

Number of Cattle and Forages (Ha)

	Size of land holding # of animals	Ha >0-2.5	Ha >2.5-5	Ha >5-10	Ha >10-15	Ha >15-20	Ha >20-50	Ha >50-100	Ha >100	Ha Total
BOUARG	Imported Cattle	0	1	13	0	7	201	26	-	248
	Local Cattle	2	8	14	11	11	-	-	-	48
	Xbred Cattle	1	20	17	19	30	13	4	-	104
	Total Cattle	3	29	44	30	48	214	30	-	398
	Forages (Ha)	0	1.5	2	0.5	0.5	15.5	10	-	30
	Ha Forages / # of cattle	0	0.05	0.05	0.02	0.01	0.07	0.33	-	0.08
SEBRA	Imported Cattle	0	13	6	0	0	0	-	-	19
	Local Cattle	0	16	4	2	0	6	-	-	28
	Xbred Cattle	4	18	8	5	2	-	-	-	37
	Total Cattle	4	47	18	7	2	6	-	-	84
	Forages (Ha)	0	2.25	2	0	1.5	0	0	0	5.75
	Ha Forages / # of cattle	0	0.05	0.1	0	0.75	0	0	0	0.07
TRIFFA	Imported Cattle	4	6	16	4	0	18	0	0	48
	Local Cattle	24	36	15	-	-	-	-	23	98
	Xbred Cattle	26	39	66	15	13	-	65	-	224
	Total Cattle	54	81	97	19	13	18	65	23	370
	Forages (Ha)	0.8	1.55	5.51	0.75	1	-	40	-	49.61
	Ha Forages / # of cattle	0.01	0.02	0.06	0.04	0.08	0	0.60	0	0.13
TOTAL	Imported Cattle	4	20	35	4	7	219	26	0	315
	Local Cattle	26	60	33	13	11	6	0	23	172
	Xbred Cattle	31	77	91	39	45	13	69	-	365
	Total Cattle	61	157	159	45	63	238	95	23	852
	Forages (Ha)	0.8	5.3	9.51	13	3	15.5	50	0	85.36
	Ha Forages / # of cattle	0.01	0.03	0.06	69	0.05	0.06	0.53	0	0.10

Comments = cattle numbers = adults and young (< 2 years) Normally 1 Feurelle unite needs 1 Ha of forages. In this case = Total numbers of cattle = 1 feuelle unit.

TABLE 2.31

Sheep and Goats

		Ha >0-2.5	Ha >2.5-5	Ha >5-10	Ha >10-15	Ha >15-20	Ha >20-50	Ha >50-100	Ha >100	Ha Total
BOU AREG	Young sheep	0	20	69	45	34	90	100	-	358
	Adult sheep	2	49	175	125	53	435	170	-	1009
	Total sheep	2	69	244	170	77	525	270	-	1367
	Young goats	0	0	3	0	0	0	0	-	3
	Adult goats	1	0	1	0	0	0	0	-	2
	Total goats	1	0	4	0	0	0	0	-	5
SEBRA	Young sheep	10	40	28	0	0	4	-	-	82
	Adult sheep	10	332	112	10	4	30	-	-	498
	Total sheep	20	372	140	10	4	34	-	-	580
	Young goats	4	0	8	0	0	0	-	-	12
	Adult goats	4	21	12	0	0	0	-	-	37
	Total goats	8	21	20	0	0	0	-	-	49
TRIFFA	Young sheep	67	63	11	0	20	-	60	0	221
	Adult sheep	166	138	65	15	30	-	280	400	1094
	Total sheep	233	201	76	15	50	-	340	400	1315
	Young goats	0	0	0	0	0	0	0	0	0
	Adult goats	0	1	1	0	0	0	0	0	2
	Total goats	0	1	1	0	0	0	0	0	2
TOTAL	Young sheep	77	123	108	45	54	94	160	0	661
	Adult sheep	178	519	352	150	87	465	450	400	2601
	Total sheep	255	642	460	195	141	559	610	400	3262
	Young goats	4	0	11	0	0	0	0	0	15
	Adult goats	5	22	14	0	0	0	0	0	41
	Total goats	9	22	25	0	0	0	0	0	56

The summary data are on on Table 2.28 which indicates that cattle are kept on 66.9% of the farms surveyed and that the average sized herd was 7.7 head. The largest herds are on the Bou Areg where the average size is 14.2 head per farmer. Less than one-third of the farmers interviewed have no cattle; however, only one farmer in our survey indicated that livestock was his main source of income.

Part of the milk produced in the area is used for family consumption, part is sold to neighboring households or small merchants and the rest is sold through ORMVAM's milk collecting units to the cooperative dairy in Oudja. Table 3.32 displays data which indicate the increase in the dairy operation from 1975-1977. Over this period capacity increased from 6,000 to 23,000 liters per day, the amount of milk distributed through ORMVAM's collection centers increased from 1,250,000 to 2,180,000 liters annually and the number of farmers involved in the operation increased from 139 to 371.

In the past five years there has been a dramatic increase in the size of the poultry population but we have little information on this subsector. In 1973 ORMVAM distributed 8,000 three week old chicks to farmers in the region. By 1977 they were distributing 50,000 annually. As will be noted in Chapter Four, the relatively new feed mill in Nador concentrates its production on poultry feed and is planning a 3 fold increase in production. This suggests that one could expect to find continuing dramatic increases in the size of the poultry population in the region.

TABLE 2.32

Milk Collecting Centers: Numbers and Capacity

	Number of Units	Capacity Liters/day	Liters of milk distributed	# of farmers
1975	4	6000	1,257,000	139
1976	8	16,000	1,926,500	254
1977	11	23,000	2,180,000 (est.)	371

Summary and Conclusion

There has been a dramatic change in the patterns of production and in the productivity of agriculture in the lower Moulouya Basin since the advent of irrigation. In spite of the fact that pump irrigation had been introduced on a significant scale on the Northern Triffa in the 1930's, the region was, until the waters of the Moulouya were harnessed, dominated by grazing lands and cereal cultivation. By 1978 citrus, vegetables and sugar beets had become the major crops. Cereals remain important but they are planted largely by farmers who for one reason or another do not irrigate fully, or by those who are primarily growing them for home consumption.

A significant diary herd has developed, goats have largely disappeared, but sheep remain in sizable numbers.

Output per hectare has increased dramatically. For crops that were grown before irrigation and continue to be planted, yields have increased from one-and one-half to five times. The major increase in productivity, however, has come from the expansion of hectorage devoted to crops that require irrigation. Net revenues averaged about 190 dirhams per hectare before the project. This average is made up of significant net revenues from the land that was irrigated with ground water before 1960 and very small returns from the dry lands. Net returns in 1978 were 1,700 to 2,200 dirhams per hectare depending upon estimates of labor costs. This is a 9 to 13 fold increase. As the cost of living about doubled, there has been a 4 to 6 fold increase in real terms.

There are some differences among the plains in cropping patterns and productivity. Citrus is grown largely on the right bank and sugar on the

left. Government policy of restricting the expansion of citrus orchards and encouraging the development of a sugar processing industry is resonsible for the difference. Vegetables are important on all three plains, but they are not grown by small farmers on the Bou Areg.

Virtually all the private farms in the region are owner operated. Over two-thirds are five hectares or less. With the exception of a tendency for the smallest farmers to put a higher percentage of land into cereals, there are few differences in land use that are related to farm size.

While smaller farmers exploit their land more intensively than larger farmers, yields are not correlated with farm size. Variation is productivity, however, is great. A part of this variation is accounted for by the fact that some farmers cannot irrigate for technical reasons and others do not irrigate largely because they appear unwilling to incurr the higher production costs associated with irrigated production.

A shift to more valuable crops, the development of a dairy herd, and a striking increase in output per hectare are the significant changes in production and productivity in the region. Whether or not these economic benefits have been worth the economic costs is the next issue to consider.

Appendix

Chapter Two

Data for the 1978 crop year reported in the first section of this chapter were taken from ORMVAM's records. The data on percent of land in various crops and on productivity by size of holdings reported later were taken from our survey. One would expect certain differences. We sampled farmers. ORMVAM's data are derived from a more complete enumeration collected locally. Our figures report the percent of a farmers cultivatable land in specific crops. ORMVAM's figures use the total irrigated area (including land in non-agricultural use as a base. Our data, therefore, indicate a more intensive use of the land. Our data do not include state farms.

The data, however, are remarkably similar. Table 2.A1 shows that significant descrepencies show up only for land in cereals and citrus on the Triffa plain.

TABLE 2.A1

% OF LAND IN VARIOUS CROP CATEGORIES BY PLAINS

SURVEY vs. ORMVAM's FIGURES 1978

	Bou Areg		Sebra		Triffa		Total	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Cereals	25.4	22.5	25.3	22.9	3.6	15	13.7	17.4
VEGETABLES	17.1	24.7	16.5	23.0	20.3	24.4	18.9	24.3
INDUSTRIAL CROPS (- NIORA)	21.3	25.1	13.4	20.9	4.1	1.3	11.3	9.4
INDUSTRIAL CROPS (+ NIORA)	27.5	36.2	28.1	37.1	5.6	3.6	15.8	13.9
CITRUS	0.66	0.8	10.2	9.6	47.4	25.1	26.7	18.5
OTHER TREES	2.1	1.4	5.1	4.4	7.5	9.9	5.3	7.5
FORAGES	4.9	3.1	3.2	3.5	1.0	1.8	2.7	2.3
TOTAL	99.56	88.7	101.87	100.4	89.57	79.77	94.42	83.87

(1) Survey

(2) ORMVAM

Chapter Two

Footnotes

1. See the Bibliography note on unpublished sources for a discussion of the Avant Projet and the Hydrotechnic study.

CHAPTER THREE

BENEFIT-COST ANALYSIS

The lower Moulouya irrigation project brought marked changes in cropping patterns and dramatic increases in output per hectare. The comparisons of agricultural activity before irrigation with that of 1978 leaves little doubt that the project has made farming operations more productive. While these changes are interesting we must look beyond them to analyze impact of the project.

In this chapter we will present the results of what might be called a "financial" benefit-cost analysis. It will look at those costs and benefits that are quite easily quantifiable and put in monetary terms and see if the project can be justified by economic criteria. In the following two chapters we will look more broadly at the social and economic factors that cannot be easily quantified but the consideration of which enables us to make some comments about more basic welfare implications of the project. This might be called an "extended" benefit-cost analysis.

In order to undertake the financial benefit-cost analysis we must make certain initial assumptions. The first concerns the expected life of the project. All previous studies have projected the useful life of the basic capital structures to end in the year 2016. We have uncovered no evidence which would suggest abandoning this date and thus have used it in the analysis. (It should be noted, however, that we have not undertaken any engineering studies that assess such matters as the sedimentation rate in the reservoirs behind the dams that would provide data which could be used to question the assumed life.)

The second assumption concerns the date at which we begin our analysis. AID was primarily interested in the project beginning in 1960, the year of the first U.S. development loan. As it would have been difficult to push

the analysis back before 1960 because data are extremely sketchy, we started the financial benefit-cost analysis from that date. Investment costs from before 1960 are treated as sunk costs and are included in the cost figures for the year 1960. Operating costs and all project benefits from before 1960 are ignored.

In addition to alerting the reader that the beginning and ending dates are assumptions based partially on pragmatic considerations, we should also alert him to the fact that we have been conservative throughout the analysis on our estimates of project benefits, and very demanding in our calculation of costs. The major exception in that we have not included private investments on the cost side of the ledger. If our conclusions at the end of the chapter are in error, however, they most likely underestimate rather than overestimate the value of the project in the terms of reference of this chapter.

PROJECT BENEFITS

Net Returns for Hectares

A major input into the benefit-cost analysis is the data on net returns per hectare for each year from 1960 to 2016. Some data on net returns were presented in the last chapter. Much more detail, however, is necessary for the benefit-cost analysis. The basic data are displayed on Tables A3.1 through A3.21 which are in an appendix at the end of this chapter. These tables present the following data on 20 crops: the number of hectares devoted to each crop on each plain, the total hectarage, the gross income, the cost of production (labor; production costs including

seeds, fertilizer, machinery, pesticides, etc.; water; rent), the net return per hectare and the total net return on all three plains. As citrus trees have no yield for the first four years and a small yield from year 5 through 9, we have included three separate tables on citrus.[1]

These charts cover the period 1960-1987. Several expository comments are necessary to provide background for their interpretation. The most important of which are:

(1) All price-value data are in constant 1978 dirhams for the period 1960-2016. Gross revenues were computed using price data reported in the last chapter (table 2.7) that were expanded to provide an estimated price for every crop for every year 1960-2016 in 1978 dirhams.

(2) Sugar cane and beets were grown only on an experimental basis in the early years of the project. For these years only the opportunity cost of land was charged against the zero gross revenue. In 1975 the sugar cane was not processed and again only the opportunity cost of land was charged as a cost in the production cane.

(3) Only the value of the marketed milk through ORMVAM milk collecting units is treated as a benefit from livestock. No production cost is computed. It is assumed that the joint products - meat, hides, manure - plus the milk consumed by the producers, cover the production costs of livestock. These assumptions were made because we had few data on the actual costs of the dairy operation or on the net value of the joint products.

(4) We have confidence in the data reported from 1967 through 1978. In most cases several sources were available. 1978 data from ORMVAM squared

well with data from our survey.[2] For the period from before 1967 there were only scattered empirical sources and in many cases we were forced to rely on our own best estimates. From 1978 to 1987 we projected the high Triffa coming fully under irrigation and some increase in area under irrigation due largely to more experience and improved practices. The Gareb is not included in the projections. 1987 figures are projected without change through the year 2016.

(5) Because of the different yields, prices, and production cost for the various crops that make up the miscellaneous vegetables and miscellaneous industrial crops, the tables 3.10 and 3.14 contain no values for production costs other than rent. The "gross" column in these tables correspond to the net returns per hectare (rent not included).

(6) Labor costs were computed using the average (not minimum) local wage rate as reported in the last chapter. Water costs were computed using the agronomic requirements for each crop in cubic meters multiplied times ORMVAM's rate.

The Recipients of Benefits

In this chapter the recipients of project benefits have been divided into four categories: (1) farm operators; (2) land owners; (3) farm labor; and (4) ORMVAM. The benefits of the project that accrue to consumers and to the agricultural industries that use farm products as an input will be treated in the next chapter.

The first category is that of farm operator or manager. They receive benefits because their managerial efforts are more heavily rewarded

under the more productive conditions of irrigated agriculture. The net returns on Tables A3.1 - A3.25 are the returns to farm operators qua entrepreneurs.

Owners of the land brought under irrigation are a second category of beneficiaries. They benefit because land rent is higher for irrigated than for non-irrigated land. Current market values for rental land were used to calculate the current value of land rent from 1960 to 1978. Projections beyond 1978 were made on the basis of assumptions about the productive value of land.

The benefits accruing to the third category, agricultural labor, are computed by taking the difference between the average wage for farm labor and the minimum wage. The scant evidence we have suggest that agricultural labor in regions where there is no irrigation receive, at most, the minimum wage. The minimum wage would probably be paid in the lower Moulouya in the absence of the irrigation project.

These three categories of beneficiaries should not be viewed as distinct social classes. The owner-operator, for example, receives benefits as a manager, as a land owner, and as a farm laborer.

The benefits to ORMVAM are taken as the receipts for water sales for agricultural purposes. Since these receipts are also treated as a cost of production they exactly cancel out in the cost-benefit analysis.[3]

PROJECT COSTS

There are four types of costs that have been fed into the study on the cost side of the benefit-cost analysis; (1) public investment in the

project; (2) ORMVAM's operating costs; (3) the opportunity costs of money; and (4) the value of production in the area if there were no project.

Public Investment

As pointed out in Chapter One the lower Moulouya project has a long history. Major construction began in the early 1950s, but there were minor expenditures going back before that time.

After exploratory efforts to seek out the investment costs made before 1961 from original sources in Paris, Madrid and Rabat indicated that many months of work would be involved to get accurate figures, we used the cost estimates for this period reported by the Avant Projet. These figures were found to be reasonable by Hydrotechnic and appear to us to be acceptable estimates. There were included in our analysis as sunk costs.

We did search archives for investment costs in the 1960's, most notably in the records of l'Office National des Irrigations. The data from these archival sources were incomplete and we had to make estimates for some years. We also relied on the Avant Projet and the Hydrotechnic studies for data on this period.

ORMVAM's records for the 1970's are a good source of data for that decade, hence, these data were used accordingly.

Operating Cost

The operating costs include expenditures for maintenance, the provision of services to farmers (e.g. extension services) and the cost of such things as topographical studies and various other engineering design

work which are budgeted annually. ORMVAM records are also a good source for these data in the 1970s. There were problems obtaining data for the 1960's and for some years estimates had to be made.

We projected ORMVAM operating costs (in constant 1978 dirhams) into the future at 1979 levels. One might argue that maintenance costs will increase as the project gets older and that we have, therefore, made an underestimate. There are, however, items in ORMVAM's operating budget that relate to the development of the high service on the Triffa which will end in the early 1980s. We had no way of identifying these costs specifically in the budget and therefore they are left in. They should balance any underestimate we may have made on future maintenance costs. Operating cost of $35 million dirhams a year (in constant dirhams) was projected annually from 1979 on. Table 3.1 contains the investment and operating cost figures we used in the analysis.

Cost of Money

If there were no lower Moulouya irrigation project, the money invested in it could have gone to other purposes like industrial development or investment in dry land agriculture. The benefit stream to consumers from investment in the project is expected, as mentioned above, to occur over more than four decades. Since consumers generally prefer present to future utility of equivalent magnitudes, there exists some discount rate that makes the consumer indifferent between a unit of present consumption to some discounted unit of future consumption. In a competitive economy with functioning goods and capital markets, the rate at which future consumption is discounted can be shown to be equal to the opportunity cost of money; or

Table 3.1 Public Investments

	HEADWORKS DEVELOPMENT						
	Prior 1961	1961	1962	1963	1964	1965	1966
Barrage + investment By ONI	121,787	11,868	16,949	24,736	8,724	14,438	27,411
Plus ONI's operating budget		1,175	3,890	3,030	4,000	4,500	5,000
Payments on Capital Budget by ORMVAM	--	--	--	--	--	--	--
Less payments for Gareb	--	--	--	--	--	--	--
Plus ORMVAM's operating Budget	--	--	--	--	--	--	--
Total Invest. + Oper. (Current Prices)	121,787	13,043	20,839	27,766	12,704	18,938	32,411
Deflator 1978=100	44.27	38.41	43.73	50.39	53.10	54.90	54.35
Total invest. + oper. costs (1978 prices)	275,100	33,957	47,653	55,102	23,925	33,495	59,634
Total invest. + oper. costs (current prices) AVANT Projet	121,787	13,043	20,839	27,766	12,704	18,938	32,411
AVANT Projet's Deflated (1978 prices)	275,100	33,957	47,653	55,102	23,925	33,495	59,634

Table 3.1 Public Investments (continued)

IRRIGATION DEVELOPMENT

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
Barrage + investment By ONI Plus ONI's operating budget	--	--	--	--	--	--	--	--	--	--
Payments on Capital Budget by ORMVAM	11,136	11,694	32,926	21,713	9.016	10,459	22,803	31,803	37,589	46,515
Less payments for Gareb	--	--	--	--	--	--	--	--	--	--
Plus ORMVAM's operating Budget	5,898	7,907	7,253	7,971	8,568	9,062	10,347	12,920	14,335	21,074
Total Invest. + Oper. (Current Prices)	17,034	19,601	40,179	29,684	17,584	19,521	33,150	44,005	51,924	21,074
Deflator 1978=100	54.03	54.12	55.80	56.47	58.73	60.83	63.45	72.40	78.31	85.02
Total invest. + oper. costs (1978 prices)	31,527	36,218	72,005	52,566	29,940	32,091	52,246	60,780	66,306	75,154
Total invest. + oper. costs (current prices) AVANT Projet	29,551	13,660	40,284	42,955	37,843	31,258	24,338	14,336	12,000	3,500
AVANT Projet's Deflated (1978 prices)	54,694	25,240	72,211	76,067	64,436	51,386	38,358	19,801	15,324	4,117

Table 3.1 Public Investments (continued)

	Completion of Garet				i = 1960	
	1977	1978	1979	1980	i = 1979	
Barrage + investment By ONI Plus ONI's operating budget						
Payments on Capital Budget by ORMVAM	74,183	80,000				
Less payments for Gareb	(63,141)	(70,000)	(56,127)			
Plus ORMVAM's operating Budget	24,304	25,000	25,000			
Total Invest. + Oper. (Current Prices)	35,346	35,000			'til 1978 'til 1976	654,412 584,066
Deflator 1978=100	95.69	100.00				
Total invest. + oper. costs (1978 prices)	36,938	35,000			'til 1978 'til 1976	1,037,699 965,761
Total invest. + oper. costs (current prices) AVANT Projet	--	--	--		'til 1976	497,253
AVANT Projet's Deflated (1978 prices)					'til 1976	950,400

in our case, the real rate of return to relatively non-risky investments. The computation of the "base line" benefit to cost ratio reported in this chapter is based on a real rate of return of 8%. This may appear high but it is in keeping with our basic orientation of conservative estimates on both costs and benefits.

In order to demonstrate the sensitivity of our results to an assumed 8% real rate of return, we have however reported results from assuming both lower and higher real rates of return.

No Project Cost

If the Moulouya project had never been undertaken there would still be agricultural production in the region that would produce some revenue. Thus the benefits of the project must be understood to be derived from a difference between the benefits with the project and those occuring if there had been no project. In other words, we must deduct from the annual net revenues the average annual net revenue that would have been generated in the absence of the irrigation project on the land irrigated every year from 1960 through 2016. We are thus not faced with the relatively simple task of assessing benefits of the project over and above the production levels of a pre-project era, but with the more difficult task of formulating a hypothetical developmental history of the region over a 56 year period, assuming no significant public investments for the improvment of agricultural production.

We get at the problem conceptually by defining incremental gross benefits as the benefits farmers enjoy from irrigated production less our estimate of the benefits they would have enjoyed without the project.

Similarly incremental costs are defined as the difference between production cost (seeds, water, fertilizer, labor, rent, etc.) of irrigated agriculture and those that would have been experienced had there been no project. More specifically, by using a " ° " symbol to designate all values (returns and costs) had the project not been carried out, and the symbol " ' " to designate all values incurred due to the project. We define net returns to the farm operator with the project as:

$$NR' = GR' - PC' - W' - L' - R' \qquad (1)$$

where

GR' = total revenue earned from crop and livestock production.

PC' = total costs, exclusive of labor and rent, incurred in crop and livestock production.

L' = value of total labor employed in crop and livestock production.

R' = value of land services, in rent equivalents, employed in crop and livestock production.

It is thus plausible to define the net return to farmers, had the project not been built, as:

$$NR^{\circ} = GR^{\circ} - PC^{\circ} - W^{\circ} - L^{\circ} - R^{\circ} \qquad (2)$$

where the variables are defined as above.

Hence, the incremental changes in net revenue to the producer as the result of the project is obviously:

$$\Delta NR = NR' - NR^{\circ} \qquad (3)$$

And substituting equations (1) and (2) into equation (3) yields:

$$\Delta NR = (GR' - PC' - W' - L' - R') - (GR^{\circ} - PC^{\circ} - W^{\circ} - L^{\circ} - R^{\circ}) \qquad (4)$$

which after regrouping can be written as:

$$\Delta NR = (GR' - GR^\circ) - [(PC' - PC^\circ) + (W' - W^\circ) + (L' - L^\circ) + (R' - R^\circ)] \quad (5)$$

To further simplify notation, we can state the incremental changes in net revenue to the producer as a result of the project [equation (5)] as:

$$\Delta NR = \Delta GR - \Delta PC - \Delta W - \Delta L - \Delta R \quad (6)$$

where

$$\Delta GR = GR' - GR^\circ$$

$$\Delta PC = PC' - PC^\circ$$

$$\Delta L = L' - L^\circ$$

$$\Delta R = R' - R^\circ$$

Values for L°, R°, and NR° for each year were taken as the per hectare values in Table 3.2, converted to 1978 constant dirhams, (see below) and then multiplied by the total number of hectares irrigated by ORMVAM. For use in later discussion values for GR° and PC° were calculated the same way. All post-project values, i.e., L', W', R', NR', GR'1, PC', are drawn from Table A 3.1 through A 3.21.

Benefits to other factors of production, namely labor and land, occur if the project yields returns to these factors that exceed their opportunity costs. In the case of labor, the project has increased both the number employed and the wage rate. Hence, benefits to labor (denoted BL) in any given year is equal to the difference between the prevailing wage less the wage that would have prevailed without the project multiplied by the number of laborers employed. In our case, this becomes:

$$BL = (w' - w^\circ)\, L' \quad (7)$$

Table 3.2

No-project Estimated Benefits and Costs

GRAND TOTALS (MDH = DH X 1,000)

YEAR	TRIFFA	BOU'G	ZERRA	TOTAL	GROSS	LABOR	PROD	WATER	RENT	AV NET	TOT NET
	(HECTARES)				(MDH)	(MDH)	(MDH)	(MDH)	(MDH)	(MDH/HA)	(MDH)
1960	11690.	0	0	11690.	22500.	4329.	9435.	1901.	3367.	.297	3468.
1961	15155.	0	0	15155.	28376.	5712.	10117.	2513.	3789.	.412	6245.
1962	16214.	0	0	16214.	30413.	7597.	12332.	2694.	4605.	.196	3195.
1963	17202.	0	0	17202.	33316.	7951.	14505.	2835.	5542.	.138	2382.
1964	18015.	0	0	18015.	38164.	8350.	16003.	2948.	6215.	.258	4647.
1965	19034.	0	0	19034.	40786.	8848.	17352.	3133.	6795.	.245	4658.
1966	21439.	0	0	21439.	48251.	9584.	18895.	3472.	7568.	.407	8733.
1967	22691.	0	0	22691.	52103.	13010.	20580.	3852.	7365.	.295	6696.
1968	23050.	0	0	23050.	58280.	13498.	21040.	3885.	8114.	.509	11744.
1969	25639.	409.	105.	26153.	73437.	15119.	24663.	4484.	9494.	.714	18677.
1970	26204.	2884.	2878.	31966.	90364.	17059.	27741.	5150.	11732.	.897	28683.
1971	25926.	3547.	4879.	34352.	102736.	23436.	33502.	5546.	13122.	.790	27129.
1972	28631.	3239.	3704.	35574.	116063.	24406.	38619.	5892.	14052.	.930	33095.
1973	25696.	5607.	4361.	35664.	118667.	24606.	40408.	5925.	14534.	.926	33034.
1974	26287.	4805.	6261.	37353.	142469.	28549.	52522.	6400.	17556.	1.002	37441.
1975	24534.	5232.	4127.	33893.	147339.	27641.	55489.	6087.	16947.	1.215	41176.
1976	26165.	6437.	5192.	37794.	197907.	45873.	69756.	6718.	20787.	1.449	54763.
1977	27116.	8942.	4389.	40447.	227119.	52062.	85514.	6850.	25077.	1.424	57616.
1978	28845.	9075.	4579.	42499.	242349.	55275.	93262.	7219.	27624.	1.387	58957.
1979	29380.	9169.	4631.	43180.	252871.	54192.	94235.	7344.	28067.	1.599	69033.
1980	29595.	9273.	4678.	43546.	256932.	54850.	95163.	7444.	28305.	1.634	71170.
1981	29680.	9345.	4735.	43760.	260261.	55288.	96046.	7532.	28444.	1.667	72952.
1982	31030.	9345.	4735.	45110.	267637.	56758.	98531.	7727.	29322.	1.669	75299.
1983	31570.	9345.	4735.	45650.	270742.	57332.	99483.	7802.	29573.	1.675	76452.
1984	32105.	9345.	4735.	46185.	273618.	57886.	100333.	7871.	30020.	1.678	77507.
1985	32370.	9345.	4735.	46450.	275392.	58140.	100698.	7900.	30193.	1.689	78462.
1986	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
1987	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
1988	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
1989	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
1990	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
1991	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
1992	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
1993	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
1994	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
1995	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
1996	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
1997	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
1998	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
1999	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
2000	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
2001	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
2002	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
2003	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
2004	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
2005	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
2006	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
2007	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
2008	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
2009	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
2010	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
2011	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
2012	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
2013	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
2014	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
2015	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.
2016	32370.	9345.	4735.	46450.	276997.	58346.	101118.	7945.	30193.	1.709	79395.

where w' and w° are the wages prevailing before and after the project respectively and L' is the amount of labor employed on farms in the irrigation perimeter.

The public investment in irrigation infrastructure has increased the productivity of land and hence its price and rental value. Thus, owners of land, whether it be the farm operator or landlord, have experienced an increase in income to this factor of production. Let R° and R' denote land rents per hectare after and before the project respectively. As in the case of labor, benefits to land ownership (BR) for any given year can be estimated as:

$$BR = (R' - R^{\circ})\ A \qquad (8)$$

where A is the land within the irrigation perimeter.

Benefits in excess of opportunity costs to the factors of production, such as agribusiness suppliers of fertilizer, capital and other inputs to farmers are not included in this analysis because available evidence suggests that the prices of these factors have not incresed beyond their opportunity costs because of the project. This is explained, in part, by the fact that many of these inputs are imported and that the use of these inputs in the irrigated perimeter amounts to a small percentage of their total use in other areas of Morocco. Hence, the increased demand for these inputs because of the project has had a negligible impact on their prices.

Total undiscounted benefits (BO) at any point in time, to owners of factors of production is given by:

$$BO = \Delta NR + \Delta BL + \Delta BR + \Delta W \qquad (9)$$

Total benefits to owners of factors of production	=	Benefits to farm operators	+	Benefits to farm labor	+	Benefit to land ownership	+	Benefit to water ownership (public)

where BO indicates the total benefits to factor owners as a consequence of the project as a function of: (a) the incremental gain in net revenue to the farm operator (ΔNR), (b) the water charges collected by ORMVAM (ΔW), (c) the incremental gain accruing to labor (BL) through higher wages and/or increased employment, and (d) the incremental gains (BR) to landowners as a result of a higher rent charged on irrigated land, enhanced by the irrigation system. Thus, equation (9) naturally leads to a break down of the results by class of economic factors.

DATA MANIPULATION AND ANALYSIS

All cost and price data which are inputs to the cost benefit analysis are stated in 1978 current dirhams for the period 1960-2016 (Price data taken from the Avant Projet were in constant 1960 prices). We corrected all price data in current terms and in constant terms with a base year other than 1978 constant dirhams. This was done by computing a GNP deflator with 1978 prices as the base. Hence, the rates of return assumed in computing the B-C ratios and the derivation of the internal rate of return are in terms of real rates of return to the project.

The Deflator

The Gross Domestic Product (GDP) in current prices was obtained for the years 1960-1976 from data provided by the World Bank and by the Secretariat d'Etat au Plan et au Development Regional. The GDP data for 1977 and 1978 were estimated on the basis of 13.4% growth in GDP fr 1977 and 12.86% for 1978 (9% inflation and a set rate of growth of 3.86%).

The GDP in constant 1975 prices was then obtained from the World Bank and referred to as GDPc. An index was then constructed, using the formula:

$$\text{Index} = \frac{\text{GDP} \cdot 100}{\text{GDPc}}$$

This index was then compared with the World Bank Consumer Price Index (CPI), using 1975 as a base year, and was found to be similar to it. Consequently, the World Bank CPI figures were adopted as an acceptable proxy of the deflator used by The Bank to convert GDP and GDPc (See Table 3.3).

In the next step, we converted the CPI (1975=100) to the CPI (1978=100) by simple division. The GDP in constant 1978 prices was then computed as:

$$\text{GDP}_c\ (1978) = \frac{\text{GDP}}{\text{CPI}\ (1978)} \cdot 100$$

As a check, the Index was recomputed using the 1978 base year (by dividing the original Index by the 1978 CPI = 127.7) and a new CDPc was then computed using the new index:

$$\text{GDPc}^* = \frac{\text{GDP}}{\text{Index}\ (1978=100)} \cdot 100$$

Table 3.3 Computation of a Deflator

	(1) GDP GDP in Current Prices	(2) GDP GDP in 1975 Prices	(3) Index = (GDPx100) (-) GDPc	(4) CPI[c] 1975=100	(5) CPI[d] 1978=100	(6) GDP [e] GDP in 1978 Prices	(7) Bank's Index 1978=100	(8) GDP_c : GDP in 1978 Prices Using (7)
1960	9.09	16.08	56.53	56.80	44.48	20.44	44.27	20.53
1961	9.04	18.43	49.05	57.80	45.26	19.97	38.41	23.54
1962	10.62	19.02	55.84	60.70	47.53	22.34	43.73	24.28
1963	11.86	18.43	64.35	64.20	50.27	23.59	50.39	23.54
1964	12.49	18.42	67.81	66.80	52.31	23.88	53.10	23.52
1965	13.16	18.77	70.11	69.00	54.30	24.24	54.90	23.97
1966	12.84	18.50	69.41	68.40	53.56	23.97	54.35	23.62
1967	13.60	19.71	69.00	67.90	53.17	25.58	54.03	25.17
1968	15.31	22.15	69.11	68.10	53.33	28.71	54.12	28.29
1969	15.92	22.34	71.26	70.10	54.89	29.00	55.80	28.53
1970	16.96	23.52	72.11	71.00	55.60	30.50	56.47	30.03
1971	18.57	24.76	75.00	74.00	57.95	32.04	58.73	31.62
1972	20.15	25.94	77.68	76.80	60.14	33.51	60.83	33.13
1973	21.31	26.30	81.03	78.90	61.78	34.49	63.45	33.59
1974	26.74	28.92	92.46	92.70	72.59	36.84	72.40	36.93
1975	29.89	29.89	100.00	100.00	78.31	38.17	78.31	38.17
1976	35.72	32.90	108.57	108.60	85.04	42.00	85.02	42.01
1977	40.51[a]	33.15[b]	--	122.20	95.69	42.33	95.69	42.33
1978	45.72[a]	35.80[b]	--	127.70	100.00	45.72	100.00	45.72

Notes:

a/ Estimated on the basis of 13.4% growth in GDP for 1977 and 12.86% for 1978 (9% inflation + 3.86% set rate of growth).
b/ Estimated from CPI 1975=100.
c/ World Bank CPI figures are adopted as an acceptable proxy of the deflator to convert GDP into GDP.
d/ CPI 1975=100 converted to CPI 1978=100 by simple division.
e/ GDP_c 1978 obtained by using the formula:

$$GDP_c(1978) = \frac{GDP}{CPI(1978)} \times 100.$$

f/ Computed by dividing col. 3 by 1978 CPI = 127.7.

The two GDPc's were then compared and were found quite similar. This tells us that either the Bank 1978 Index or the 1978 CPI could be used. We chose to use the Bank's Index. All computations are summarized in Table 3-3.

Use of the Internal Rate of Return (IRR), Benefit Cost Ratio B/C, Net Present Value (NPV) and Cash Flow (CF).

The internal rate of return is that interest rate which equates the value of discounted net benefits with the value of discounted project investment and maintenance cost. Hence, the IRR has the advantage over B/C of not having to assign a value to the interest rate (r) in order to estimate social profitability. In the case of IRR, social profitability is measured by the extent to which the IRR exceeds the discount rate (8 percent) assigned to the B/C analysis. The IRR method is predominately used by World Bank project analysis. The formula is:

Find IRR such that:

$$\sum_{i}^{n} \frac{B_i}{(1+IRR)^i} - K_o + \sum_{i}^{n} \frac{K_i + C_i}{(1+IRR)^i} = 0$$

where the variables B_i, C_i, K_i are defined in Table 3-4.

The formula for the computation of the benefit-cost ratio (B/C) appears in the footnote of Table 3-4. An interest rate (r) is assigned a value of 8%. Since benefits (B_i) and costs (K_i, C_i) are in real terms, the 8% discount rate is also in real terms. A B/C ratio of unity implies that

Table 3-4 ALTERNATIVE NET PRESENT VALUES (NPV), BENEFIT-COST RATIOS(B/C), INTERNAL RATES OF RETURNS (IRR), AND CASH FLOWS (CF) - AT 8% INTEREST RATE

RUN	ALTERNATIVE SPECIFICATION OF NET PRESENT VALUE	NPV 1/ (1,000 DH)	B/C 2/	IRR 3/	NEGATIVE CF IN YRS:
1	GR - TC	743,840	1.93	18	1960-1973
2	NR + BL + BR + W' - TC(a)	199,982	1.25	10.5	1960-1983
3	CP + NR + BL + BR + W' - TC(b)	247,720	1.31	11.10	1960-1982

a) This is equivalent to discounted value from 1960 to 2016 of equation (9) except that TC equals discounted capital costs plus maintenance cost less water payments W'.

b) This adds consumer benefits (CP) to the analysis. See the next chapter.

1/ $NPV = -K + \sum_i^n \left[\frac{B_i - C_i}{(1+r)} i - \frac{B_i}{(1+r)} i \right]$ where B_i = estimated benefits from equation (10), r = interest rate, C_i = ORMVAM maintenance and operating costs, K initial project investment costss and K_i denotes investment costs incurred after the first year, i = 1,..., h for years 1960 to 2016.

2/ $B/C = \sum_i^n \left(\frac{B_i}{(1+r)} i \right) \Big/ \left(K + \sum_i^n \frac{K_i + C_i}{(1+r)} i \right)$, where variables B_i, C_i, K_i, r i are as defined above.

3/ See text.

the project is earning a social rate of return to all of the private and ublic resources invested in the project of 8%.

The net present value (NPV) is simply the discounted value of net project benefits less the discounted value of net project cost. In the early stages of a project, when investments are large, costs exceed benefits so that NPV is negative. If NPV equals zero, then the project has "broken even" in the sense that benefits and costs, each discounted at 8%, are equal. A positive NPV suggests a social rate of return in excess of 8%. Hence, the net present value provides insights into the point in time when a project breaks even and into the total net profits to society of the project.

When analyzing several projects, circumstances arise where the B/C method will yield a social profitability ranking that differs from the ranking given by the IRR method. This is not a problem here, of course, because we are focusing at a single project. It should also be noted that investment projects carry some level of risk, i.e., a probability of failure and the loss of all a part of private and public capitol contained in the project. As this risk increases, the interest or discount rate will need to be increased on the conceptual grounds that higher rewards are needed in order to accept more risky investments. This component of the problem is ignored in our analysis and, in any case, its inclusion would have little effect on the results obtained.

A cash flow (CF) analysis was added to the study to determine the viability of the project year by year. Outflows of cash are basically total costs while inflows of cash are total benefits generated by the

project. Their difference is the net cash inflow or the incremental present value of the project, discounted over time, and computed for each year. Essentially, the CF indicates the period of time when public inflows of resources to the project exceed the outflow of goods and services, in value terms. We adopted the NPV, the Benefit-cost ratio, the internal rate of return, and the cash flow analysis as the decision criteria for determining the profitability of the project, given the availability of data.

Economic Profitability

Table 3-4 is an array of net present values (NPVs), Benefit-cost ratios (B/C), internal rates of return (IRR), and cash flow information (CF), computed under the assumption of 8% real interest rate for alternative specifications of the net present value. Three alternative specifications have been chosen to reflect the preferences of various decision makers.

We believe that a more plausible definition of NPV, as discussed above, is found in either run 2 or run 3 in table 3.4. In run 2, NPV is defined as the sum of the incremental rent, and the water charges, minus total project costs. The NPV is found to be 199,982,000 DH, the B/C ratio is 1.25, the IRR is 10.5% and cash flows are negative through 1983, and positive thereafter. Run 3 adds an estimate of consumer benefits to the analysis. This will be discussed in the next chapter.

This analysis suggests that the project is indeed economically profitable. The IRR of 10.5 percent is the real average role of return to society over the life of the project. In nominal terms, this rate is in the vacinity

of 20 percent. The next question is to obtain insights into the distribution of these benefits to farm operators, laborers, land owners and consumers.

THE DISTRIBUTION OF BENEFITS

The present values of each estimate are displayed in Table 3-5. "No-project" present values are our estimates of what the present value of the benefit stream would have been, had the Moulouya irrigation project not been undertaken. Post-project present values represent the actual present values as observed in 1978 and as estimated through 2016. Subtracting "no-project" present values from post-project present values yields the incremental present values - i.e. those present values increases due to the project.

The sum of discounted net benefits to owners of factors of production, namely farm operators (347,133 DH), labor (333,120 DH), land owners (223,504 DH) measures the benefits occuring to these various groups. These values are reported in Table 3-6. The percentage distribution of these benefits are reported in Table 3-7.

Table 3-7 is self-explanatory. Almost two-fifths of the increase in the present value of total net benefits went to farm operators and more than one-third went to farm laborers. About one-fourth of the total went to landowners. As an interesting aside, the undiscounted value of water

TABLE 3-5 THE RESULTS OF THE ANALYSIS: THE PRESENT VALUES

PROJECT ESTIMATOR	POST-PROJECT PRESENT VALUES (1978 DH X 1,000)		NO-PROJECT PRESENT VALUES (1978 DH X 1,000)		INCREMENTAL PRESENT VALUES (1978 DH X 1,000
PROJECT COST	798,106		0		798,106
GROSS REVENUE	1,987,312		455,366		1,541,946
LABOR	426,655		93,535		333,120
RENT	246,655		23,170		223,504
WATER	94,331		0		94,331
NET REVENUE	487,007		139,874		347,133
OTHER PRODUCTION COSTS	732,645		188,787		543,858
CONSUMER SURPLUS		NC		NC	47,738

Table 3-6 FARM, CONSUMER, AND TOTAL BENEFITS
ALL BENEFITS IN 1978 CONSTANT DH X 1,000

YEAR	FARM	CB CONSUMER[1]	TOTAL
	NR + BL + BR + W		
1960	21627.	266.	21893
1961	37233.	959.	38192.
1962	30620.	1113.	31743.
1963	25620.	1316.	26936.
1964	29487.	1646.	31132.
1965	29788.	2058.	31846.
1966	39530.	2527.	42057.
1967	42984.	2254.	45238.
1968	53320.	2471.	55791.
1969	69633.	3297.	72930.
1970	89244.	4242.	93486.
1971	94483.	4018.	98501.
1972	102971.	3514.	106485.
1973	99550.	3304.	102854.
1974	98885.	4193.	103078.
1975	94666.	3549.	98215.
1976	125667.	6195.	131862.
1977	121354.	5656.	127010.
1978	120368.	6594.	126962.
1979	129458.	6748.	136206.
1980	132343.	6223.	138566.
1981	134646.	7077.	141723.
1982	138623.	7308.	145931.
1983	140411.	7445.	147859.
1984	142075.	7588.	149663.
1985	143307.	7840.	151147.
1986	144491.	7840.	152331.
1987	144491.	7840.	152331.
1988	144491.	7840.	152331.
1989	144491.	7840.	152331.
1990	144491.	7840.	152331.
1991	144491.	7840.	152331.
1992	144491.	7840.	152331.
1993	144491.	7840.	152331.
1994	144491.	7840.	152331.
1995.	144491.	7840.	152331.
1996	144491.	7840.	152331.
1997	144491.	7840.	152331.
1998	144491.	7840.	152331.
1999	144491.	7840.	152331.
2000	144491.	7840.	152331.
2001	144491.	7840.	152331.
2002	144491.	7840.	152331.
2003	144491.	7840.	152331.
2004	144491.	7840.	152331.
2005	144491.	7840.	152331.
2006	144491.	7840.	152331.
2007	144491.	7840.	152331.
2008	144491.	7840.	152331.
2009	144491.	7840.	152331.
2010	144491.	7840.	152331.
2011	144491.	7840.	152331.
2012	144491.	7840.	152331.
2013	144491.	7840.	152331.
2014	144491.	7840.	152331.
2015	144491.	7840.	152331.
2016	144491.	7840.	152331.

[1] Consumer benefits will be treated in the next chapter.

TABLE 3-7 % share of benefits to each economic class		
PROJECT ESTIMAOTR	INCREMENTAL PV (1978 DH X 1,000)	% OF TOTAL
FARM OPERATORS	347,133	38.41
FARM LABORERS	333,120	36.86
LAND OWNERS	223,504	24.73
TOTAL BENEFITS	903,757	100.0

value of water payments was calculated to be 439 million DH; the undiscounted value of the project cost stream was 2,440 million DH. If the project is to be "self-supporting" from water payment income, much higher water charges would have to be levied.

While not part of the benefit indicator, production cost NPV's provide further insight into the overall impact of the project. The incremental gain in production input purchases was 544 million DH. This gain represents an increased monetary flow to vendors of tractors, fertilizers, and farm chemicals, etc. While this figure is greater than the incremental benefits to operators, or laborers or owners, for reasons stated above, it was not treated as a benefit in this analysis.

SENSITIVITY ANALYSIS

Many decisions were made in evaluating the net present value, benefit-cost ratio, internal rate of return, and cash flow of the project

that could substantially affect the outcome of the analysis. In this section, we examine the sensitivity of the results of the analysis to: (1) alternative discount rates, (2) alternative project life spans, (3) overall estimation errors, and (4) specific estimation errors.

Alternative Discount Rates

The choice of discount rates would have an impact on the B/C ratio. The project will appear more socially profitable at low rates of discount than at higher discount rates. The baseline analysis was repeated with interest rates of zero to twenty percent and the results are summarized in Table 3-8 and graphed in Figure 3-1. The undiscounted (zero interest rate) results show that benefits are 2.77 times as large as costs. On the other hand, the results obtained under the assumption of a 20% discount rate show that the NPV of the benefits is barely over half that of costs. When the results displayed in Table 3-8 are plotted in Figure 3-1, we obtain a negatively sloping B/C ratio curve reflecting the inverse relationship between BC ratios and interest rates, lower B/C ratios prevail. Please note that at the "break-even" point of the B/C criterion (i.e. B/C = 1), the B/C ratio curve crosses the horizontal line B/C = 1 at an interest rate of 10.5%. Notice from Table 3-8 that this interest rate of 10.5% is also the IRR. In fact, the IRR can also be defined as that rate of interest that makes the B/C ratio equal to unity. Point BE in Figure 3.1 marks this break even point. On portions of the curve lying below BE, costs will exceed benefits and the project is not economically justified.

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* All discount rates are in real, not nominal terms.

TABLE 3-8

DISCOUNTED BENEFIT-COST RATIOS, 1960-2016

DISCOUNT RATE		0
NPV OF BENEFITS	=	6767124. (DH X 1,000)
NPV OF COSTS	=	2439637. (DH X 1,000)
BENEFIT-COST RATIO	=	2.77
DISCOUNT RATE	=	.010
NPV OF BENEFITS	=	4944549. (DH X 1,000)
NPV OF COSTS	=	1953246. (DH X 1,000)
BENEFIT-COST RATIO	=	2.53
DISCOUNT RATE	=	.020
NPV OF BENEFITS	=	3698659. (DH X 1,000)
NPV OF COSTS	=	1611917. (DH X 1,000)
BENEFIT-COST RATIO	=	2.29
DISCOUNT RATE	=	.030
NPV OF BENEFITS	=	2830281. (DH X 1,000)
NPV OF COSTS	=	1366644. (DH X 1,000)
BENEFIT-COST RATIO	=	2.07
DISCOUNT RATE	=	.040
NPV OF BENEFITS	=	2213140. (DH X 1,000)
NPV OF COSTS	=	1186199. (DH X 1,000)
BENEFIT-COST RATIO	=	1.87
DISCOUNT RATE	=	.050
NPV OF BENEFITS	=	1766030. (DH X 1,000)
NPV OF COSTS	=	1050370. (DH X 1,000)
BENEFIT-COST RATIO	=	1.68
DISCOUNT RATE	=	.060
NPV OF BENEFITS	=	1435965. (DH X 1,000)
NPV OF COSTS	=	945865. (DH X 1,000)
BENEFIT-COST RATIO	=	1.52
DISCOUNT RATE	=	.070
NPV OF BENEFITS	=	1187850. (DH X 1,000)
NPV OF COSTS	=	863793. (DH X 1,000)
BENEFIT-COST RATIO	=	1.38
DISCOUNT RATE	=	.080
NPV OF BENEFITS	=	998088. (DH X 1,000)
NPV OF COSTS	=	798107. (DH X 1,000)
BENEFIT-COST RATIO	=	1.5

Baseline Analysis

TABLE 3-8 (continued) Discount Rate = 100

DISCOUNT RATE	=	.090	
NPV OF BENEFITS	=	734165.	(DH X 1,000)
NPV OF COSTS	=	700388.	(DH X 1,000)
BENEFIT-COST RATIO	=	1.05	
DISCOUNT RATE	=	.110	
NPV OF BENEFITS	=	640921.	(DH X 1,000)
NPV OF COSTS	=	663296.	(DH X 1,000)
BENEFIT-COST RATIO	=	.97	
DISCOUNT RATE	=	.120	
NPV OF BENEFITS	=	565316.	(DH X 1,000)
NPV OF COSTS	=	631806.	(DH X 1,000)
BENEFIT-COST RATIO	=	.89	
DISCOUNT RATE	=	.130	
NPV OF BENEFITS	=	503254.	(DH X 1,000)
NPV OF COSTS	=	604778.	(DH X 1,000)
BENEFIT-COST RATIO	=	.83	
DISCOUNT RATE	=	.140	
NPV OF BENEFITS	=	451746.	(DH X 1,000)
NPV OF COSTS	=	581353.	(DH X 1,000)
BENEFIT-COST RATIO	=	.78	
DISCOUNT RATE	=	.150	
NPV OF BENEFITS	=	408564.	(DH X 1,000)
NPV OF COSTS	=	560875.	(DH X 1,000)
BENEFIT-COST RATIO	=	.73	
DISCOUNT RATE	=	.160	
NPV OF BENEFITS	=	372028.	(DH X 1,000)
NPV OF COSTS	=	542835.	(DH X 1,000)
BENEFIT-COST RATIO	=	.89	
DISCOUNT RATE	=	.170	
NPV OF BENEFITS	=	340852.	(DH X 1,000)
NPV OF COSTS	=	526834.	(DH X 1,000)
BENEFIT-COST RATIO	=	.65	
DISCOUNT RATE	=	.180	
NPV OF BENEFITS	=	314044.	(DH X 1,000)
NPV OF COSTS	=	512552.	(DH X 1,000)
BENEFIT-COST RATIO	=	.61	
DISCOUNT RATE	=	.190	
NPV OF BENEFITS	=	290827.	(DH X 1,000)
NPV OF COSTS	=	499736.	(DH X 1,000)
BENEFIT-COST RATIO	=	.58	

TABLE 3-8 (continued) Discount Rate = 100

DISCOUNT RATE	=	.090	
NPV OF BENEFITS	=	734165.	(DH X 1,000)
NPV OF COSTS	=	700388.	(DH X 1,000)
BENEFIT-COST RATIO	=	1.05	
DISCOUNT RATE	=	.110	
NPV OF BENEFITS	=	640921.	(DH X 1,000)
NPV OF COSTS	=	663296.	(DH X 1,000)
BENEFIT-COST RATIO	=	.97	
DISCOUNT RATE	=	.120	
NPV OF BENEFITS	=	565316.	(DH X 1,000)
NPV OF COSTS	=	631806.	(DH X 1,000)
BENEFIT-COST RATIO	=	.89	
DISCOUNT RATE	=	.130	
NPV OF BENEFITS	=	503254.	(DH X 1,000)
NPV OF COSTS	=	604778.	(DH X 1,000)
BENEFIT-COST RATIO	=	.83	
DISCOUNT RATE	=	.140	
NPV OF BENEFITS	=	451746.	(DH X 1,000)
NPV OF COSTS	=	581353.	(DH X 1,000)
BENEFIT-COST RATIO	=	.78	
DISCOUNT RATE	=	.150	
NPV OF BENEFITS	=	408564.	(DH X 1,000)
NPV OF COSTS	=	560875.	(DH X 1,000)
BENEFIT-COST RATIO	=	.73	
DISCOUNT RATE	=	.160	
NPV OF BENEFITS	=	372028.	(DH X 1,000)
NPV OF COSTS	=	542835.	(DH X 1,000)
BENEFIT-COST RATIO	=	.89	
DISCOUNT RATE	=	.170	
NPV OF BENEFITS	=	340852.	(DH X 1,000)
NPV OF COSTS	=	526834.	(DH X 1,000)
BENEFIT-COST RATIO	=	.65	
DISCOUNT RATE	=	.180	
NPV OF BENEFITS	=	314044.	(DH X 1,000)
NPV OF COSTS	=	512552.	(DH X 1,000)
BENEFIT-COST RATIO	=	.61	
DISCOUNT RATE	=	.190	
NPV OF BENEFITS	=	290827.	(DH X 1,000)
NPV OF COSTS	=	499736.	(DH X 1,000)
BENEFIT-COST RATIO	=	.58	

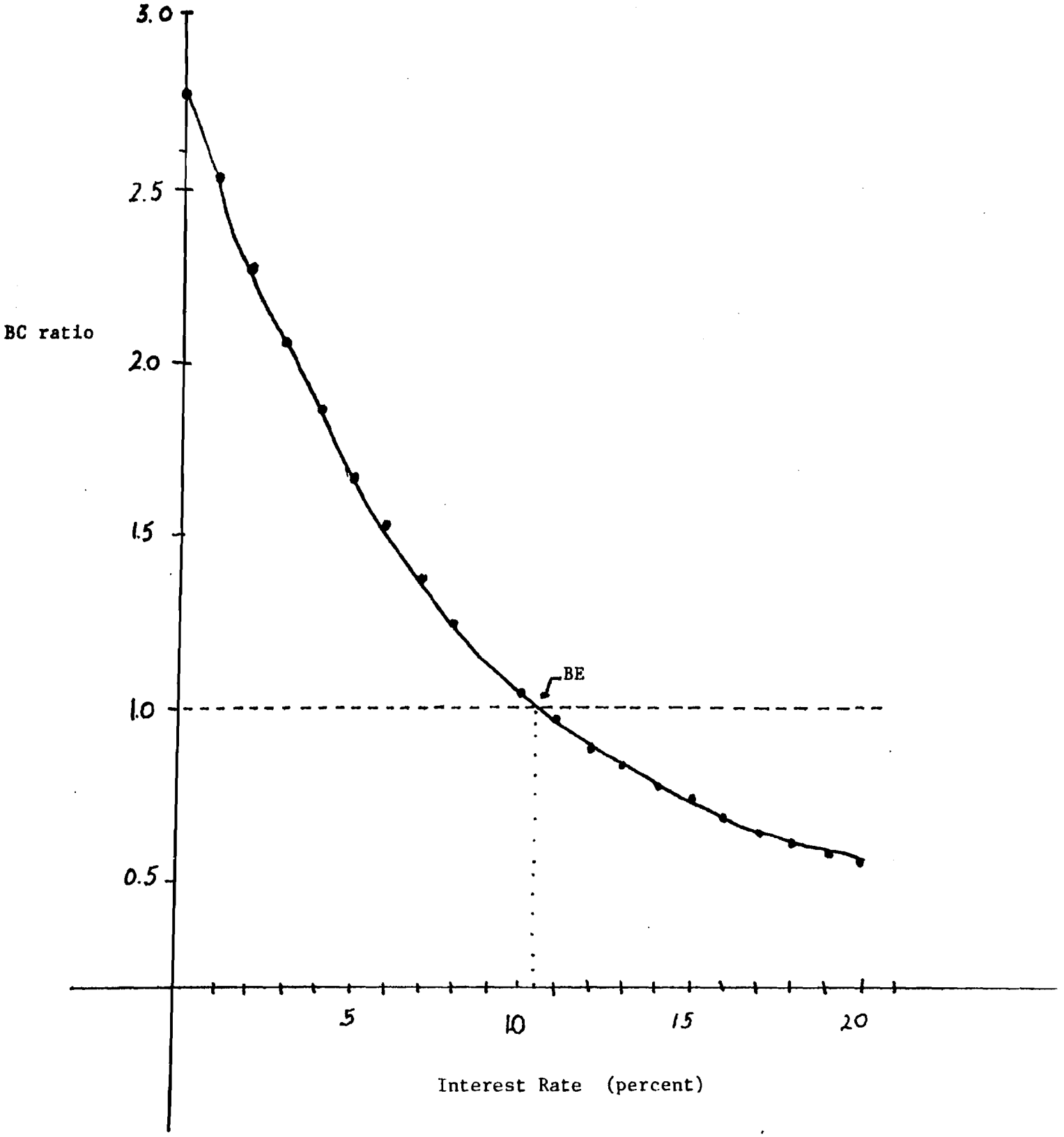


Figure 3.1 = BC ratio curve as a function of Interest Rates.

Hence, if the opportunity cost of capital or the social time preference rate from the national viewpoint had been higher than 10.5%, the project should not have been undertaken. Our preferred choice of a discount rate of 8% is based on the assumption that an 8% opportunity cost of capital in pre-project times (prior 1960) is probably an adequate estimation of the actual opportunity cost of capital at the time.

Project Life

A third assumption that would affect the results is the choice of project life, 57 years (1960-2016) in the baseline case. To gain insight into the effect of project life on the analysis, the present values of total benefits minus the present values of total costs, assuming an 8% discount rate, were computed for each of the 57 years. These values were then plotted, in Figure 3-2, against project life span in years.

Negative net present values indicate years for which the project has not yet "paid for itself" and are found along the lower portion of the "Net PV", curve laying below the "break-even" horizontal line in Figure 3-2. The "break-even" horizontal line is drawn where the present value of total benefits exactly balances with the present value of total costs, i.e. where net present value is zero - above net level, the project "pays for itself", below it the project does not pay for itself. By 1978, the present value of costs still exceeded the present value of benefits by 113,755,910 DH. The project is projected to "break even" in 1984, in the sense that discounted benefits and costs are equal, and thereafter provide

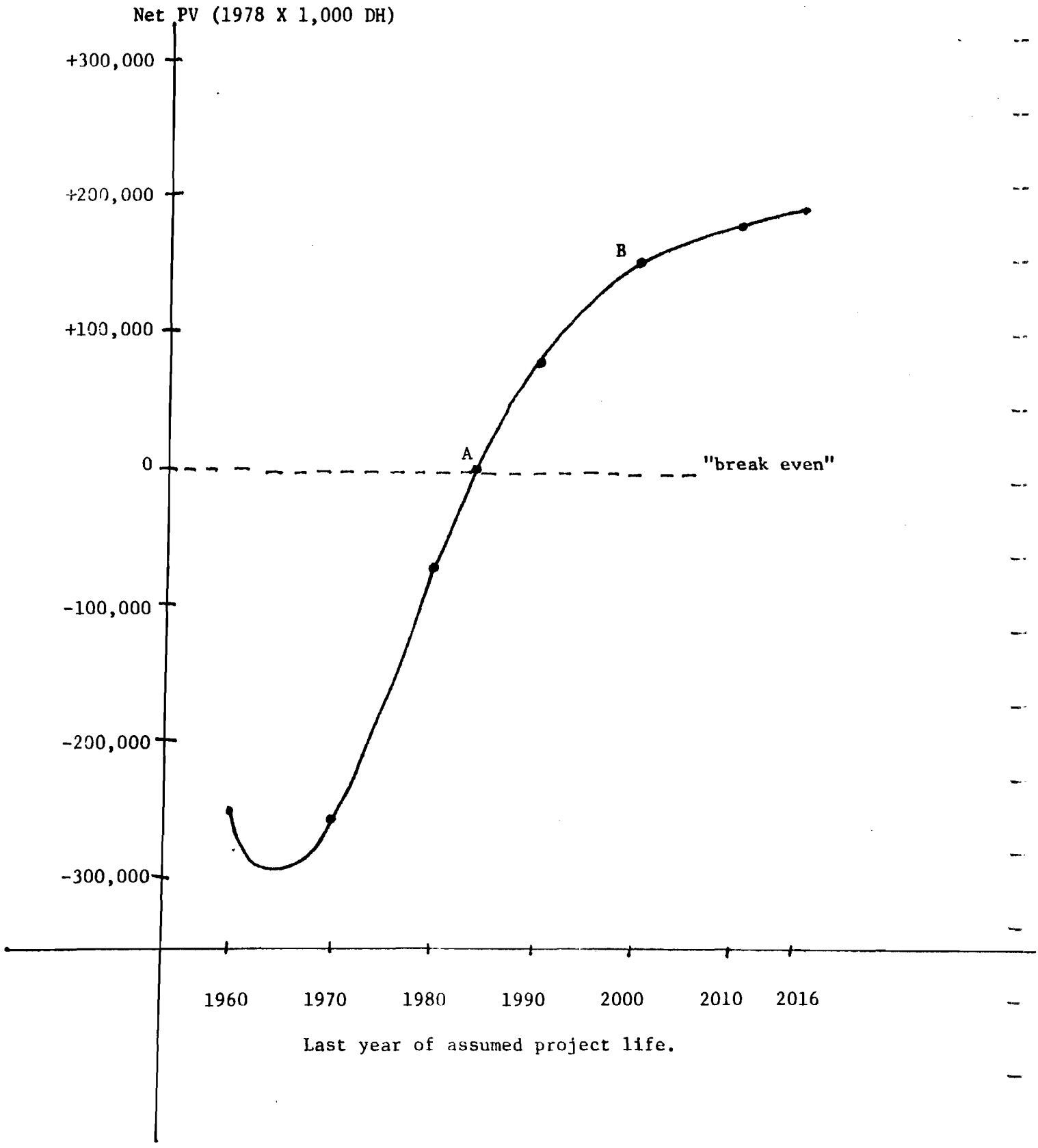


Figure 3.2 Net PV curve as a function of project life.

increasing accumulated excesses of benefits over costs for the remainder of its life. However, increases in the net present value in the latter years of the project life span are relatively small and the BC ratio increases only by .05 from 2000 to 2016. Thus an overestimate of project life by 16 years (over 25%) has little effect on the conclusions of this analysis.

Aggregate Estimation Errors

The fourth area of sensitivity analysis was the effect of error in estimating the costs and benefit of the projects. This analysis provides insights into the sensitivity of the results reported to errors in estimating project benefits and costs. The results of the error analysis are shown in Table 3-9 and 3-10.

Table 3-9: Baseline Benefit Error Analysis, Costs Held Constant.

Benefits	B/C Ratio	IRR (percent)
20% underestimated	1.5	12.9
10% underestimated	1.38	11.7
BASELINE	1.25	10.5
10% overestimated	1.13	9.3
20% overestimated	1.00	8.0

If the costs estimates were essentially accurate, but the benefits were consistently over estimated by as much as 20 percent (i.e., the true benefits were 20% lower than the estimates), the project would still "break even" at an eight percent interest rate. The B/C ratio would be exactly

1.0 and the IRR would be 8%. If the benefits were 20 percent underestimated, again with no change in costs, the "true" B/C ratio would be 1.5 and the "true" IRR would be 12.9 percent.

An analysis of cost errors with benefits assumed accurate showed similar effects (although in the opposite direction) of errors in the ± 20 percent range (see Table 3-10).

If we assume that the benefits estimated were essentially accurate, but the costs were consistently underestimated by as much as 20% (i.e. the true costs were 20% higher than the estimates), the project would still "break-even" at an 8.4% interest rate. If the costs were 20% overestimated, again, with no change in benefits, the "true" B/C ratio would be 1.56 and the true IRR would be 13.5%.

Table 3-10: Baseline Cost Error Analysis, Benefits Held Constant

Costs	B/C Ratio	IRR (percent)
20% underestimated	1.04	8.4
10% underestimated	1.14	9.4
BASELINE	1.25	10.5
10% overestimated	1.39	11.9
20% overestimated	1.56	13.5

These results lead to the conclusion that the baseline B/C ratio, IRR, and net present value are fairly robust. They will stand substantial aggregate data estimation errors, in the range of ± 20 percent, without reversing a decision favorable to the undertaking or continuation of the project. We can be fairly certain that, given a range of ± 20 percent

error in aggregate data estimation, the IRR of this project will be found between 8.00 and 13.5 percent.

Specific Estimation Errors

In the section above, we assumed that all costs or benefits may be over-estimated or underestimated while all benefits or costs were held constant. We could also be faced with the case where a specific category of costs, or benefits is overestimated or underestimated while all other benefits and costs are held constant. In this case, one may expect our baseline results to be even more sturdy in the sense that a larger wider range of misestimation will be possible for one particular category of costs or benefits than that within which all costs or benefits may be misestimated before reversing a decision favorable to the project. This is due to the fact that, for example, a 20% underestimation of project maintenence costs will have less of an impact on the B/C ratio than a 20% underestimation of total project costs. The "true" present value of the total costs will be smaller in the first case than in the second. Hence, the B/C ratio will be larger - i.e. closer to the baseline B/C ratio. This indicates that the decision criteria will be less sensitive to estimation errors of specific costs or benefit estimators than to estimation errors of aggregate cost or benefit estimators. Although the computations have not been done here, it would be relatively easy to perform the same cost or benefit error analysis on specific estimators, as we did on aggregate estimators in Table 3-9 and 3-10. Prime candidates for such sensitivity analysis would be more specific cost or benefit estimators in which we have

relatively little faith. Considering the results of the aggregate sensitivity analysis, one may predict with confidence that the range within which a specific cost or benefit estimator may fluctuate without reversing a favorable decision towards the project will be fairly wide, certainly more than $\pm$ 20% in all cases. Hence we conclude that unless a specific benefit or cost estimator has been grossly over or underestimated, or has been completely omitted the baseline results of B/C = 1.25 at an 8% discount rate, and IRR = 10.5%, are sturdy and can be relied upon.

Summary and Conclusions

The benefit-cost analysis presented in this chapter deals with benefits and costs that can easily be stated in monetary terms. The benefits are the private incremental benefits that accrue to farm operators, land owners and farm labor. The costs are the public investments. ORMVAM's operating costs, the opportunity cost of money and the value of production forgone because of the project.

The analysis yields a net present value of 200 million dirham, a benefit cost ratio of 1.25, and an internal rate of return of 10.5%. The cash flow is negative before 1983, but turns positive thereafter.

Out of the total benefits generated by the project, 38.41% went to farm operators, 36.86% to arm laborers, and 24.73% to land owners. While not a part of the benefit indicator, the incremental gain in production input purchases was 544 million Dirham, about 200 million more than the gains to farm operators or to farm laborers, and 300 million more than the gains to land owners. We treated these benefits as a leakage to the regional economy.

The analysis is very robust. The results will stand aggregate data estimation errors of plus or minus 20% without affecting the general conclusions. The results can tolerate even greater specific data estimation errors.

Only a very small portion of the net benefits accrue in the last 16 years of the project. Thus, even if we over-estimated the life of the project by 25%, our conclusions would remain essentially undhanged.

In all cases conservative estimates and assumptions were made. If we erred it was on the side of under-estimating benefits and over-estimating costs.

Hydrotechnic did a cost benefit analysis in 1965 based on data collected in the early 1960's. This ex-ante study using a discount rate of 4.5%, yielded a benefit cost ratio of 1.68. Our analysis, using a discount rate of 5% yields a benefit cost ratio of 1.68. The project is thus yielding net benefits about as expected almost 15 years ago.

With a positive benefit cost ratio, an internal rate of return of over 10% and returns which have gone heavily to farm managers and farm laborers (rather than as rents collected by landlords) we must conclude that in terms of the factors considered in this chapter, the project has been a success. But there are other considerations, more difficult to quantify, but equally important in the understanding of the impact of the project.

Chapter Three

Appendix

AREAS, YIELDS, AND PRODUCTION COSTS PER CROP AND BY PLAIN

Table 1

DURUM WHEAT

YEAR	TRIFFA	BOU'G	ZEBRA	TOTAL	GROSS	LABOR	PROD	WATER	RENT	NET	TOTAL NET
	(HECTARES)				(DH/HECTARE)						(DH)
1960	210.	0	0	210.	920.	60.	409.	87.	288.	76.	15960.
1961	210.	0	0	210.	920.	60.	365.	87.	250.	158.	33180.
1962	210.	0	0	210.	920.	75.	418.	87.	284.	56.	11760.
1963	330.	0	0	330.	920.	75.	458.	87.	328.	-38.	-12540.
1964	330.	0	0	330.	1050.	75.	499.	87.	345.	44.	14520.
1965	330.	0	0	330.	920.	75.	518.	87.	357.	-117.	-38610.
1966	630.	0	0	630.	920.	70.	502.	87.	353.	-92.	-57960.
1967	825.	0	0	825.	960.	84.	489.	87.	351.	-51.	-42075.
1968	780.	0	0	780.	1650.	96.	537.	87.	352.	578.	450840.
1969	550.	0	0	550.	1425.	96.	554.	87.	363.	325.	178750.
1970	820.	420.	610.	1850.	909.	84.	523.	87.	367.	-152.	-281200.
1971	825.	15.	610.	1450.	1070.	98.	573.	87.	382.	-70.	-101500.
1972	1720.	0	110.	1830.	1275.	105.	626.	87.	395.	52.	113460.
1973	1520.	290.	200.	2010.	1149.	112.	638.	87.	412.	-100.	-201000.
1974	1380.	0	610.	1990.	1278.	112.	731.	87.	470.	-122.	-242780.
1975	165.	0	0	165.	1371.	112.	796.	87.	500.	-124.	-20460.
1976	695.	0	15.	710.	1875.	192.	930.	87.	550.	116.	82360.
1977	915.	110.	215.	1240.	1685.	180.	975.	87.	620.	-177.	-219480.
1978	990.	115.	215.	1320.	2120.	208.	1100.	87.	650.	75.	99000.
1979	1010.	120.	215.	1345.	1964.	192.	1050.	87.	650.	-25.	-33060.
1980	1020.	125.	215.	1360.	1964.	192.	1060.	87.	650.	-25.	-33429.
1981	1025.	130.	215.	1370.	1964.	192.	1050.	87.	650.	-25.	-33675.
1982	1085.	130.	215.	1430.	1964.	192.	1050.	87.	650.	-25.	-35149.
1983	1110.	130.	215.	1455.	1964.	192.	1060.	87.	650.	-25.	-35764.
1984	1135.	130.	215.	1480.	1964.	192.	1060.	87.	650.	-25.	-36378.
1985	1150.	130.	215.	1495.	1964.	192.	1050.	87.	650.	-25.	-36747.
1986	1150.	130.	215.	1495.	1964.	192.	1050.	87.	650.	-25.	-36747.
1987	1150.	130.	215.	1495.	1964.	192.	1060.	87.	650.	-25.	-36747.

Table 2

SOFT WHEAT

YEAR	TRIFFA	BOU'G	ZEBRA	TOTAL	GROSS	LABOR	PROD	WATER	RENT	NET	TOTAL NET
	(HECTARES)				(DH/HECTARE)						(DH)
1960	140.	0	0	140.	900.	60.	397.	99.	288.	56.	7840.
1961	140.	0	0	140.	900.	60.	353.	99.	250.	138.	19320.
1962	140.	0	0	140.	900.	75.	406.	99.	284.	36.	5040.
1963	220.	0	0	220.	900.	75.	456.	99.	328.	-58.	-12760.
1964	220.	0	0	220.	990.	75.	487.	99.	345.	-16.	-3520.
1965	220.	0	0	220.	900.	75.	506.	99.	357.	-137.	-30140.
1966	420.	0	0	420.	940.	70.	490.	99.	353.	-72.	-30240.
1967	400.	0	0	400.	990.	84.	477.	99.	351.	-21.	-8400.
1968	400.	0	0	400.	1440.	96.	525.	99.	352.	368.	147200.
1969	400.	0	0	400.	1250.	96.	542.	99.	363.	150.	60000.
1970	345.	515.	190.	1050.	936.	84.	511.	99.	367.	-125.	-131250.
1971	340.	520.	190.	1050.	1008.	98.	547.	99.	382.	-118.	-123900.
1972	640.	0	220.	860.	1220.	105.	614.	99.	395.	7.	6020.
1973	1200.	440.	120.	1760.	1224.	112.	616.	99.	412.	-15.	-26400.
1974	970.	0	380.	1350.	1350.	112.	706.	99.	470.	-37.	-49950.
1975	1310.	0	50.	1360.	1350.	112.	785.	99.	500.	-146.	-198560.
1976	825.	0	105.	930.	1750.	192.	916.	99.	550.	-7.	-6510.
1977	1920.	910.	310.	3140.	1656.	180.	953.	99.	620.	-206.	-646840.
1978	2070.	920.	315.	3305.	2375.	208.	1080.	99.	650.	338.	1117090.
1979	2115.	925.	320.	3360.	1977.	192.	1044.	99.	650.	-8.	-27678.
1980	2130.	935.	325.	3390.	1977.	192.	1044.	99.	650.	-8.	-27925.
1981	2135.	940.	330.	3405.	1977.	192.	1044.	99.	650.	-8.	-28049.
1982	2255.	940.	330.	3525.	1977.	192.	1044.	99.	650.	-8.	-29037.
1983	2305.	940.	330.	3575.	1977.	192.	1044.	99.	650.	-8.	-29449.
1984	2355.	940.	330.	3625.	1977.	192.	1044.	99.	650.	-8.	-29861.
1985	2380.	940.	330.	3650.	1977.	192.	1044.	99.	650.	-8.	-30067.
1986	2380.	940.	330.	3650.	1977.	192.	1044.	99.	650.	-8.	-30067.
1987	2380.	940.	330.	3650.	1977.	192.	1044.	99.	650.	-8.	-30067.

Table 3

BARLEY & OATS

YEAR	TRIFFA	BOU'G	ZEBRA	TOTAL	GROSS	LABOR	PROD	WATER	RENT	NET	TOTAL NET
	(HECTARES)				(DH/HECTARE)						(DH)
1960	280.	0	0	280.	825.	60.	379.	87.	288.	11.	3080.
1961	280.	0	0	280.	825.	60.	335.	87.	250.	93.	26040.
1962	280.	0	0	280.	825.	75.	376.	87.	284.	3.	840.
1963	440.	0	0	440.	825.	75.	426.	87.	328.	-91.	-40040.
1964	440.	0	0	440.	980.	75.	453.	87.	345.	10.	4400.
1965	440.	0	0	440.	875.	75.	470.	87.	357.	-114.	-50160.
1966	840.	0	0	840.	925.	70.	454.	87.	353.	-39.	-32760.
1967	900.	0	0	900.	800.	84.	447.	87.	351.	-169.	-152100.
1968	900.	0	0	900.	990.	96.	495.	87.	352.	-40.	-36000.
1969	900.	0	0	900.	875.	96.	512.	87.	363.	-183.	-164700.
1970	2120.	1300.	580.	4000.	1110.	84.	475.	87.	367.	97.	388000.
1971	2140.	60.	600.	2800.	820.	98.	511.	87.	382.	-258.	-722400.
1972	3440.	0	170.	3610.	1025.	105.	554.	87.	395.	-116.	-418760.
1973	3300.	1880.	900.	6080.	1040.	112.	568.	87.	412.	-139.	-845120.
1974	2700.	0	1560.	4260.	1375.	112.	646.	87.	470.	60.	255600.
1975	2390.	0	845.	3235.	1100.	112.	701.	87.	500.	-300.	-970500.
1976	2850.	0	1950.	4800.	1400.	192.	832.	87.	550.	-261.	-1252800.
1977	2000.	1250.	770.	4020.	1440.	180.	867.	87.	620.	-314.	-1262280.
1978	2150.	1260.	775.	4185.	1875.	208.	978.	87.	650.	-48.	-200880.
1979	2195.	1265.	780.	4240.	1612.	192.	942.	87.	650.	-259.	-1097429.
1980	2210.	1275.	785.	4270.	1612.	192.	942.	87.	650.	-259.	-1105193.
1981	2215.	1280.	790.	4285.	1612.	192.	942.	87.	650.	-259.	-1109076.
1982	2335.	1280.	790.	4405.	1612.	192.	942.	87.	650.	-259.	-1140135.
1983	2380.	1280.	790.	4450.	1612.	192.	942.	87.	650.	-259.	-1151782.
1984	2425.	1280.	790.	4495.	1612.	192.	942.	87.	650.	-259.	-1163430.
1985	2445.	1280.	790.	4515.	1612.	192.	942.	87.	650.	-259.	-1168606.
1986	2445.	1280.	790.	4515.	1612.	192.	942.	87.	650.	-259.	-1168606.
1987	2445.	1280.	790.	4515.	1612.	192.	942.	87.	650.	-259.	-1168606.

Table 4

FORAGES

YEAR	TRIFFA	BOU'G	ZEBRA	TOTAL	GROSS	LABOR	PROD	WATER	RENT	NET	TOTAL NET
	(HECTARES)				(DH/HECTARE)						(DH)
1960	500.	0	0	500.	1495.	400.	344.	348.	288.	115.	57500.
1961	600.	0	0	600.	1495.	400.	327.	348.	250.	170.	102000.
1962	500.	0	0	500.	1495.	500.	348.	348.	284.	15.	7500.
1963	500.	0	0	500.	1495.	500.	384.	348.	328.	-65.	-32500.
1964	500.	0	0	500.	1750.	500.	416.	348.	345.	141.	7 500.
1965	500.	0	0	500.	1750.	500.	421.	348.	357.	124.	62000.
1966	500.	0	0	500.	1750.	500.	431.	348.	353.	118.	59000.
1967	535.	0	0	535.	1750.	600.	429.	348.	351.	22.	11770.
1968	410.	0	0	410.	1800.	600.	439.	348.	352.	61.	25010.
1969	595.	0	0	595.	1800.	600.	445.	348.	363.	44.	26180.
1970	555.	100.	25.	680.	1950.	600.	488.	348.	367.	147.	99960.
1971	645.	115.	55.	815.	2160.	700.	557.	348.	382.	173.	140995.
1972	645.	175.	100.	920.	2250.	700.	631.	348.	395.	176.	161920.
1973	635.	135.	410.	1180.	2520.	800.	731.	348.	412.	229.	270220.
1974	575.	125.	200.	900.	2520.	800.	834.	348.	470.	68.	61200.
1975	1280.	235.	200.	1715.	2880.	800.	942.	348.	500.	290.	497350.
1976	1790.	310.	200.	2300.	2880.	1200.	1198.	348.	550.	-416.	-956800.
1977	790.	590.	305.	1685.	3600.	1200.	1223.	348.	620.	209.	199595.
1978	1360.	630.	315.	2305.	3600.	1300.	1250.	348.	650.	52.	59540.
1979	1530.	655.	325.	2510.	3616.	1250.	1288.	348.	650.	80.	94179.
1980	1595.	680.	335.	2610.	3616.	1250.	1288.	348.	650.	80.	96972.
1981	1615.	705.	345.	2665.	3616.	1250.	1288.	348.	650.	80.	99766.
1982	2065.	705.	345.	3115.	3616.	1250.	1288.	348.	650.	80.	99766.
1983	2245.	705.	345.	3295.	3616.	1250.	1288.	348.	650.	80.	99766.
1984	2425.	705.	345.	3475.	3616.	1250.	1288.	348.	650.	80.	99766.
1985	2515.	705.	345.	3565.	3616.	1250.	1288.	348.	650.	80.	99766.
1986	2515.	705.	345.	3565.	3616.	1250.	1288.	348.	650.	80.	99766.
1987	2515.	705.	345.	3565.	3616.	1250.	1288.	348.	650.	80.	99766.

Table 5

POTATOES

YEAR	TRIFFA	BOU'G	ZEBRA	TOTAL	GROSS	LABOR	PROD	WATER	RENT	NET	TOTAL NET
	(HECTARES)				(DH/HECTARE)						(DH)
1960	420.	0	0	420.	2000.	416.	1078.	130.	288.	88.	36960.
1961	965.	0	0	965.	2000.	416.	1019.	130.	250.	185.	178525.
1962	1000.	0	0	1000.	2000.	550.	1091.	130.	284.	-55.	-55000.
1963	1100.	0	0	1100.	2000.	550.	1152.	130.	328.	-170.	-187000.
1964	1180.	0	0	1180.	2400.	580.	1318.	130.	345.	27.	31860.
1965	1200.	0	0	1200.	2400.	580.	1338.	130.	357.	-5.	-6000.
1966	1300.	0	0	1300.	3300.	565.	1423.	130.	353.	829.	1077700.
1967	1300.	0	0	1300.	2400.	524.	1384.	130.	351.	-89.	-115700.
1968	1385.	0	0	1385.	4800.	732.	1630.	130.	352.	1956.	2709060.
1969	2540.	25.	5.	2570.	4800.	732.	1650.	130.	363.	1925.	4947250.
1970	1195.	55.	210.	1460.	6000.	750.	1698.	130.	367.	3055.	4460300.
1971	1210.	65.	325.	1600.	5250.	875.	2239.	130.	382.	1624.	2598400.
1972	1405.	90.	175.	1670.	4050.	840.	2738.	130.	395.	-73.	-121910.
1973	1030.	50.	170.	1250.	9100.	976.	3317.	130.	412.	4265.	5331250.
1974	1580.	140.	260.	1980.	5400.	928.	4402.	130.	470.	-530.	-1049400.
1975	1840.	225.	280.	2345.	5600.	1000.	4536.	130.	500.	-566.	-1327270.
1976	1710.	170.	195.	2075.	10400.	1536.	6183.	130.	550.	2001.	4152075.
1977	2960.	310.	250.	3520.	9675.	1776.	6437.	130.	620.	712.	2506240.
1978	3075.	320.	255.	3650.	9000.	1625.	6337.	130.	650.	258.	941700.
1979	3110.	325.	260.	3695.	9650.	1646.	6549.	130.	650.	675.	2492832.
1980	3125.	330.	265.	3720.	9650.	1646.	6549.	130.	650.	675.	2509698.
1981	3130.	335.	270.	3735.	9650.	1646.	6549.	130.	650.	675.	2519818.
1982	3220.	335.	270.	3825.	9650.	1646.	6549.	130.	650.	675.	2580536.
1983	3255.	335.	270.	3860.	9650.	1646.	6549.	130.	650.	675.	2604149.
1984	3290.	335.	270.	3895.	9650.	1646.	6549.	130.	650.	675.	2627762.
1985	3305.	335.	270.	3910.	9650.	1646.	6549.	130.	650.	675.	2637881.
1986	3305.	335.	270.	3910.	9650.	1646.	6549.	130.	650.	675.	2637881.
1987	3305.	335.	270.	3910.	9650.	1646.	6549.	130.	650.	675.	2637881.

Table 6

BEANS

YEAR	TRIFFA	BOU'G	ZEBRA	TOTAL	GROSS	LABOR	PROD	WATER	RENT	NET	TOTAL NET
	(HECTARES)				(DH/HECTARE)						(DH)
1960	700.	0	0	700.	1170.	320.	381.	150.	288.	31.	21700.
1961	2150.	0	0	2150.	1170.	320.	346.	150.	250.	104.	223600.
1962	2300.	0	0	2300.	1170.	400.	389.	150.	284.	-53.	-121900.
1963	2530.	0	0	2530.	1300.	400.	428.	150.	328.	-6.	-15180.
1964	2715.	0	0	2715.	1400.	400.	458.	150.	345.	47.	127605.
1965	2990.	0	0	2990.	1400.	400.	469.	150.	357.	24.	71760.
1966	3680.	0	0	3680.	1400.	400.	465.	150.	353.	32.	117760.
1967	4000.	0	0	4000.	1500.	560.	464.	150.	351.	-25.	-100000.
1968	4000.	0	0	4000.	1500.	560.	465.	150.	352.	-27.	-108000.
1969	4350.	0	0	4350.	1500.	560.	475.	150.	363.	-48.	-208800.
1970	4555.	10.	120.	4685.	1320.	560.	483.	150.	367.	-240.	-1124400.
1971	3890.	80.	340.	4310.	1650.	693.	535.	150.	382.	-110.	-474100.
1972	3720.	225.	310.	4255.	1575.	693.	605.	150.	395.	-268.	-1140340.
1973	3375.	100.	170.	3645.	1950.	688.	682.	150.	412.	18.	65610.
1974	2880.	270.	190.	3340.	2380.	744.	734.	150.	470.	222.	741480.
1975	2830.	490.	380.	3700.	2170.	744.	842.	150.	500.	-66.	-244200.
1976	2235.	165.	285.	2685.	2100.	1188.	950.	150.	550.	-748.	-2008380.
1977	2855.	405.	255.	3515.	3520.	1272.	1174.	150.	620.	304.	1068560.
1978	3025.	415.	260.	3700.	3750.	1287.	1200.	150.	650.	463.	1713100.
1979	3080.	425.	265.	3770.	3175.	1244.	1151.	150.	650.	-30.	-111611.
1980	3100.	435.	270.	3805.	3175.	1244.	1161.	150.	650.	-30.	-112647.
1981	3105.	440.	280.	3825.	3175.	1244.	1151.	150.	650.	-30.	-113239.
1982	3240.	440.	280.	3960.	3175.	1244.	1151.	150.	650.	-30.	-117236.
1983	3295.	440.	280.	4015.	3175.	1244.	1151.	150.	650.	-30.	-118864.
1984	3350.	440.	280.	4070.	3175.	1244.	1161.	150.	650.	-30.	-120492.
1985	3375.	440.	280.	4095.	3175.	1244.	1151.	150.	650.	-30.	-121232.
1986	3375.	440.	280.	4095.	3175.	1244.	1161.	150.	650.	-30.	-121232.
1987	3375.	440.	280.	4095.	3175.	1244.	1151.	150.	650.	-30.	-121232.

Table 7

ARTICHOKES

YEAR	TRIFFA	BOU'G	ZEBRA	TOTAL	GROSS	LABOR	PROD	WATER	RENT	NET	TOTAL NET
	(HECTARES)				(DH/HECTARE)						(DH)
1960	210.	0	0	210.	2250.	568.	995.	330.	288.	59.	14490.
1961	400.	0	0	400.	2250.	588.	933.	330.	250.	149.	59600.
1962	500.	0	0	500.	2250.	735.	989.	330.	284.	-88.	-44000.
1963	550.	0	0	550.	2500.	735.	1059.	330.	328.	48.	26400.
1964	590.	0	0	590.	3250.	775.	1245.	330.	345.	555.	327450.
1965	650.	0	0	650.	3600.	765.	1265.	330.	357.	883.	573950.
1966	800.	0	0	800.	3600.	765.	1259.	330.	353.	893.	714400.
1967	980.	0	0	980.	4550.	930.	1305.	330.	351.	1634.	1601320.
1968	830.	0	0	830.	4550.	930.	1306.	330.	352.	1632.	1354560.
1969	1020.	0	20.	1040.	4800.	918.	1424.	330.	363.	1765.	1835600.
1970	1535.	5.	195.	1735.	6000.	918.	1438.	330.	367.	2947.	5113045.
1971	735.	10.	200.	945.	6000.	1071.	1675.	330.	382.	2542.	2402190.
1972	750.	5.	180.	935.	4500.	1015.	1912.	330.	395.	848.	792880.
1973	430.	40.	30.	500.	5400.	1160.	2110.	330.	412.	1388.	694000.
1974	385.	10.	100.	495.	4950.	1160.	2459.	330.	470.	521.	257895.
1975	345.	55.	100.	500.	6600.	1215.	2603.	330.	500.	1951.	975500.
1976	530.	125.	110.	765.	7150.	1850.	3072.	330.	550.	1338.	1023570.
1977	470.	85.	220.	775.	8400.	1896.	3235.	330.	620.	2319.	1797225.
1978	510.	90.	220.	820.	8400.	2054.	3830.	330.	650.	1536.	1259520.
1979	525.	90.	220.	835.	8526.	1949.	3546.	330.	650.	2051.	1712871.
1980	530.	95.	220.	845.	8526.	1949.	3546.	330.	650.	2051.	1733384.
1981	530.	95.	225.	850.	8526.	1949.	3546.	330.	650.	2051.	1743641.
1982	560.	95.	225.	880.	8526.	1949.	3546.	330.	650.	2051.	1805181.
1983	575.	95.	225.	895.	8526.	1949.	3546.	330.	650.	2051.	1835952.
1984	590.	95.	225.	910.	8526.	1949.	3546.	330.	650.	2051.	1866722.
1985	595.	95.	225.	915.	8526.	1949.	3546.	330.	650.	2051.	1876978.
1986	595.	95.	225.	915.	8526.	1949.	3546.	330.	650.	2051.	1876978.
1987	595.	95.	225.	915.	8526.	1949.	3546.	330.	650.	2051.	1876978.

Table 8

MELONS

YEAR	TRIFFA	BOU'G	ZEBRA	TOTAL	GROSS	LABOR	PROD	WATER	RENT	NET	TOTAL NET
	(HECTARES)				(DH/HECTARE)						(DH)
1960	150.	0	0	150.	1800.	400.	636.	116.	288.	360.	54000.
1961	320.	0	0	320.	1800.	400.	559.	116.	250.	465.	148800.
1962	350.	0	0	350.	2250.	500.	634.	116.	284.	716.	250600.
1963	385.	0	0	385.	2250.	500.	710.	116.	328.	596.	229460.
1964	410.	0	0	410.	3000.	500.	745.	116.	345.	1294.	530540.
1965	455.	0	0	455.	3000.	500.	771.	116.	357.	1256.	571480.
1966	500.	0	0	500.	3000.	600.	765.	116.	353.	1166.	583000.
1967	500.	0	0	500.	3000.	600.	752.	116.	351.	1171.	585500.
1968	455.	0	0	455.	3750.	600.	752.	116.	352.	1920.	873600.
1969	730.	5.	15.	750.	3750.	600.	786.	116.	363.	1885.	1413750.
1970	335.	50.	85.	470.	5000.	600.	865.	116.	367.	3052.	1434440.
1971	390.	60.	390.	840.	6000.	700.	936.	115.	382.	3866.	3247440.
1972	320.	65.	190.	575.	7000.	700.	963.	116.	395.	4826.	2774950.
1973	260.	105.	215.	580.	4750.	800.	1054.	116.	412.	2358.	1367640.
1974	440.	295.	175.	910.	6650.	800.	1218.	115.	470.	4045.	3681850.
1975	315.	325.	25.	665.	7600.	800.	1337.	116.	500.	4847.	3223255.
1976	950.	960.	225.	2135.	5625.	1200.	1544.	115.	550.	2215.	4729025.
1977	715.	685.	180.	1580.	5625.	1200.	1488.	116.	620.	2201.	3477580.
1978	770.	690.	180.	1640.	6000.	1300.	1630.	116.	650.	2304.	3778560.
1979	790.	690.	185.	1665.	7068.	1250.	1681.	115.	650.	3371.	5611912.
1980	795.	695.	185.	1675.	7068.	1250.	1681.	116.	650.	3371.	5645617.
1981	795.	695.	190.	1680.	7068.	1250.	1681.	115.	650.	3371.	5662469.
1982	840.	695.	190.	1725.	7068.	1250.	1681.	116.	650.	3371.	5814143.
1983	860.	695.	190.	1745.	7068.	1250.	1681.	115.	650.	3371.	5881553.
1984	880.	695.	190.	1765.	7068.	1250.	1681.	116.	650.	3371.	5948963.
1985	890.	695.	190.	1775.	7068.	1250.	1681.	116.	650.	3371.	5982669.
1986	890.	695.	190.	1775.	7068.	1250.	1681.	116.	650.	3371.	5982669.
1987	890.	695.	190.	1775.	7068.	1250.	1681.	116.	650.	3371.	5982669.

Table 9

TOMATOES

YEAR	TRIFFA	BOU'G	ZEBRA	TOTAL	GROSS	LABOR	PROD	WATER	RENT	NET	TOTAL NET
	(HECTARES)				(DH/HECTARE)						(DH)
1960	100.	0	0	100.	1800.	800.	472.	188.	288.	52.	5200.
1961	100.	0	0	100.	1800.	800.	424.	188.	250.	138.	13800.
1962	100.	0	0	100.	2250.	1000.	471.	188.	284.	307.	30700.
1963	110.	0	0	110.	2700.	1000.	505.	188.	328.	679.	74690.
1964	110.	0	0	110.	2700.	1000.	573.	188.	345.	594.	65340.
1965	110.	0	0	110.	3000.	1000.	589.	188.	357.	866.	95260.
1966	120.	0	0	120.	3000.	1000.	589.	188.	353.	870.	104400.
1967	120.	0	0	120.	3000.	1200.	536.	188.	351.	675.	81000.
1968	120.	0	0	120.	3000.	1200.	593.	188.	352.	667.	80040.
1969	100.	40.	0	140.	3750.	1200.	609.	188.	363.	1390.	194600.
1970	95.	25.	10.	130.	3750.	1200.	621.	188.	367.	1374.	178620.
1971	105.	65.	20.	190.	4200.	1400.	667.	188.	382.	1563.	296970.
1972	90.	100.	50.	240.	3000.	1400.	707.	188.	395.	310.	74400.
1973	115.	30.	25.	170.	7200.	1600.	761.	188.	412.	4239.	720630.
1974	110.	145.	65.	320.	6750.	1600.	853.	188.	470.	3629.	1161280.
1975	120.	230.	60.	410.	7200.	1600.	944.	188.	500.	3968.	1626880.
1976	120.	145.	45.	310.	9000.	2400.	1050.	188.	550.	4802.	1488620.
1977	130.	350.	60.	540.	9000.	2400.	1153.	188.	620.	4629.	2499660.
1978	155.	355.	60.	570.	8000.	2600.	1215.	188.	650.	3347.	1907790.
1979	160.	355.	65.	580.	9322.	2500.	1224.	188.	650.	4760.	2760616.
1980	165.	355.	65.	585.	9322.	2500.	1224.	188.	650.	4760.	2784414.
1981	165.	355.	65.	585.	9322.	2500.	1224.	188.	650.	4760.	2784414.
1982	185.	355.	65.	605.	9322.	2500.	1224.	188.	650.	4760.	2879608.
1983	190.	355.	65.	610.	9322.	2500.	1224.	188.	650.	4760.	2903406.
1984	200.	355.	65.	620.	9322.	2500.	1224.	188.	650.	4760.	2951003.
1985	205.	355.	65.	625.	9322.	2500.	1224.	188.	650.	4760.	2974802.
1986	205.	355.	65.	625.	9322.	2500.	1224.	188.	650.	4760.	2974802.
1987	205.	355.	65.	625.	9322.	2500.	1224.	188.	650.	4760.	2974802.

Table 10

MISC.VEG.

YEAR	TRIFFA	BOU'G	ZEBRA	TOTAL	GROSS	LABOR	PROD	WATER	RENT	NET	TOTAL NET
	(HECTARES)				(DH/HECTARE)						(DH)
1960	590.	0	0	590.	500.	-0	-0	-0	288.	212.	125080.
1961	640.	0	0	640.	500.	-0	-0	-0	250.	250.	160000.
1962	700.	0	0	700.	800.	-0	-0	-0	284.	516.	361200.
1963	700.	0	0	700.	800.	-0	-0	-0	328.	472.	330400.
1964	800.	0	0	800.	1000.	-0	-0	-0	345.	655.	524000.
1965	900.	0	0	900.	1000.	-0	-0	-0	357.	643.	578700.
1966	1000.	0	0	1000.	1200.	-0	-0	-0	353.	847.	847000.
1967	300.	0	0	300.	1400.	-0	-0	-0	351.	1049.	314700.
1968	500.	0	0	500.	1600.	-0	-0	-0	352.	1248.	624000.
1969	595.	105.	0	700.	2000.	-0	-0	-0	363.	1637.	1145900.
1970	675.	125.	120.	920.	2800.	-0	-0	-0	367.	2433.	2238360.
1971	625.	300.	220.	1145.	2800.	-0	-0	-0	382.	2418.	2768610.
1972	550.	230.	215.	995.	2800.	-0	-0	-0	395.	2405.	2392975.
1973	650.	315.	160.	1125.	3000.	-0	-0	-0	412.	2588.	2911500.
1974	890.	245.	400.	1535.	3000.	-0	-0	-0	470.	2530.	3883550.
1975	480.	310.	110.	900.	3000.	-0	-0	-0	500.	2500.	2250000.
1976	830.	680.	170.	1680.	3400.	-0	-0	-0	550.	2850.	4788000.
1977	785.	630.	330.	1745.	3400.	-0	-0	-0	620.	2780.	4851100.
1978	945.	645.	335.	1925.	3400.	-0	-0	-0	650.	2750.	5293750.
1979	995.	655.	340.	1990.	3705.	0	0	-0	650.	3056.	6080445.
1980	1015.	660.	345.	2020.	3705.	0	0	-0	650.	3056.	6172110.
1981	1020.	665.	350.	2035.	3705.	0	0	-0	650.	3056.	6217943.
1982	1150.	665.	350.	2165.	3705.	0	0	-0	650.	3056.	6615158.
1983	1200.	665.	350.	2215.	3705.	0	0	-0	650.	3056.	6767933.
1984	1250.	665.	350.	2265.	3705.	0	0	-0	650.	3056.	6920708.
1985	1275.	665.	350.	2290.	3705.	0	0	-0	650.	3056.	6997095.
1986	1275.	665.	350.	2290.	3705.	0	0	-0	650.	3056.	6997095.
1987	1275.	665.	350.	2290.	3705.	0	0	-0	650.	3056.	6997095.

Table 11

SUGAR BEETS

YEAR	TRIFFA	BOU'G	ZEBRA	TOTAL	GROSS	LABOR	PROD	WATER	RENT	NET	TOTAL NET
	(HECTARES)				(DH/HECTARE)						(DH)
1960	0	0	0	0	0	0	0	0	288.	-288.	0
1961	0	0	0	0	0	0	0	0	250.	-250.	0
1962	34.	0	0	34.	0	0	0	0	284.	-284.	-9656.
1963	37.	0	0	37.	0	0	0	0	328.	-328.	-12136.
1964	20.	0	0	20.	0	0	0	0	345.	-345.	-6900.
1965	39.	0	0	39.	0	0	0	0	357.	-357.	-13923.
1966	49.	0	0	49.	0	0	0	0	353.	-353.	-17297.
1967	21.	0	0	21.	0	0	0	0	351.	-351.	-7371.
1968	23.	0	0	23.	0	0	0	0	352.	-352.	-8096.
1969	17.	3.	0	20.	0	0	0	0	363.	-363.	-7260.
1970	16.	25.	60.	101.	0	0	0	0	367.	-367.	-37067.
1971	809.	1746.	898.	3453.	2463.	875.	846.	145.	382.	215.	742395.
1972	833.	1814.	839.	3486.	3138.	924.	895.	145.	395.	779.	2715594.
1973	519.	1371.	480.	2370.	3064.	1040.	966.	145.	412.	501.	1187370.
1974	1317.	2247.	621.	4185.	3534.	1048.	1104.	145.	470.	767.	3209895.
1975	1242.	2128.	616.	3986.	5476.	1128.	1233.	145.	500.	2470.	9845420.
1976	1631.	2530.	797.	4958.	5000.	1644.	1396.	145.	550.	1265.	6271870.
1977	1337.	1978.	434.	3749.	6394.	1704.	1536.	145.	620.	2389.	8956361.
1978	1560.	1990.	440.	3990.	6100.	1820.	1615.	145.	650.	1870.	7461300.
1979	1625.	2000.	445.	4070.	6431.	1748.	1513.	145.	650.	2274.	9255892.
1980	1650.	2010.	450.	4110.	6431.	1748.	1613.	145.	650.	2274.	9346859.
1981	1655.	2020.	455.	4130.	6431.	1748.	1613.	145.	650.	2274.	9392343.
1982	1835.	2020.	455.	4310.	6431.	1748.	1513.	145.	650.	2274.	9801694.
1983	1905.	2020.	455.	4380.	6431.	1748.	1613.	145.	650.	2274.	9960886.
1984	1975.	2020.	455.	4450.	6431.	1748.	1613.	145.	650.	2274.	10120079.
1985	2010.	2020.	455.	4485.	6431.	1748.	1513.	145.	650.	2274.	10199675.
1986	2010.	2020.	455.	4485.	6431.	1748.	1613.	145.	650.	2274.	10199675.
1987	2010.	2020.	455.	4485.	6431.	1748.	1513.	145.	650.	2274.	10199675.

Table 12

SUGAR CANE

YEAR	TRIFFA	DOU'G	ZEBRA	TOTAL	GROSS	LABOR	PROD	WATER	RENT	NET	TOTAL NET
	(HECTARES)				(DH/HECTARE)						(DH)
1960	0	0	0	0	0	0	0	0	288.	-288.	0
1961	0	0	0	0	0	0	0	0	250.	-250.	0
1962	0	0	0	0	0	0	0	0	284.	-284.	0
1963	0	0	0	0	0	0	0	0	328.	-328.	0
1964	0	0	0	0	0	0	0	0	345.	-345.	0
1965	0	0	0	0	0	0	0	0	357.	-357.	0
1966	0	0	0	0	0	0	0	0	353.	-353.	0
1967	0	0	0	0	0	0	0	0	351.	-351.	0
1968	12.	0	0	12.	0	0	0	0	352.	-352.	-4224.
1969	4.	0	0	4.	0	0	0	0	363.	-363.	-1452.
1970	4.	16.	9.	29.	0	0	0	0	367.	-367.	-10643.
1971	4.	48.	44.	96.	0	0	0	0	382.	-382.	-36672.
1972	4.	189.	121.	314.	0	0	0	0	395.	-395.	-124030.
1973	2.	285.	135.	422.	2640.	1160.	1088.	348.	412.	-368.	-155296.
1974	102.	425.	201.	728.	2730.	1328.	1242.	348.	470.	-658.	-479024.
1975	41.	513.	193.	747.	0	0	0	0	500.	-500.	-373500.
1976	14.	554.	214.	782.	3855.	1716.	1481.	348.	550.	-240.	-187680.
1977	0	565.	202.	767.	3888.	1740.	1657.	348.	620.	-477.	-365859.
1978	0	570.	204.	774.	4500.	2002.	1729.	348.	650.	-229.	-177246.
1979	0	574.	206.	780.	3283.	1463.	1304.	348.	650.	-483.	-376547.
1980	0	578.	208.	786.	3283.	1463.	1304.	348.	650.	-483.	-379443.
1981	0	580.	210.	790.	3283.	1463.	1304.	348.	650.	-483.	-381374.
1982	0	580.	210.	790.	3283.	1463.	1304.	348.	650.	-483.	-381374.
1983	0	580.	210.	790.	3283.	1463.	1304.	348.	650.	-483.	-381374.
1984	0	580.	210.	790.	3283.	1463.	1304.	348.	650.	-483.	-381374.
1985	0	580.	210.	790.	3283.	1463.	1304.	348.	650.	-483.	-381374.
1986	0	580.	210.	790.	3283.	1463.	1304.	348.	650.	-483.	-381374.
1987	0	580.	210.	790.	3283.	1463.	1304.	348.	650.	-483.	-381374.

Table 13

NIORA

YEAR	TRIEFA	BOU'G	ZEBRA	TOTAL	GROSS	LABOR	PROD	WATER	RENT	NET	TOTAL NET
	(HECTARES)				(DH/HECTARE)						(DH)
1960	1000.	0	0	1000.	2880.	544.	454.	261.	288.	1323.	1323000.
1961	1500.	0	0	1500.	2880.	544.	415.	261.	250.	1410.	2115000.
1962	1500.	0	0	1500.	2880.	680.	490.	261.	284.	1175.	1762500.
1963	1500.	0	0	1500.	2880.	680.	535.	261.	328.	1076.	1614000.
1964	1500.	0	0	1500.	2880.	680.	552.	261.	345.	1032.	1548000.
1965	1400.	0	0	1400.	2880.	680.	577.	261.	357.	1005.	1407000.
1966	1400.	0	0	1400.	3200.	680.	597.	261.	353.	1309.	1832600.
1967	1370.	0	0	1370.	3200.	816.	594.	261.	351.	1178.	1613860.
1968	1565.	0	0	1565.	3200.	815.	595.	261.	352.	1176.	1840440.
1969	2008.	101.	35.	2144.	3200.	816.	634.	261.	363.	1126.	2414144.
1970	1639.	5.	117.	1761.	3600.	858.	542.	261.	367.	1472.	2592192.
1971	1423.	54.	660.	2137.	4180.	1085.	658.	261.	382.	1784.	3812408.
1972	1589.	111.	604.	2304.	3760.	952.	716.	261.	395.	1435.	3308544.
1973	862.	226.	856.	1944.	4800.	1192.	747.	261.	412.	2188.	4253472.
1974	1178.	537.	804.	2519.	3280.	1088.	853.	261.	470.	608.	1531552.
1975	629.	394.	563.	1586.	2250.	1064.	912.	261.	500.	-487.	-772382.
1976	280.	103.	183.	566.	3750.	1596.	1014.	261.	550.	329.	186214.
1977	445.	521.	330.	1296.	5600.	1560.	1128.	261.	620.	2031.	2632176.
1978	560.	525.	335.	1420.	5250.	1729.	1165.	261.	650.	1445.	2051900.
1979	595.	530.	335.	1460.	4609.	1653.	1178.	261.	650.	866.	1264915.
1980	610.	535.	335.	1480.	4609.	1653.	1178.	261.	650.	866.	1282242.
1981	615.	535.	340.	1490.	4609.	1653.	1178.	261.	650.	866.	1290906.
1982	705.	535.	340.	1580.	4609.	1653.	1178.	261.	650.	866.	1368880.
1983	740.	535.	340.	1615.	4609.	1653.	1178.	261.	650.	866.	1399204.
1984	775.	535.	340.	1650.	4609.	1653.	1178.	261.	650.	866.	1429527.
1985	795.	535.	340.	1670.	4609.	1653.	1178.	261.	650.	866.	1446855.
1986	795.	535.	340.	1670.	4609.	1653.	1178.	261.	650.	866.	1446855.
1987	795.	535.	340.	1670.	4609.	1653.	1178.	261.	650.	866.	1446855.

Table 14

MISC. INDUS.

YEAR	TRIFFA	BOU'G	ZEBRA	TOTAL	GROSS	LABOR	PROD	WATER	RENT	NET	TOTAL NET
	(HECTARES)				(DH/HECTARE)						(DH)
1960	0	0	0	0	550.	-0	-0	-0	288.	262.	0
1961	0	0	0	0	480.	-0	-0	-0	250.	230.	0
1962	0	0	0	0	540.	-0	-0	-0	284.	256.	0
1963	0	0	0	0	620.	-0	-0	-0	328.	292.	0
1964	100.	0	0	100.	660.	-0	-0	-0	345.	315.	31500.
1965	200.	0	0	200.	680.	-0	-0	-0	357.	323.	64600.
1966	200.	0	0	200.	670.	-0	-0	-0	353.	317.	63400.
1967	240.	0	0	240.	670.	-0	-0	-0	351.	319.	76560.
1968	60.	0	0	60.	690.	-0	-0	-0	352.	338.	20280.
1969	25.	130.	0	155.	700.	-0	-0	-0	363.	337.	52235.
1970	95.	138.	242.	475.	1000.	-0	-0	-0	367.	633.	300675.
1971	70.	274.	12.	356.	1000.	-0	-0	-0	382.	618.	220008.
1972	140.	65.	0	205.	1000.	-0	-0	-0	395.	605.	124025.
1973	158.	150.	5.	313.	900.	-0	-0	-0	412.	488.	152744.
1974	175.	141.	15.	331.	900.	-0	-0	-0	470.	430.	142330.
1975	177.	122.	0	299.	900.	-0	-0	-0	500.	400.	119600.
1976	160.	470.	3.	633.	850.	-0	-0	-0	550.	300.	189900.
1977	214.	608.	13.	835.	800.	-0	-0	-0	620.	180.	150300.
1978	250.	610.	15.	875.	800.	-0	-0	-0	650.	150.	131250.
1979	260.	615.	15.	890.	949.	0	0	-0	650.	299.	265888.
1980	260.	615.	20.	895.	949.	0	0	-0	650.	299.	267381.
1981	260.	620.	20.	900.	949.	0	0	-0	650.	299.	268875.
1982	290.	620.	20.	930.	949.	0	0	-0	650.	299.	277838.
1983	305.	620.	20.	945.	949.	0	0	-0	650.	299.	282319.
1984	320.	620.	20.	960.	949.	0	0	-0	650.	299.	286800.
1985	325.	620.	20.	965.	949.	0	0	-0	650.	299.	288294.
1986	325.	620.	20.	965.	949.	0	0	-0	650.	299.	288294.
1987	325.	620.	20.	965.	949.	0	0	-0	650.	299.	288294.

Table 15

CITRUS, 1-4 YRS

YEAR	TRIFFA	BOU'G	ZEBRA	TOTAL	GROSS	LABOR	PROD	WATER	RENT	NET	TOTAL NET
	(HECTARES)				(DH/HECTARE)						(DH)
1960	1190.	0	0	1190.	0	320.	318.	55.	288.	-981.	-1167390.
1961	1400.	0	0	1400.	0	320.	286.	55.	250.	-911.	-1275400.
1962	1150.	0	0	1150.	0	400.	314.	55.	284.	-1053.	-1210950.
1963	1200.	0	0	1200.	0	400.	350.	55.	328.	-1133.	-1359600.
1964	1360.	0	0	1360.	0	400.	357.	55.	345.	-1157.	-1587120.
1965	1400.	0	0	1400.	0	400.	377.	55.	357.	-1189.	-1664600.
1966	1600.	0	0	1600.	0	400.	374.	55.	353.	-1182.	-1891200.
1967	2000.	0	0	2000.	0	480.	372.	55.	351.	-1258.	-2516000.
1968	2610.	0	0	2610.	0	480.	370.	55.	352.	-1257.	-3280770.
1969	3065.	0	0	3065.	0	480.	381.	55.	363.	-1279.	-3920135.
1970	2720.	10.	150.	2880.	0	480.	389.	55.	367.	-1291.	-3718080.
1971	2575.	50.	215.	2840.	0	560.	424.	55.	382.	-1421.	-4035640.
1972	1690.	85.	300.	2075.	0	560.	458.	55.	395.	-1468.	-3046100.
1973	720.	95.	335.	1150.	0	640.	499.	55.	412.	-1606.	-1846900.
1974	480.	80.	320.	880.	0	640.	570.	55.	470.	-1735.	-1526800.
1975	195.	35.	270.	500.	0	640.	529.	55.	500.	-1824.	-912000.
1976	200.	25.	190.	415.	0	960.	702.	55.	550.	-2267.	-940805.
1977	425.	10.	205.	640.	0	960.	777.	55.	620.	-2412.	-1543680.
1978	765.	20.	75.	860.	0	1040.	817.	55.	650.	-2562.	-2203320.
1979	785.	30.	65.	880.	0	1000.	817.	55.	650.	-2522.	-2218993.
1980	785.	35.	65.	885.	0	1000.	817.	55.	650.	-2522.	-2231601.
1981	620.	45.	20.	685.	0	1000.	817.	55.	650.	-2522.	-1727284.
1982	585.	30.	15.	630.	0	1000.	817.	55.	650.	-2522.	-1588597.
1983	600.	20.	10.	630.	0	1000.	817.	55.	650.	-2522.	-1588597.
1984	660.	10.	5.	675.	0	1000.	817.	55.	650.	-2522.	-1702068.
1985	715.	0	0	715.	0	1000.	817.	55.	650.	-2522.	-1802931.
1986	575.	0	0	575.	0	1000.	817.	55.	650.	-2522.	-1449910.
1987	575.	0	0	575.	0	1000.	817.	55.	650.	-2522.	-1449910.

Table 16

CITRUS, 5-9 YRS

YEAR	TRIFFA	BOU'G	ZEBRA	TOTAL	GROSS	LABOR	PROD	WATER	RENT	NET	TOTAL NET
	(HECTARES)				(DH/HECTARE)						(DH)
1960	640.	0	0	640.	2400.	460.	1150.	252.	288.	250.	160000.
1961	870.	0	0	870.	2400.	460.	1041.	252.	250.	397.	345390.
1962	1330.	0	0	1330.	2400.	575.	1138.	252.	284.	151.	200830.
1963	1500.	0	0	1500.	2400.	575.	1251.	252.	328.	-15.	-24000.
1964	1490.	0	0	1490.	2400.	575.	1320.	252.	345.	-92.	-137080.
1965	1700.	0	0	1700.	2400.	575.	1353.	252.	357.	-137.	-232900.
1966	1650.	0	0	1650.	2450.	555.	1343.	252.	353.	-53.	-87450.
1967	1400.	0	0	1400.	2800.	690.	1336.	252.	351.	171.	239400.
1968	1550.	0	0	1550.	3200.	714.	1338.	252.	352.	544.	843200.
1969	1910.	0	0	1910.	3400.	732.	1359.	252.	363.	684.	1306440.
1970	1950.	0	0	1950.	3825.	732.	1390.	252.	367.	1084.	2113800.
1971	2250.	0	0	2250.	3600.	805.	1522.	252.	382.	639.	1437750.
1972	2960.	0	0	2960.	4250.	882.	1652.	252.	395.	1069.	3164240.
1973	3615.	0	0	3615.	4000.	952.	1800.	252.	412.	584.	2111160.
1974	3270.	10.	150.	3430.	4800.	952.	2055.	252.	470.	1071.	3673530.
1975	3145.	30.	215.	3390.	5250.	952.	2264.	252.	500.	1282.	4345980.
1976	2690.	45.	300.	3035.	6400.	1428.	2519.	252.	550.	1651.	5010785.
1977	1760.	60.	335.	2155.	6000.	1872.	2790.	252.	620.	466.	1004230.
1978	710.	65.	470.	1245.	5600.	1833.	2945.	252.	650.	-80.	-99600.
1979	620.	55.	335.	1010.	6543.	1676.	2936.	252.	650.	1029.	1039532.
1980	295.	40.	275.	610.	6543.	1676.	2936.	252.	650.	1029.	627836.
1981	455.	25.	240.	720.	6543.	1676.	2936.	252.	650.	1029.	741053.
1982	720.	25.	210.	955.	6543.	1676.	2936.	252.	650.	1029.	982924.
1983	900.	30.	80.	1010.	6543.	1676.	2936.	252.	650.	1029.	1039532.
1984	885.	40.	70.	995.	6543.	1676.	2936.	252.	650.	1029.	1024094.
1985	875.	45.	70.	990.	6543.	1676.	2936.	252.	650.	1029.	1018948.
1986	880.	45.	20.	945.	6543.	1676.	2936.	252.	650.	1029.	972632.
1987	880.	45.	20.	945.	6543.	1676.	2936.	252.	650.	1029.	972632.

Table 17

CITRUS, MATURE

YEAR	TRIFFA	BOU'G	ZEBRA	TOTAL	GROSS	LABOR	PROD	WATER	RENT	NET	TOTAL NET
	(HECTARES)				(DH/HECTARE)						(DH)
1960	1510.	0	0	1510.	3900.	712.	1416.	348.	288.	1136.	1715360.
1961	1530.	0	0	1530.	3900.	712.	1285.	348.	250.	1305.	1996650.
1962	1520.	0	0	1520.	3900.	890.	1402.	348.	284.	976.	1483520.
1963	1500.	0	0	1500.	3900.	890.	1550.	348.	328.	784.	1176000.
1964	1650.	0	0	1650.	3900.	890.	1619.	348.	345.	698.	1151700.
1965	1900.	0	0	1900.	3900.	890.	1559.	348.	357.	646.	1227400.
1966	2150.	0	0	2150.	4200.	855.	1647.	348.	353.	997.	2143550.
1967	2900.	0	0	2900.	4550.	1068.	1639.	348.	351.	1144.	3317600.
1968	3050.	0	0	3050.	5200.	1068.	1641.	348.	352.	1791.	5462550.
1969	3190.	0	0	3190.	5600.	1116.	1678.	348.	363.	2095.	6683050.
1970	3650.	0	0	3650.	6300.	1116.	1701.	348.	367.	2768.	10103200.
1971	3850.	0	0	3850.	5850.	1246.	1858.	348.	382.	2006.	7723100.
1972	4000.	0	0	4000.	7000.	1302.	2030.	348.	395.	2925.	11700000.
1973	4000.	0	0	4000.	6500.	1424.	2213.	348.	412.	2103.	8412000.
1974	4550.	0	0	4550.	7800.	1424.	2526.	348.	470.	3032.	13795600.
1975	4940.	0	0	4940.	7700.	1368.	2782.	348.	500.	2702.	13347880.
1976	5425.	0	0	5425.	9600.	2136.	3088.	348.	550.	3478.	18868150.
1977	6315.	0	0	6315.	9600.	2400.	3424.	348.	620.	2808.	17732520.
1978	7250.	0	0	7250.	9800.	2314.	3620.	348.	650.	2868.	20793000.
1979	7385.	10.	150.	7545.	10266.	2276.	3605.	348.	650.	3387.	25552048.
1980	7735.	30.	215.	7980.	10266.	2276.	3605.	348.	650.	3387.	27025228.
1981	7750.	45.	300.	8095.	10266.	2276.	3605.	348.	650.	3387.	27414689.
1982	7700.	60.	335.	8095.	10266.	2276.	3605.	348.	650.	3387.	27414689.
1983	7575.	65.	470.	8110.	10266.	2276.	3605.	348.	650.	3387.	27465488.
1984	7600.	65.	485.	8150.	10266.	2276.	3605.	348.	650.	3387.	27600953.
1985	7590.	70.	490.	8150.	10266.	2276.	3605.	348.	650.	3387.	27600953.
1986	7725.	70.	540.	8335.	10266.	2276.	3605.	348.	650.	3387.	28227478.
1987	7725.	70.	540.	8335.	10266.	2276.	3605.	348.	650.	3387.	28227478.

Table 13

VINES, WINE

YEAR	TRIFFA	BOU'G	ZEBRA	TOTAL	GROSS	LABOR	PROD	WATER	RENT	NET	TOTAL NET
	(HECTARES)				(DH/HECTARE)						(DH)
1960	3600.	-0	-0	3600.	1680.	256.	1027.	101.	288.	8.	28800.
1961	3600.	-0	-0	3600.	1680.	256.	838.	101.	250.	235.	846000.
1962	4050.	-0	-0	4050.	1440.	310.	942.	101.	284.	-197.	-797850.
1963	4050.	-0	-0	4050.	1680.	320.	1100.	101.	328.	-159.	-684450.
1964	4050.	-0	-0	4050.	2100.	320.	1150.	101.	345.	174.	704700.
1965	4050.	-0	-0	4050.	2100.	320.	1199.	101.	357.	123.	498150.
1966	4050.	-0	-0	4050.	2240.	320.	1187.	101.	353.	279.	1129950.
1967	4300.	-0	-0	4300.	1800.	354.	1150.	101.	351.	-156.	-670800.
1968	3800.	-0	-0	3800.	1620.	348.	1144.	101.	352.	-325.	-1235000.
1969	2900.	-0	-0	2900.	2000.	354.	1188.	101.	363.	-6.	-17400.
1970	2630.	-0	-0	2630.	1800.	348.	1193.	101.	367.	-209.	-549670.
1971	2365.	-0	-0	2365.	2000.	413.	1249.	101.	382.	-145.	-342925.
1972	2440.	-0	-0	2440.	2400.	434.	1272.	101.	395.	198.	483120.
1973	1580.	-0	-0	1580.	2700.	464.	1341.	101.	412.	382.	603560.
1974	1550.	-0	-0	1550.	2700.	464.	1531.	101.	470.	134.	207700.
1975	1295.	-0	-0	1295.	2700.	464.	1656.	101.	500.	-21.	-27195.
1976	1315.	-0	-0	1315.	3430.	708.	1809.	101.	550.	262.	344530.
1977	1100.	-0	-0	1100.	3500.	708.	2036.	101.	620.	35.	38500.
1978	1100.	-0	-0	1100.	3500.	767.	2128.	101.	650.	-146.	-160600.
1979	1100.	-0	-0	1100.	3670.	735.	2130.	101.	650.	54.	58998.
1980	1100.	-0	-0	1100.	3670.	735.	2130.	101.	650.	54.	58998.
1981	1100.	-0	-0	1100.	3670.	735.	2130.	101.	650.	54.	58998.
1982	1100.	-0	-0	1100.	3670.	735.	2130.	101.	650.	54.	58998.
1983	1100.	-0	-0	1100.	3670.	735.	2130.	101.	650.	54.	58998.
1984	1100.	-0	-0	1100.	3670.	735.	2130.	101.	650.	54.	58998.
1985	1100.	-0	-0	1100.	3670.	735.	2130.	101.	650.	54.	58998.
1986	1100.	-0	-0	1100.	3670.	735.	2130.	101.	650.	54.	58998.
1987	1100.	-0	-0	1100.	3670.	735.	2130.	101.	650.	54.	58998.

Table 19

VINES, TABLE

YEAR	TRIFFA	BOU'G	ZEBRA	TOTAL	GROSS	LABOR	PROD	WATER	RENT	NET	TOTAL NET
	(HECTARES)				(DH/HECTARE)						(DH)
1960	400.	0	0	400.	4200.	508.	1255.	58.	288.	2081.	832400.
1961	400.	0	0	400.	4500.	532.	1038.	58.	250.	2562.	1024800.
1962	450.	0	0	450.	4500.	665.	1250.	58.	284.	2243.	1009350.
1963	450.	0	0	450.	4550.	610.	1441.	58.	328.	2113.	950850.
1964	450.	0	0	450.	4200.	585.	1519.	58.	345.	1693.	761850.
1965	450.	0	0	450.	4900.	635.	1570.	58.	357.	2280.	1026000.
1966	450.	0	0	450.	5600.	635.	1555.	58.	353.	2999.	1349550.
1967	500.	0	0	500.	6000.	798.	1545.	58.	351.	3248.	1624000.
1968	500.	0	0	500.	4800.	702.	1547.	58.	352.	2141.	1070500.
1969	500.	0	30.	530.	5850.	732.	1595.	58.	363.	3102.	1644060.
1970	970.	5.	25.	1000.	6750.	798.	1616.	58.	367.	3911.	3911000.
1971	1375.	5.	20.	1400.	7200.	966.	1679.	58.	382.	4115.	5761000.
1972	1395.	5.	20.	1420.	8800.	966.	1740.	58.	395.	5641.	8010220.
1973	1395.	5.	20.	1420.	7200.	936.	1815.	58.	412.	3979.	5650180.
1974	1395.	35.	20.	1450.	7200.	936.	2070.	58.	470.	3666.	5315700.
1975	1395.	35.	20.	1450.	7800.	936.	2239.	58.	500.	4067.	5897150.
1976	1415.	50.	20.	1485.	10400.	1656.	2432.	58.	550.	5704.	8470440.
1977	1600.	55.	35.	1690.	10500.	1752.	2736.	58.	620.	5334.	9014460.
1978	1640.	60.	35.	1735.	10500.	1729.	2860.	58.	650.	5203.	9027205.
1979	1650.	65.	35.	1750.	10945.	1680.	2867.	58.	650.	5690.	9957395.
1980	1655.	65.	40.	1760.	10945.	1680.	2857.	58.	650.	5690.	10014294.
1981	1660.	65.	40.	1765.	10945.	1680.	2857.	58.	650.	5690.	10042744.
1982	1690.	65.	40.	1795.	10945.	1680.	2867.	58.	650.	5690.	10213442.
1983	1700.	65.	40.	1805.	10945.	1680.	2857.	58.	650.	5690.	10270342.
1984	1700.	65.	40.	1805.	10945.	1680.	2857.	58.	650.	5690.	10270342.
1985	1705.	65.	40.	1810.	10945.	1680.	2857.	58.	650.	5690.	10298791.
1986	1705.	65.	40.	1810.	10945.	1680.	2857.	58.	650.	5690.	10298791.
1987	1705.	65.	40.	1810.	10945.	1680.	2857.	58.	650.	5690.	10298791.

Table 20

MISC. TREES

YEAR	IRIFEA	BOU'G	ZEBRA	TOTAL	GROSS	LABOR	PROD	WATER	RENT	NET	TOTAL NET
	(HECTARES)				(DH/HECTARE)						(DH)
1960	50.	0	0	50.	1800.	280.	500.	104.	288.	628.	31400.
1961	50.	0	0	50.	1500.	280.	500.	104.	250.	366.	18300.
1962	100.	0	0	100.	1700.	350.	560.	104.	284.	402.	40200.
1963	100.	0	0	100.	2000.	350.	550.	104.	328.	658.	65800.
1964	100.	0	0	100.	2100.	350.	560.	104.	345.	741.	74100.
1965	100.	0	0	100.	2200.	350.	560.	104.	357.	829.	82900.
1966	100.	0	0	100.	2200.	350.	550.	104.	353.	833.	83300.
1967	100.	0	0	100.	2200.	420.	700.	104.	351.	625.	62500.
1968	100.	0	0	100.	2200.	420.	700.	104.	352.	624.	62400.
1969	240.	0	0	240.	2200.	420.	700.	104.	363.	613.	147120.
1970	300.	80.	130.	510.	2300.	420.	700.	104.	367.	709.	361590.
1971	300.	80.	80.	460.	2300.	490.	770.	104.	382.	554.	254840.
1972	300.	80.	100.	480.	2400.	490.	770.	104.	395.	641.	307680.
1973	330.	90.	130.	550.	2500.	560.	840.	104.	412.	584.	321200.
1974	360.	100.	190.	650.	2900.	560.	840.	104.	470.	926.	601900.
1975	400.	105.	200.	705.	3100.	560.	840.	104.	500.	1096.	772680.
1976	500.	105.	185.	790.	3400.	840.	1000.	104.	550.	906.	715740.
1977	580.	105.	185.	870.	3800.	840.	1000.	104.	620.	1236.	1075320.
1978	690.	110.	190.	990.	4000.	910.	1300.	104.	650.	1036.	1025640.
1979	725.	115.	195.	1035.	3993.	875.	1151.	104.	650.	1212.	1254627.
1980	735.	125.	195.	1055.	3993.	875.	1151.	104.	650.	1212.	1278871.
1981	740.	130.	195.	1065.	3993.	875.	1151.	104.	650.	1212.	1290993.
1982	830.	130.	195.	1155.	3993.	875.	1151.	104.	650.	1212.	1400091.
1983	870.	130.	195.	1195.	3993.	875.	1151.	104.	650.	1212.	1448579.
1984	910.	130.	195.	1235.	3993.	875.	1151.	104.	650.	1212.	1497067.
1985	930.	130.	195.	1255.	3993.	875.	1151.	104.	650.	1212.	1521311.
1986	930.	130.	195.	1255.	3993.	875.	1151.	104.	650.	1212.	1521311.
1987	930.	130.	195.	1255.	3993.	875.	1151.	104.	650.	1212.	1521311.

Table 21

LIVESTOCK (TOTALS, ALL VALUES IN 1,000 DH)

YEAR	TRIFFA	BOU'G	ZEBRA	TOTAL	GROSS	LABOR	PROD	WATER	RENT	NET
	(HECTARES)				(TOTAL DH X 1,000)					
1960	0	0	0	0	203.	0	0	0	0	203.
1961	0	0	0	0	209.	0	0	0	0	209.
1962	0	0	0	0	260.	0	0	0	0	260.
1963	0	0	0	0	295.	0	0	0	0	295.
1964	0	0	0	0	414.	0	0	0	0	414.
1965	0	0	0	0	435.	0	0	0	0	435.
1966	0	0	0	0	744.	0	0	0	0	744.
1967	0	0	0	0	780.	0	0	0	0	780.
1968	0	0	0	0	852.	0	0	0	0	852.
1969	0	0	0	0	948.	0	0	0	0	948.
1970	0	0	0	0	1240.	0	0	0	0	1240.
1971	0	0	0	0	1560.	0	0	0	0	1560.
1972	0	0	0	0	1816.	0	0	0	0	1816.
1973	0	0	0	0	2056.	0	0	0	0	2056.
1974	0	0	0	0	2268.	0	0	0	0	2268.
1975	0	0	0	0	3120.	0	0	0	0	3120.
1976	0	0	0	0	3795.	0	0	0	0	3795.
1977	0	0	0	0	4650.	0	0	0	0	4650.
1978	0	0	0	0	5148.	0	0	0	0	5148.
1979	0	0	0	0	5496.	0	0	0	0	5496.
1980	0	0	0	0	6216.	0	0	0	0	6216.
1981	0	0	0	0	6816.	0	0	0	0	6816.
1982	0	0	0	0	7278.	0	0	0	0	7278.
1983	0	0	0	0	7740.	0	0	0	0	7740.
1984	0	0	0	0	8238.	0	0	0	0	8238.
1985	0	0	0	0	9000.	0	0	0	0	9000.
1986	0	0	0	0	9000.	0	0	0	0	9000.
1987	0	0	0	0	9000.	0	0	0	0	9000.

Chapter Three

Footnotes

1. Trees have not been depreciated in this analysis. Generally, capital is depreciated because, even after maintenance, a point is reachd where it simply wears out. In the case of trees that have not eached maturity, however, they are actually appreciating in value. Trees in the parimeter tend to be a mixture of maturing, mature and to a lesser extent old-post push productivity trees. By not depreciating trees, the analysis assumes a "steady state" or constant tree-age mixture over the life of the project. Since a large portion of the trees are not mature, we have probably over estimated the cost of fruit production since, a point in time will be reached where farmers will not incur costs of planting and removal of old trees and a point will be reached whee a larger portion of the trees will be bearing fruit than was assumed in our analysis.
2. Officials at ORMVAM read a preliminary draft of this chapter and pointed out that some of our estimates for 1978 production did not square with their final figures. Most of our estimates were too high. The descrepency is understandable as our data was taken from the field in November 1978 before final reports were complete. We carefully recomputed the entire benefit cost analysis to reflect the changes made by ORMVAM which affected not only 1978 data, but also projections into the future. The results slightly lowered the intenal rate of return and the benefit cost ratio. The differences, however, were inconsequential.

3. There are hydro-electric generators at the main storage dam capable of generating 15,000 to 25,000 KWH of electricity that is fed into the national grid. We have not been able to gather data on the actual amounts generated each year and to estimate the proceeds. Thus these benefits are not included in this analysis.

Chapter Four

Benefits to Consumers and Agri Businesses

The benefit cost analysis presented in Chapter Three includes a conventional but rather narrow set of variables. The costs were limited to public investments, operating costs, no project costs, and a discount rate for the capital. Most obviously, private investment was not considered and to the degree it was significant, benefits were overestimated. For reasons explained above, we have no way of even making reasonable guesses about the magnitude of private investment.

The beneficiaries were limited to labor, management and land owners. There are, however, other rather direct beneficiaries of the project, most notably consumers, who may have benefited through lower relative prices of farm produce and the agri-businesses that process some of the product from the irrigation project. Some estimates of the benefits to consumers and to the agri-businesses that have developed in the region can be made.

CONSUMER BENEFITS

Hayami and Ruttan in their noted work on agriculture development point out: "a secular consequence of rapid growth in agriculture output, relative to demand, is a downward shift in the aggregate cost and supply schedules for food staples. The effect is to transfer at least part of the gain in agricultural productivity from farmers to other sectors of the economy".[1] Consumers, of course, will emerge as the major beneficiaries of this kind of transfer. The impact over time can be dramatic. In poor countries where expenditures on food are a high percentage of household income, a lowering in the relative price of food will distribute benefits

widely and will favor those with lower incomes. Dantuala in his Presidential address to the annual conference of the Indian Economic Association in 1970 also calls attention to distribution effects of lower food prices in a developing country. He states "...in the Indian Context, one of the most rewarding egalitarian device(s) is cheaper food."[2] If we can demonstrate that consumers have benefitted from the project we can conclude that it has been a benefit that favors the poorer segments of the population, as these segments of the population spend a higher proportion of their income on food.

When output of food is rising and the population and aggregate incomes are relatively static, it is easy to understand why food prices will fall giving rise to a consumer benefit from increased production. This is the case discussed specifically by Hayami and Ruttan. But these conditions do not characterize the lower Moulouya. Population has been growing rapidly and there is little reason to predict that the natural rate of increase will decline in the near future. In the 1960's and 70's, aggregate incomes in the region were enhanced by the remittances from the migrant workers in Western Europe and by the multiplier effects of these remittances. As pointed out in Chapter One, however, remittances have historically been important in the region. Demand for food undoubtedly increased from 1960 through the late 1970's. With the decline of employment in Western Europe, one cannot be confident that this source of income will continue into the next century. But even if the rate of increase declines, it would not be reasonable to assume that the growth in agricultural output over the life of the project would exceed the growth in demand. Thus, we cannot conclude

on the basis of the reasoning presented by Hayami and Ruttan that there has been a transfer of the benefits of increased agricultural productivity to consumers. There is, however, a related argument. If a case can be made that in the absence of the project, the growth in population in the area and the increase in demand for food would have been about the same as they have been with the project, but that the increase in agricultural output would have been much lower, then we can conclude that some of the benefits of the project have been transferred to the consumers. In other words, while there has been growth in both demand and production, the growth in the latter is relatively much greater than it would have been in the absence of the project. The evidence presented in Chapter One on population and income supports such a case.

A significant part of the increase in demand in the region in the 1960's and 1970's has been a result of the remittances from labor in Western Europe. The increases in demand from this source would have been present even in the absence of the project. As the demand for Moroccan labor in Western Europe declines, however, remittances are likely to play a smaller role in the economy of the region in the period 1980-2000 than they did in 1960-80.

The natural rate of population increase in the region has been high for over 50 years. The project has probably had little effect on the birthrate. The population change in the region, however, is determined not only by the natural rate of growth, but also by migration in and out of the area. The project has clearly attracted agriculture laborers from outside the region, but the numbers are small relative to the total population. If

the project has had a significant effect on the size of the population, it would more likely be in keeping people in the region that otherwise would have moved to other parts of Morocco. It is impossible to make any decent, data based estimate of the probable size of the migration that would have occurred in the absence of the project. There are, however, reasons to believe that it would not have been great.

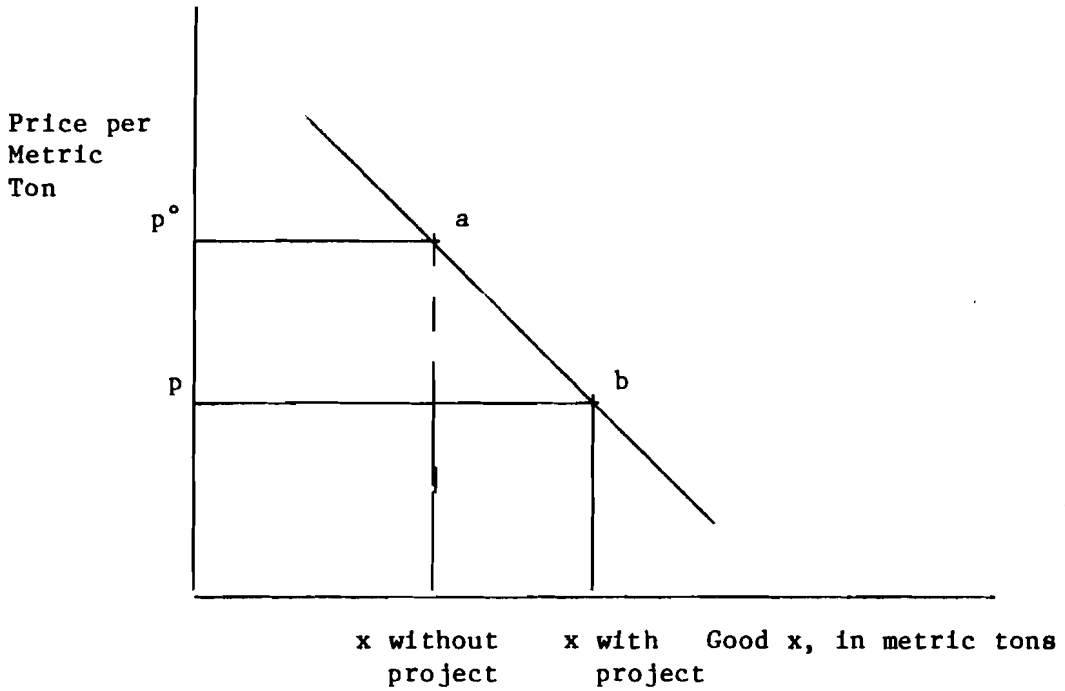
The typical pattern of migration from rapidly growing rural areas with few employment opportunities is from the countryside into the cities. If there were some cities in Morocco with a rapidly growing industrial sector that was creating jobs in excess of the labor supply we would expect rural migration into those cities. There has, however, not been this kind of urban migration. In its absence, the rural out migration would typically go to the closest urban centers. For the Moulouya basin, this means primarily Oujda which is, of course, within the market region of the Moulouya basin. The rapid growth of Oujda since the late nineteen fifties indicates that there has been much in migration. The lower Moulouya basin is one of the few areas in the Northeast that has both the size and proximity of population to provide this growth.

The labor migration to Europe has had the effect of making a good proportion of the remaining population less mobile. When men go to Europe for employment they leave their families and other dependents behind. They are very unlikely to move from the region and away from families while the men are gone. The fact that the remittances have gone significantly into domestic housing contributes to the immobility of the population. It is unlikely for a family to move after it has built a nice, new house.

Given these factors and the data on agriculture output presented in the last chapter, it seems reasonable to conclude that agriculture output grew rapidly from 1960 to 1980 and will grow more slowly but significantly after 1980. In the absence of the project, this output would have grown much more slowly, if at all. (The overexploitation of the water table on Northern Triffa, for example, might have even led to a decline in output in the absence of the project). Net disposable income has significantly increased through the 1960's and 70's. Since remittances have been so significant in the region, net disposable income would probably have increased significantly albeit more slowly even in the absence of the project.

We believe it is reasonable to conclude that some of the benefits of the project have been transferred to consumers in the form of food prices which are relatively lower than they would have been without the project. But, in the case of this project the direct measurement of consumer gains is extremely complex. To briefly depict the nature of the complexity, consider the demand schedule for the case of a single consumer, figure 4-1.

Figure 4-1



Suppose that a consequence of the project has been an increase in the supply of x on the market which results in a lowering of the price to the individual consumer from p° to p. To determine his welfare gain we determine how much the consumer is willing to pay for the movement from p° to p. The amount that he is willing to pay is a measure of the gain in his utility because of the project. The amount is the area $p^\circ abp$. An estimate of this area, requires knowledge of market demand functions for each of the major food commodities grown in the perimeter for <u>each year</u>, 1960 through 2061 <u>and</u> the market prices (p°) and disposable income that would have existed without the project.

The determination of prices p° and income levels that would have prevailed during this period is complicated by the change in income and population that was discussed above. In order to determine the income and price levels that would have prevailed without the project, a thorough analysis of population changes under varying assumptions would be required. The additional expense and time to pursue this line of investigation is not justfied by the more precise estimates of gains in consumer welfare that would be obtained.

Therefore, our strategy is to derive an estimate of welfare gain that is reasonable, but almost surely underestimates the gain in consumer welfare due to the project. Essentially, the approach is to estimate the income consumers save from not having to import the food grown on the irrigated land to meet consumption levels observed during each of the years 1960 to 1978 and to make projections for the years 1979 to 2061.

The procedure consists of 2 parts. First, the quantity of food crops produced on irrigated land in excess of the crops that would have been roduced without irrigation is estimated. The food crops included in this category are: cereals, potatoes, pulses, beans and vegetables. These stimates are taken from data presented in the last chapter. These are the quantities of food crops that would have to be imported if consumers were to maintain their consumption levels.

Price and transportation cost assumptions are made. It is assumed that the prices of the foods that would be imported without the project would be equal to prices observed in Oujda and Nador provinces during the 1960-2061 period plus transportation costs. Transportation costs are based on the

average distance of 350 km and a deflated transportation cost per metric ton per km. of .12 dirhams or 42 dirhams per metric ton (.12 x 350), in 1978 prices. (See Table 4.1.)

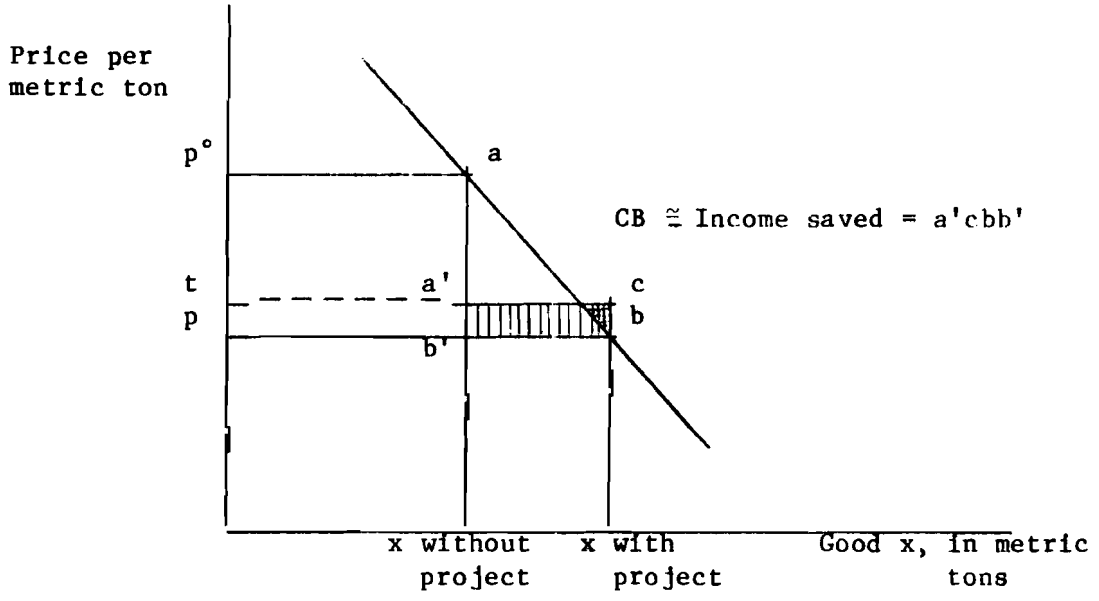
Based on these assumptions, estimates of income saved as a proxy for consumer benefits (denoted CB) are essentially equal to multiplying 42 dirhams per metric ton (with the appropriate deflation factor) by the total quantity, in metric tons, of foods that would be imported if consumers were to maintain their observed and projected consumption levels without the project. This is equivalent to:

$$CB \cong \text{Income saved} = \frac{42 \text{ dirhams per metric ton (crop produced with project} - \text{project crop produced without project)}}{\text{deflation factor}}$$

This quantity is almost surely less than the area $p^{\circ}abp$.

We produce Figures 4-2 to demonstrate why our measure is almost surely less than the "true" gain to consumers, i.e., area $p^{\circ}abp$.

Figure 4-2



The income saved is denoted by the shaded area a'cbb'. This area is clearly less than the area $p^{\circ}abp$.

Under what circumstances might our estimate exceed the true gain in consumer welfare? There are two cases. If $p^{\circ} = p + t$, our estimate would almost surely be less than the true gain in consumer welfare unless the cross hatch triangle, exceeded the area of the rectangle ta'b'p. In order for this to be the case, the direct price elasticity of demand for good x would need to be extremely elastic. Based on consumer demand studies from other countries this is almost surely not the case.

Our estimate could also exceed the true gain in consumer utility if $p^{\circ} < p + t$. However, a comparison of the annual average prices plus our transport cost estimates (p + t) for cereals, pulses and beans, vegetables and potatoes with prices in other food deficit areas in Morocco indicates that generally p + t is less than these prices. Thus, prices (p°) in the Oujda-Nador area without the project would very likely have exceeded p + t. Hence, we conclude that our estimate almost surely <u>underestimates</u> the true gain in consumer welfare.

Table 4-1 Transportation Costs

	Tons Cereals additional	Tons Potatoes additional	Tons Beans additional	Tons Vegetables additional	Total Tons Grains and Veg. additional	0.2DH/km per 350 km Total case Tons x .2D x 350 FILL IN
1960	800	2,200	800	-	3,800	266
1961	800	5,400	2,700	4,800	13,700	959
1962	800	5,500	2,800	6,800	15,900	1,113
1963	1,300	6,100	3,100	8,300	18,800	1,316
1964	1,600	6,400	3,700	11,800	23,500	1,645
1965	1,900	9,900	4,000	13,600	29,400	2,058
1966	3,500	10,500	5,000	17,100	36,100	2,527
1967	2,200	10,900	5,900	13,800	32,200	2,254
1968	5,300	11,500	5,900	12,600	35,300	2,471
1969	5,800	14,700	6,400	20,200	47,100	3,297
1970	9,800	15,900	5,500	29,400	60,600	4,242
1971	4,700	16,800	6,300	29,600	57,400	4,018
1972	8,100	17,600	6,100	18,400	50,200	3,514
1973	8,300	17,500	4,600	16,800	47,200	3,304
1974	8,700	19,000	4,500	27,100	59,900	4,193
1975	4,400	24,200	5,000	17,000	50,700	3,549
1976	11,100	24,300	3,900	49,200	88,500	6,195
1977	9,000	28,000	5,800	38,000	80,800	5,656
1978	12,800	29,000	5,400	48,200	94,200	6,594
1979	13,000	29,700	5,500	48,200	96,400	6,748
1980	13,100	21,600	5,600	48,600	88,900	6,223
1981	13,200	33,200	5,600	48,100	101,100	7,077
1982	13,600	33,400	5,800	51,000	104,400	7,308
1883	13,800	34,100	5,900	52,600	106,400	7,448
1984	13,900	34,800	6,000	53,200	108,400	7,538
1985-1986	14,000	37,800	6,000	54,300	112,000	7,840

We can make quantitative estimates of the consumer benefits by the method described and incorporate them into the benefit cost analysis. The B/C ratio raises to 1.3 and the internal rate of return to 11.10%. If we recompute the percent of benefits accruing to each economic group, 4.6% of the total goes to consumers. (See table 4.2. We must reiterate, however, that the method we have used almost surely underestimates the benefits to consumers.

TABLE 4.2

Percent share of benefits to each economic class.		
PROJECT ESTIMATOR	INCREMENTAL PV (1978 DH X 1,000)	% OF TOTAL
FARM OPERATORS	347,133	33.2
FARM LABORERS	333,120	31.8
LAND OWNERS	223,504	21.4
ORMVAM (WATER)	94,331	9.0
CONSUMERS	47,738	4.6
TOTAL BENEFITS	1,045,826	100.0

Benefits to Agri Business

Even when we add the consumer benefits into the benefit cost analysis it is the direct factor suppliers, agricultural laborers, land owners and farm managers, who reap the over whelming direct benefits from the irrigation project. But there are several limits on the contributions that an

agriculture development project can make to more general economic growth and development if the benefits cannot be spread beyond those directly involved in agricultural prediction. A successful irrigation project does increase the productivity of land. It thus can absorb more labor, and help make managers more productive and capital investments more rewardng. But in relatively densely populated regions where the population is growing, if it cannot contribute to off-farm economic activity, it will always benefit only a small minority of the population.

But a successful agricultural development project should create off farm economic activities. Firms that supply inputs such as fertilizers, pesticides and farm machinery should arise and provide entrepreneurial and employment opportunities. Firms that process the agricultural product should also emerge and create employment opportunities and contribute to the economic growth of the region. It is to these processing firms in the Lower Moulouya region that we now turn our attention.

Before 1960 there were a few agriculturally based industries in the lower Moulouya basin - wineries, citrus packers, small cotton gins and niora grinding mills. The changes in agriculture that have come with the irrigation project have had their impact on these industries. As cotton production ceased the gins have disappeared. Wine making has declined in importance but citrus packing and niora processing have increased. New industries have also emerged, most notable, a sugar mill, plants processing vegetables, some units directly related to the development of animal husbandry. In 1978 the principal agri-business facilities in the basin were:

- A sugar mill in Zaio, (SUCRAFOR).
- Fourteen citrus grading and packing plants on the right bank.
- Four wineries on the right bank..
- An essential oils extracting and distilling plant (Les Aromes du Maroc).
- A freezing unit (Les Aromes du Maroc).
- A clementine (tangerine) juice extraction plant (Les Aromes du Maroc).
- A quick freezing plant (Les Aromes du Maroc).
- Three niori (pepper) grinding units in Berkane.
- A compound feed-mill in Nador (CODESA).
- A plant for dehydration, canning, etc., in Berkane (COMAOR).
- A dairy cooperative in Oujda (SOCOLMO).
- Ten modern flour mills and grain silos.
- Some small artisanal olive processing units, etc.

The largest and most imposing plant in the region in 1978 was the sugar plant located at the edge of Zaio. The company that built the plant was founded in 1971 as a largely foreign operation with Europeans holding more than two-thirds of the stock. It was not, however, a successful commerical undertaking.

By 1977 it had lost about fourteen million dirham and the Moroccan government took over 75% of the equity shares leaving 25% in private hands - both Moroccan and European - and put more money into the operation. (See Table 4.3)

The plant started processing sugar beets in June 1972 when it ran for 47 days and processed 1725 metric tons per day for a total production run of about 77,000 metric tons. In 1978 it processed sugar beets for 65 days averaging 2,660 tons per day. 163,980 tons of beets were processed. (See Table 4.4 for details on production.)

TABLE 4.3. EVOLUTION OF SUCRAFOR'S CAPITAL: 1971-1977

Date	Increase in Capital		Decrease in Capital			
	Dirhams	$	Dirhams	$	Dirhams	$
2-22-71	-	-	-	-	30,000,000	7,500,000
6-29-73	10,000,000	2,500,000	-	-	40,000,000	10,000,000
5-21-75	4,190,000	1,047,500	-	-	44,190,000	11,047,500
2-29-76	4,982,100	1,254,525	-	-	49,172,100	12,293,025
2-28-77	3,417,600	854,400	-	-	52,589,700	13,147,425
5-3-77	-	-	42,589,700	10,647,525	10,000,000	2,500,000
	Losses after 5 years estimated at 14,000,000 Dirhams ($3,500,000)					
7-7-77	35,000,000	8,750,000			45,000,000	11,250,000

Source: SUCRAFOR, Zaio

Table 4.4 Sugar Beets Processing: 1972-1978 - SUCRAFOR

	1972	1973	1974	1975	1976	1977	1978
Beginning: Campaign - date	6-10	6-29	7-2	6-21	6-7	6-7	5-30
Duration = Number of days	47	36	40	49	76	55	65
Beets received: Metric Tons	81,100	77,850	88,450	122,140	177,870	137,530	173,050
Beets Processed: Metric Tons	77,180	74,950	84,740	117,300	174,850	132,650	163,980
Average/day = Metric Tons	1,725	2,163	2,211	2,493	2,340	2,500	2,660
Production							
Refined Sugar (T)	998	3,385	4,483	4,743	6,621	6,397	7,873
Unrefined Sugar (T)	9,685	6,071	5,170	7,867	9,219	7,886	10,031
Dried Pulp (T)	1,000	2,200	920	1,740	6,330	6,930	1,380
Pellets (T)	600		2,950	4,350	2,150	5,780	8,060
Sugar Content %	18.9	16.5	16.4	16.2	14.3	15.8	16.5

Source: SUCRAFOR, Zaio

The plant is designed to process 200,000 metric tons of sugar beets per year, but it has never reached that level of production. In 1976 a major effort was made to reach this goal but because of failure in plant equipment which slowed down production and a lack of transport, processing fell short of planned production and 9,000 metric tons of beets stayed in the field. This angered the farmers who did not get paid for the unprocessed beets and in the following years there was some reluctance on the part of farmers to expand production up to the point where the plant could run at or near capacity.

In 1974 the plant first started processing sugar cane but the experience with sugar cane has not been totally successful. In 1975 there was a frost in another part of Morocco which is heavily in sugar cane production and part of the lower Moulouya's production was sent there to be used as slips for the 1975-76 planting program. This reduced processing of cane at the Zaio plant. In 1976 technical breakdowns and strikes prevented the processing of any cane and 16,000 tons were left in the field. This made farmers reluctant to plant cane the following year and in 1977 only one-third of the planned hectarage was actually planted. In 1978 28,000 metric tons were processed in a production run that averaged 582 tons a day. This was only about 53% capacity. (See table 4.5 for details).

The plant has had a significant impact on employment on the Sebra plain. In 1978 total employment - both permanent and seasonal - was 452. Of this number 184 were seasonal or occasional, 192 were regular unskilled laborers, 81 were skilled laborers and between 80 and 90 were in management and in lower level white collar positions (See Table 4.6).

Table 4.5. Sugarcane Processing - SUCRAFOR - 1974-1978

	1974	1975	1976	1977	1978
Beginning Campaign: date	5-12	4-24	NO	3-8	2-3
Duration: Number of days	44	29		57	58
Cane Processed: MT	10,610	13,540	PROCESSING	35,120	27,950
Average/day: MT	378	466		616	582
Production: Refined Sugar MT	869	1,220		3,652	2,211
Molosses MT	-	655		1,378	1,220

Source: Sucrafor, Zaio

Table 4.6 PERSONNEL - SUCRAFOR - 1971-1978

	Manage-ment	Higher STAFF	Foremen	Controllers	Employees	Laborers (Unskilled)	Laborers (Machinery)	Seasonals	Occasion-als	Total
1971	4	13	-	22	1	1	0	0	0	41
1972	4	8	-	20	9	50	38	130	0	259
1973	4	13	-	25	13	64	56	208	0	383
1974	4	15	-	23	14	72	59	201	0	388
1975	3	12	-	20	16	94	65	179	50	439
1976	3	12	-	19	16	102	79	122	38	391
1977	2	15	-	34	15	92	84	135	25	402
1978	3	20	-	49	16	92	81	164	20	452

Source, SUCRAFOR, Zaio

While the sugar plant is the most imposing agri-business structure in the region, the grading and packing of citrus involves the employment of many more people. In 1978 there were 14 citrus grading and packing units in the region employing about 4,000 workers (60% women) from November through January of each year. Most of the citrus grown is intended for export and the packing plants operate with contracts under the OCE (Office du Commerce Exterieur).

Table 4.7 lists the plants in the region and gives the amount of clementines in metric tons which have been packed for export from 1966 through 1979. (Fruit that does not meet the standards for export is sold on the local market or to a juice extraction and freezing plant which will be discussed below.) From Table 4.8 it is clear that over the years two firms have dominated the grading and packing of citrus. From 1966 to 1972 they were ART (Agrumiculteurs reunis des Triffa) and Bel Hadj which were responsible for 48% to 63% of total exports. From 1973 to 1977 ART and SOCOBER handled 40% to 48% of the total packed for export. Most of the firms doing grading and packing are producer cooperatives.

The cooperative El Ouahda was started by 182 farmers in 1977. It has a capacity of 3,000 metric tons per year. In the first year of operation 2,976 tons of clementines were packed and exported. In 1978-79 it is expected that production will dcline to about 2,300 tons. Net profits for the 1977-78 season were 360,000 dirhams. All of the clementines that were packed were grown on 440 hectares belonging to the 182 members of the co-op. These figures indicate that it is a cooperative made up of relatively small producers.

Table 4.7 Export Packing (M.T.) Clementines

Packing Plant	1966-67	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79*
A.R.T.(Berkane)	2642	2669	3251	5356	6860	—	4216	4754	5174	3332	5166	7666	9800
Bel Hadj(Berkane)	2422	2777	4187	4377	4503	—	—	—	—	—	—	—	—
Ben Said(Berkane)	704	960	854	2054	2888	—	2567	4001	4405	3415	4076	5595	4550
Primfruit(Berkane)	945	845	702	846	843	—	1004	1200	1628	1901	2407	2840	1750
S.C.A.B.(Berkane)	446	533	1109	1142	2161	—	2456	2046	A.	R. T. -	-------	-------	-------
Ruffier(Atamna Saidia)	901	684	756	1498	1088	—	437	A.	R. T. -	-------	-------	-------	-------
Moulouya(Berkane)	—	—	947	1558	1819	—	1248	1762	1604	1315	1434	2750	1400
Cherraa (Atamna)	—	—	170	427	513	—	585	389	A.	R. T.	-------	-------	--------
Tissot	—	—	120	375	225	—	-------	--------	-------	-------	-------	-------	--------
Zegzel (Navaro)	—	—	270	673	1180	—	1380	2308	1604	1248	1351	2104	1050
Boughriba (Nasr)	—	—	294	438	733	658	1130	1264	1337	1642	2039	3015	1750
Slimania (Fath)	—	353	289	716	696	—	1038	1376	1384	1128	1009	1646	1050
Socober (Berkane)	—	—	—	—	—	—	3304	5451	4284	5038	6512	9688	7000
Sidi Bouzid (Berkane)	—	—	—	—	—	—	—	—	1764	2035	2354	3104	1750
El Quahda (Aklim)	—	—	—	—	—	—	—	—	—	—	—	2976	2275
Es Salem	—	—	—	—	—	—	—	—	—	—	—	—	2625
TOTAL	8060	8821	12949	19760	23509	17300	19374	24569	21851	21036	26348	41384	35000

Source: D.C.E., Berkane.
*Estimated

In 1978 between November and January 170 temporary women and 38 temporary men were employed. They were paid 1.5 dirhams per hour and could process 6,500-7,000 wooden cases each with 10 kilograms of fruit every day.

Another cooperative, EN NASR, was started in 1967. In its first year of production it packed only 294 tons of clementines for export. By 1977-78 3,000 tons were processed which were grown on 390 hectares belonging to the 116 members of the co-op. Net profits for that year were approximately 800,000 dirham. 109 women and 84 men were employed by this co-op during the peak season, at a wage of 1.5 dirhams per hour. (See Table 4.8)

The largest grader and packer in the area is ART, which was started in Berkane in 1957. In the first year it packed 2,642 tons of clementine and in 1958 production had risen to 7,666 tons of which about 10% were oranges. ART has three plants, two in Berkane and one in Atamna. A majority of the shares in this company are held by the state farms SODEA and SOGETA. About 1,000 people work in the ART plants during the peak season from November to January.

The grading and packing industry in the region has, of course, descended directly from the operations that were set up under the French. By contrast, a different industry has been established in the region by Les Aromes du Maroc which owns two farms on the right bank totaling 280 hectares and has three processing facilities: 1) an essential oils extracting and distilling facility, 2) a clementine juice extracting and freezing unit, and 3) a quick freezing unit to process vegetables. The majority of the stock (51%) in this firm is owned by the King. The other 49% is owned by five Frenchmen.

Table 4.8. Packing: Cooperative NASR - Boughriba - 1968-1978

Year	Members Nb.	Total Exports Tonnes	Value of Exports		Average Price per Kg.	
			Dirhams	Dollars	Dirhams	Dollars
1968-69	58	294	203,528	50,880	0.69	0.17
1969-70	76	442	559,400	139,850	1.27	0.32
1970-71	83	754	472,400	118,100	0.63	0.16
1971-72	88	658	530,300	132,575	0.81	0.20
1972-73	99	1230	848,600	212,150	0.69	0.17
1973-74	102	1372	758,800	189,700	0.55	0.14
1974-75	103	1371	1,334,900	333,725	0.97	0.24
1975-76	115	1629	1,980,500	495,125	1.22	0.30
1976-77	120(1)	2059	1,791,600	447,900	0.87	0.22
1977-78	120	3000	--	--	--	--
1978-79	120	2500(2)	--	--	--	--

Source: Cooperative NASR

(1) 116 members plus 4 private farmers

(2) Estimated

The distillery was the first unit in operation beginning work in 1969-70 to extract the essential oils from flowers, mostly jasmine and geraniums, but also including verbena, sage, violets, jonquils and orange blossoms. Both the distolite which is called "essence" and the residue which is called "concrete" are exported to France where they are processed into perfume.

In 1976 a flash freezing unit was constructed and in 1978 it processed green beans, artichokes, raspberries and broccoli. It achieves a 50 degree centigrade drop in temperature in eight minutes and can process a half ton of vegetables per hour. Present plans call for the building of a second flash freezing tunnel with one-ton-a-hour capacity.

In 1978 a clementine juice extracting and freezing unit began working. It has a capacity of two tons of frozen clementine juice per hour. It was built in order to take advantage of the clementines which were rejected by the packing houses as not meeting the quality necessary for export. In the 1978-79 season, however, there were not very many rejects and the production was not significant.

The plants employ 30 people on a permanent basis throughout the year and hire from 200 to 1200 seasonal workers. The salary range is between 9-12 dirhams per day for temporary workers except for children who are hired to pick the jasmine flowers who are paid 2.5 dirhams per kilogram. Productivity ranges from .8 to 8 kilograms per person per day. (See Table 4.9 for data on farm production).

All of the industries treated above process a product from the irrigated perimeter largely for export from the region. In 1978 a compound feed mill (CODESA) was built in Nador to use the by-products of the flour mills

Table 4.9. Les Aromes du Maroc - Flowers and Vegetables Grown on the Two Farms - 1967 - 197[illegible]
(Hectares)

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Jasmine	60	60	60	60	60	60	60	65	65	65	65	60
Geranium (Rosa)	60	60	60	100	100	10	100	100	100	100	100	90
Roses	32	32	32	-	-	-	-	-	-	-	-	-
Seville Orange	-	-	-	32	32	32	32	32	32	32	32	32
Camomile	10	10	10	-	-	-	-	-	-	-	-	-
Verbena	-	-	-	10	10	10	10	10	10	10	10	10
Violets	-	-	-	-	-	-	-	-	-	2	2	2
Jonquil	4	4	4	4	4	4	4	11	11	11	11	11
Tuberose (Polyantheo Tuberosa)	-	-	-	-	-	-	-	1	1	1	1	1
Basil	-	-	-	4	4	4	4	4	4	4	4	4
Isope	-	-	-	1	1	1	1	1	1	1	1	1
Peppermint	-	-	-	5	5	5	5	5	5	5	5	5
Sage	-	-	-	5	5	5	5	5	5	5	5	5
Rasberries	-	-	-	-	-	-	-	10	30	60	60	60
Green Beans	-	-	-	-	-	-	-	-	-	-	-	15
Artichokes	-	-	-	-	-	-	-	-	-	-	-	17
Broccoli	-	-	-	-	-	-	-	-	-	-	-	7
Potatoes	-	-	-	-	-	-	-	-	-	37	37	37
Total Hectares	166	166	166	221	221	221	221	224	264	333	333	357

Source: Les Aromes du Maroc, interviews.

(bran) and the sugar mills (pulps) and produce a feed for livestock largely for use in the region. In December of 1978 it produced 70 tons of feed per day of which 70% was for poultry, 20% for sheep, 5% for milk cows and 5% for other cattle.

The plant employed 30 people on a regular basis, but employment may expand because the owner is planning to use the facility 25 hours a day. Production could rise under this plan to 200 tons per day.

One of the commercial crops which pre dates the irrigation project is niora (red pepper), which was introduced into the region in 1929. Some of the niora is processed by the farmers and additional small amounts are sold to small shops where processing takes place. There are, however, three small privately owned grinding facilities in the region to which farmers can sell their products. These three mills employ 15 to 20 people on a permanent basis throughout the year and produce about 900 tons of finished product.

The largest winery in the region is the Beni Snassen cooperative which accounts for 72% of the total production in 1978-79. This winery was created in 1929. At the present time about 80% of its shares are owned by the state farms SODEA and SOGETA. Over 80% of the grapes processed in the winery are also grown on the state farms. (See Tables 4.10 and 4.11).

The plant employs about 25 people on a year-round basis during the vintage season - mid August to mid October - 150 to 200 additional people are employed.

Most of the wine produced is shipped unlabeled in bulk to Meknes and Casablanca where it is bottled and sold in Morocco or shipped in bulk overseas. The Beni Snassen cooperatives also produces about 100 hectolitres of 94% alcohol each year.

Table 4.10 Lower Moulouya Winery Statistics

Winery	Production 1970-71 HL	Production 1971-72 HL	Production 1978-79 HL	Storage Capacity HL	Observations
Societe Cooperative Vinicle des Beni-Snassen (Berkane)	175,884	170,430	92,600	380,000	
Boutine	12,063	18,404	10,000*	35,000	
SABS	10,462	13,325	6,000	18,500	
Kraus (Sogeta)	6,466	7,160	-	18,000	closed
Bayon (Oujda)	9,738	24,364	-	30,000	closed
Jonville (Belhadj)	8,228	6,990	-	23,700	closed
Cooperative Oujda	7,247	9,520	-	12,000*	closed
El Aleb	4,162	14,440	20,000*	30,000*	
Touboul	8,432	9,347	-	12,000*	closed
Frontiere	4,302	5,110	-	10,000*	closed
TOTAL	250,984	279,090	128,600	569,200	

Source: Beni Snassen Cooperative and interviews.

*Estimated

Production of Beni-Snassen

Table 4.11. Cooperative Winery (Hl)

Year	Production Processed Grapes - quintals	Red Wine	Rose Wine	White Wine	Unfermented Juice (Mute)	Basic wine (mistelles)	Total	Average Degree
1966	-	150,000	13,000	8,000	65,000	1,000	237,000	-
1967	-	214,000	10,000	5,000	74,000	Nil	303,000	-
1968	-	67,000	4,000	1,000	77,000	1,000	150,000	-
1969	-	59,000	5,000	6,000	54,000	Nil	124,000	-
1970	-	136,000	16,000	23,000	Nil	Nil	175,000	-
1971	-	-	-	-	-	-	170,000	-
1972	179,430	-	-	-	-	-	149,000	12.38
1973	-	-	-	-	-	-	-	-
1974	190,706	166,000	Nil	1,100	2,000	Nil	169,100	13.32
1975	91,716	64,000	7,400	4,700	Nil	Nil	76,100	13.1
1976	138,400	93,000	11,300	6,400	Nil	180	111,280	13.2
1977	131,354	73,800	24,700	7,600	Nil	Nil	106,100	13.1
1978	119,800	79,700	12,900	Nil	Nil	Nil	92,600	13.2

Source: Beni Snassen cooperative

Chapter Four

Summary and Conclusion

One of the most effective ways of spreading the benefits of an agricultural project to the poorer elements in society is to lower the relative real costs of food. We have made a very conservative estimate of the consumer benefits by computing the cost of importing from other parts of Morocco the differences between food grown with irrigation and that which would have been grown without. This calculation indicates that about 5% of the benefit of the project accrue to consumers.

Several observations can be made about agri-business in the region. The first is that it was rather slow to develop. Up until 1972 the only agri-business of consequence in the area - wineries, niora processors, and citrus packers - all predated the irrigation project. The first dramatic change came with the sugar plant, which has not been a really successful venture. Since 1976, however, new industries appear to be developing at a more rapid pace. But interesting operations like Aromes des Maroc and the new compound feed mill in Nador are so new, that no firm evaluation of their role in the region is possible.

The impact of agri-business on employment is mixed. While they add close to 7,500 jobs in agri-business in the region, about 6000 of them are seasonal and/involve low levels of skill. But it should also be noted that a significant number of jobs are held by females and the agri-businesses must be recognized as providing work opportunities for females that before irrigation were very limited.

Chapter Four

Footnotes

1. Yujiro Hayami and Vernon W. Ruttan, Agricultural Development: An International Perspective, Johns Hopkins Press, Baltimore (1971) p. 217.
2. M.S. Dantwala, "From Stagnation to Growth," Presidential Address, Indian Economic Association, Fifty Third Annual Conference 1970, p. 18.

Chapter Five

The Social Impact of the Irrigation Project

The previous three chapters present an assessment of the more directly economic effects of the irrigation project — the new pattern of crops and the increased productivity, the favorable ratio of the economic returns to costs, and the benefits that have accrued to consumers and to agricultural processing industries. The impact of the irrigation project, however, has not been limited to these economic dimensions. There has been a larger social structural change in the region to which the irrigation project has contributed, if not caused. An understanding of these social structural developments -- particularly the change in social classes and their interrelationships — leads to a deeper appreciation of the implications of the more strictly economic effects and also sets the context for examining the effects of the project on the welfare of the farm family.

General Overview of Social Structural Change

The significant social structural changes experienced in the region over the past 25 years did not have their beginnings with the irrigation project even though the advent of the project augmented the forces for change. Let us review briefly some of the history of the region presented in Chapter One to gain some historical perspective.

At the end of the nineteenth century peasants made up the overwhelming majority of the population of the region. They were largely self-sufficient, using household labor to produce largely for home consumption. Small quantities of their agricultural product might be sold to provide money for taxes and the purchase of a few products they could

not raise. There were almost no merchants who earned their living from buying and selling alone and no large land owners who employed laborers who were not members of their household.

Even by the last years of the 19th century, however, this peasant economy and the class structure it gave rise to were beginning to break down. The high population growth rate was a major driving force. As more children survived to maturity, "melk" properties were divided into ever smaller holdings and greater pressure developed on the communal lands. The land in its traditional mode of exploitation could not support the number of people who wished to eke a living from it. The first major outlet for the excess population was in Algeria where the large colon estates had developed a huge appetite for seasonal agricultural labor. Men from the northeast went to Algeria and they returned with money into a largely non-monetary peasant economy. While they could probably find lodging with family, they stretched the capacity of the farm household to provide other necessities of life. The cash they brought with them back from Algeria helped to contribute to the development of a small market economy in the region.

The French settlers that moved into the northern Triffa created some employment opportunities, but a significant demand did not arise until irrigation began on a commercial scale in the 1930s. By this time small towns and villages had emerged in the region and other employment opportunities arose as investment in infrastructure became significant on the right bank. While economic activity on the left bank was at a much lower level, the Spanish army in the 1930s had become a significant employer.

By the mid 1930s the class structure was significantly different than it had been in 1900. The self sufficient peasant class remained significant but new classes which had a symbiotic relationship to one another emerged. There was a small class of capitalist farmers, almost exclusively foreign, who hired labor and produced crops for market. The number of landless laborers or of small peasants whose holdings were too small to support a family had increased dramatically. Tens of thousands emigrated seasonally to Algeria for work as the local employment opportunities in the modern agricultural sector, on construction projects, and in the direct employ of the occupying power did not meet the need for jobs generated by a growing population.

Commercial activity in the region was much greater than it was in 1900; a merchant class had arisen. Some merchants occupied small permanent quarters in the towns and villages. Others were itinerant, moving their wares daily from town to town in regular rotation.

While we can speak of economic classes in the areas in the 1930's, it must be pointed out that members of a given household could be involved in several occupations and thus be members of several occupationally defined classes. Working one's own land (or keeping one's own herd as would be the dominent pattern on the Sebra) remained a highly desirable and prestigious thing to do. Thus families held onto their land even though inheritance practices or forced sales of part of a holding in hard times made the farms too small to support the household. The men would seek a second occupation. They might spend short periods as day laborers on colon's farms, work on road construction, try to establish themselves as merchants or join the

army or go to Algeria. It was not only those with the smallest holdings who sought alternative employment. Given the fickle climate--political and economic as well as meteorological--even larger landowners sought alternative ways of earning money. Pursuing multiple sources of income became a highly desirable economic strategy in the face of uncertainty.

The situation as described above persisted until the mid nineteen fifties. The continued population growth, however, put more pressure on local resources and it appears that existence became ever more hazardous. While the years of droughts in the late 1940's do not seem to have been more severe than those in earlier decades, the effect on the population appear to be much greater, suggesting that the basic agricultural economy of the region was becoming less and less able to support the growing population.

The coming of independence and the opening of the Southern Triffa plain to irrigation from the Moulouya in 1956 initiated profound changes in the northeast. Let us look at some of the major factors that were involved. First, independence marks the beginning of the end of a significant foreign population in the region. Western European landowners either sold their land to Moroccan Nationals or had them taken over by the state to form the core of the state farms in the regions. Many of the foreigners in the region, however, were not large landowners; they made their living in commercial undertakings. When they left, native Moroccans moved into these roles in the towns and villages. Thus the class of capitalist farmers which had been made up of foreigners in the early 1950s was smaller in the 1960s and was made up largely of Moroccans. There was also an expansion of Moroccans in the commercial class.

A second major effect of independence was a decline in employment opportunities. Employment with the French or Spanish state was immediately cut off, the Algerian border was shortly sealed, and labor emigration stopped. Investment in infrastructure and housing slowed markedly leading to a decline in employment. Thus, the major "safety valves" for absorbing the rapidly growing population were removed. The increase in unemployment created the potential for real social turmoil and political unrest.

The immediate economic effect of the opening of the Triffa to large scale irrigation with waters from the Moulouya were less than those associated with the coming of independence. But important forces were set in motion. A number of small peasants owned land in the area that came under irrigation and were suddenly presented with quite different conditions of production. Another small number of landless laborers and small peasants were given plots averaging about 7 hectares in the irrigated regions. While production for household consumption remained important for the small farmers who gained access to irrigated land, they also began to produce a cash crop for market. We do not wish to label this group of small land owners as "capitalist farmers" because they used household labor almost exclusively. Yet they were different from the peasants on the dry land who produced essentially for household consumption. We will call them "commodity producers", and while they constituted only a small group in the 1950s they become numerically the most significant class on the irrigated lands by the end of the 1970s.

As the irrigation project expanded more crops were produced for market and as was pointed out in the last chapter new jobs were created in firms

that processed the new agricultural products and in those it marketed the inputs for agricultural production.

Over a period of a quarter of a century there have been major changes in the class structure. The high natural rate of population growth contributed greatly to the emergence out of the self-sufficient peasants a class of landless or near landless labor. The first significant employment opportunities for this class were created by the colonial powers first in Algeria and later some became employees of the state or of the small new class of capitalist farmers that developed on the right bank. Increase in commercial activity and in the growth of towns both directly associated with foreign intervention gave rise to a class of merchants.

Changes in the Class Structure After Irrigation

On the eve of irrigation and independence there were four significant social classes defined by their means of livelihood: peasants, landless laborers, capitalist farmers (almost exclusively European) and merchants (largely European or Moroccan Jews). What happened to them after 1956?

Peasants

The peasants in the region were the product of the conditions of dry land agriculture. When water from the Moulouya flowed on the land, the conditions were drastically changed. The amount of land needed to sustain a family was drastically reduced. The crop options increased, and the

traditional livestock no longer had a place on high priced irrigated land. The peasant largely disappeared from the irrigated land. He was transformed into what we have called a commodity producer--a farmer who used household labor to produce a cash crop(s) for the market. A few peasants, however, still remain. About 15 percent of our sample should be classified as such for they produce largely for home consumption and market little other produce. It is significant that many of these farm in areas within the irrigation perimeter where design or engineering problems make it impossible to irrigate. They remain, in effect, dry land, peasant farmers.

It should also be pointed out that where the traditional conditions of dry land agriculture remain, the traditional peasant family remains raising cereals and sheep and goats and consuming a goodly proportion of what is produced.

Landless Laborers

The combination of high population growth, limited agricultural development, and few non-agricultural employment opportunities had produced in the region before 1956 a large class of landless laborers with peasant origins. Up until independence what employment they had was directly or indirectly dependent on the colonial powers. This source of livelihood was soon to dry up.

The problem of the landless was recognized from independence onwards by the Moroccan government. The distribution of land to landless labourers and small peasants in the area of Boughriba in the Triffa at the very

beginning of the project in 1956 provides an indication of this recognition. In the period from 1956 to 1967 land was distributed in 496 plots (amounting to roughly 3,290 hectares of irrigable land) to landless labourers and small peasants in Boughriba (1956), Slimania (1958) and Schouyaya (1967). This meant that including the "collective of Madagh" (where the French before independence had assigned 259 small plots to Moroccans) the total number of plots of irrigated land distributed up to 1967 was 745. If it is assumed that each plot represents, as it was intended to do in the conception of the allotissements, a farm household, then the population to which land distribution provided access to irrigated land was about 5,000 to 7,500 (average household size: 7-10). In 1964 the Avant Projet estimated that the total population of the future irrigation perimeter (excluding Europeans) was around 186,000 - 25% of which was urban, leaving 138,500 in the rural areas. Avant Projet surveys suggest that the categories of landless, near-landless and small peasants accounted for at least 40% of this, in which case the land distribution affected about 10% of the 55,800 concerned.

During the next decade a further 474 plots were distributed (279 in the Sebra on the left bank,and 165 in the area of Ain Chella/Sidi Ikhlef and 30 in the high Triffa on the right bank, while 168 plots were re-allocated to the members of one douar in the Sebra where a land dispute has prevented the development of effective irrigated farming within the sector of Khaled.

In total, land distributed since independence to those previously landless or near landless amounts to some 6,500 hectares and has affected some 970 households with a total population of 7,000-10,000). It is

proposed to continue with land distribution, and the proposed distributions for 1978 would account for a further 1,560 hectares. Given the rate of population growth within the region as a whole and the irrigation perimeters in particular, the percentage of the landless and near landless affected by land distribution up to mid-1978 must be well under 10%. Whatever the precise percentage involved, it has remained very small and has declined. This is not to deny in any way the value of the contribution made by the programme of land distribution; it is merely to indicate that the size of the social category of landless and near landless which has continued to grow, partly as a simple consequence of population growth and partly as a function of growing pressure on small and medium peasants, cannot be significantly reduced by simple land distribution.

TABLE 5.1

Allocation of State Land

Name	date of dist.	net area	no. plots
collective Madagh	1939	615 Ha.	249
domanial Boughriba	1965	1,475	202
domanial Slimania	1957/8	1,020	196
domanial Schouyaya (Najah)	1967	795	98
collective Sebra	1969	1,400	279
Khaled (re-distribution)	1974	*	168
domanial Ain Chellah/Sidi Ikhelf	1975	1,630	165
domanial Triffa H S	1976	180	30
		7,115	1,387

*disputed land taken over by the state and re-distributed as 669 Ha. for plots 391 for orchard and 1,800 for grazing

It is clear that for the minority which received land in the process of distribution to previously landless and near landless the irrigation project has transformed their capacity to generate incomes as farmers. In the majority of cases this has enabled them to move into the class of commodity producers. In some cases, however, for a variety of reasons often associated with problems of irrigation or else with the relative attraction of alternative sources of income, they have remained essentially peasant farmers assured of land but failing to make the transformation to commodity production to any significant degree.

For those who are landless or near landless and have not received land through the Reform Agraire, farming is not possible and alternative occupations must be sought. A significant proportion are unable to find more than the most sporadic of casual employment and must be regarded essentially as unemployed. Some have become involved in minor forms of commercial activity or petty commodity production in the towns as traders, small artisans, shopkeepers and so on, but these constitute only a small proportion of the total. The majority remain dependent on employment in agriculture.

While the expansion of irrigation over the decade from 1967 to 1977 within the irrigated perimetres has increased the demand for labour, it is not only locals who have benefited. Migrant workers from other parts of Morocco have to an increasing extent moved into the northeast in search of employment. Our survey suggests that up to one third of agricultural laborers employed by farmers within the irrigated areas came from outside the region --from Taza and the Rif or from further afield (Ouarzazate, Fes, even the far west).

For the landless and near landless seeking employment in the region, the increasing demand for labor generated by the growth of irrigated farming has been reduced in effect by the response from individuals within the same category, but originating from outside the region. If the concern, however, goes beyond assessing the impact on those residents within the region and seeks to identify the impact of the Lower Moulouya Irrigation Project on, say, the landless and near landless in Morocco as a whole, then one must conclude that the aggregate effect has been beneficial, in the sense that the demand for labor has dramatically increased within the region, thereby providing opportunities for employment to a substantially greater number of poor Moroccans in the category of landless or near landless.

Rates of unemployment and the difficulty for individuals in securing more than sporadic employment seem to indicate that the supply of labor is greater than the demand, despite suggestions locally of a 'labor shortage'. It is also true that the cost of living is high in the northeast in comparison with other parts of Morocco, and therefore, represents a threat to potential savings from wage labor (and remittances for those coming from outside the region). But wage increases have, in general, more than kept pace with the rise in the cost of living, as indeed they have with increases in the cost of other farm inputs. As a consequence, although the condition of those without employment is serious, the position of those able to secure employment on a reasonably regular basis has not deteriorated. Indeed it would seem that the increase in the wage rate during the period 1970-1978 more than kept pace with the increasing cost of farm inputs and the rising cost of living. The average wage for a daily

unskilled agricultural laborer in 1970 in the region generally was 5 dirhams; by 1978 this had risen to 13-15 dirhams--an increase of 260%-300%. Between 1971 and 1978 the most popular type of tractor in the region, the Massey Ferguson 165, increased in price (new) from 23,700 dirhams to 52,120 dirhams--an increase of 120%. The cost of living in Oujda (the only center in the region for which this information has been systematically collected) rose from an index of 100 in 1972-3 to around 170 in mid-1978--an increase of 70%. (These figures differ slightly from those reported in chapter three where a different index was used.) Certainly, the rate of increase in prices for certain important foodstuffs was sharper than for many other items (such as clothes), but cereal prices were partly controlled and rose only some 48%. The cost of eating out in restaurants--of crucial importance for those in casual daily wage employment who are generally unable to return home and often require some food at midday or in the evening--rose by approximately 65%, and the price of meat, fresh fruit, fresh vegetables and other vegetables rose by roughly 100%, 80%, 140%, and 120%, respectively. These are urban prices and are probably higher than for the region as a whole. In general, however, wages more than kept pace with other price increases.

The irrigation project has not, however, been able to generate sufficient employment opportunities to absorb the unemployed of the region or, to any significant degree to date, the disguised unemployed in the 'tertiary' sector that is of such importance throughout the region. This is true not only of the direct employment effects of the project, but even of the direct and indirect combined. But with a national population growth rate of about 3% and with about one-half of the population under 15, the

number of new entries to the work force each year is phenomenal. It is unlikely that any agricultural project could absorb the unemployed and the underemployed.

The discussion so far has concentrated on the effects of irrigation on the class of landless and near landless laborers. We should treat this class as distinct from that of agricultural workers in permanent or regular employment who are largely a product of irrigated production. These constitute only a minority within the region, as they do in Morocco as a whole. In the mid-1960s, according to the Avant Projet, only in the Triffa (where irrigated farming had already developed to a significant degree), was there any evidence of a substantial proportion (around 10%) of the rural population in regular employment. The same remains the case a decade later, even after the massive expansion of irrigation as a result of the Lower Moulouya project, although the same percentage involves a much larger number. The Avant Projet suggests that the social and economic condition of this class was relatively good in comparison with that of the temporary or seasonal workers (broadly equivalent to the landless and near landless laborers). It is important, however, to identify two different strata within this category; the highest paid, skilled and semi-skilled workers, usually employed by the larger farmers as tractor drivers, specialists in the cultivation of vines and citrus and other cash crops, who are among the better of sections of the working class within the region, and the relatively low paid 'permanent' workers. The former are generally paid for piece work rather than for a defined period and are much in demand. The long experience of irrigation in the region, particularly in the Triffa has

meant that there exists a body of skills of considerable value for the regional economy (even in the colonial period men from this region were much in demand elsewhere in Morocco as skilled or semi-skilled workers). More important numerically are the low paid workers attached over relatively lenghty periods to particular farms or enterprises and often 'tied' closely to the employer by inter-personal links of various kinds. The majority of these are at the present time employed by the state farms rather than by private enterprise. Technically, they are often temporary workers being hired for the maximum period for which legal employer's obligations can be avoided, dismissed at the end of this period, and then being re-hired for a further limited period. In effect, these workers are more or less permanently attached to a particular farm. In return for this relative security from the difficulties and uncertainties of the open market for labour in the region they accept wages below those available on the open market to temporary or seasonal workers (8-10 dirhams a day instead of 13-15 dirhams). It is significant that, despite these low wages, it is among the workers on state farms that trades union membership is highest. Extremely low among agricultural workers in the region as a whole, union membership is concentrated heavily within the state farm sector. This is the case throughout Morocco as far as can be ascertained. It may well be that permanent workers by virtue of their longer standing attachment to the employer enjoy, here also as in the private sector, what might be termed 'fringe benefits' in addition to cash wages. Here, as in the private sector, such 'benefits' can also be seen as the means whereby wages in cash can be kept low, but it is rare to find workers who see them as such.

A significant proportion of those employed by the state farms as seasonal labor are women, while for certain crops children are also employed, particularly for the harvest. The employment of women is relatively rare among the employers of the private sector, except in citrus packing, and it could be argued that in certain respects the employment of women parallels that of 'permanent' workers, in that wage rates are significantly lower than the going rate for temporary or seasonal (male) labor, payment in kind is often of importance, and the exceptional 'opportunity' for employment provided is considered as sufficient reason to accept low wages. The poor bargaining position of both 'permanent' workers and women in the region is evident. With a very large number of local and immigrant labourers seeking employment at any point in time, there is constant pressure on those in regular or 'sheltered' employment or with exceptional access to jobs (whether permanent or seasonal), to accept lower wages than the rate on the open market. On the whole, however, employers in the private sector appear unwilling to accept the trade-off between a docile and relatively low-paid labour force on the one hand and a low level of productivity and efficiency on the other. It is of importance that, in respect of productivity per hectare and crop yields, the state farms, notably the SOGETA, appear less efficient than the privately owned farms. (This is particularly clear in the case of sugar beet production, for example). For the majority of employers the advantages of employing temporary (but relatively higher paid) labour outweighs the apparent advantages of lower paid (but relatively inefficient) labour. This, despite the constant complaint of farmers in the region that the costs of labor are too high and seriously inhibit their capacity to generate profits.

Whether relatively well paid or relatively poorly paid, however, it can be argued that the expansion of irrigation has made possible the employment of a significantly larger proportion of the local labor force (and of men from outside the region) than would otherwise have been the case. This is undeniable. If the benefits are differentially distributed, discriminating against the low paid, women and those attached in various ways to particular farms, and in favour of those with skills in high demand, men and the better paid, it is nevertheless the case that the level of wages and the number of persons employed in agriculture has increased very dramatically over the last decade with the development of irrigation.

Finally, it must be remembered that an analysis of the effects of irrigation on a particular socio-economic group or class is not precisely the same as an analysis of the effect on particular kinds of households. Many households in the region have both men and women in employment in agriculture during a given year, whether as temporary, permanent or seasonal workers. Consequently, any particular household will be differentially affected, depending upon its particular domestic structure and its involvement in the sale of labour within the region. We will examine specifically the impact of the project on the farm household (as distinct from it simpact as classes and the class structure, in a latter section in this chapter.

Merchants

While there was on the eve of irrigation one large class of landless or near landless laborers in the Northeast, there was not a large class of

Moroccan merchants. Commercial activity was at a relatively low level. On the left bank the towns and villages were small and inhabited by a largely European population. Berkane on the right bank was larger but was basically a French town with a significant Moroccan population. The region produced food for local but not regional Moroccan markets. European merchants handled the export of the product from the colon farms and imported goods were largely for European customers.

Smuggling at both the Spanish and Algerian border did create some opportunities to get involved in trade, but the number involved were small. Itinerent merchants did move small quantities of housewares, tea, sugar, spices, and small amounts of food stuffs on a regular weekly circuit. Each town had its market day. But again, the numbers involved were small and even the aggregate turnover was low.

The coincidential events of independence and the beginnings of irrigation changed the situation dramatically. European and somewhat later, Jewish merchants left creating a vacuum which Moroccans quickly filled. Irrigation as it expanded had the twin effects of producing an even larger amount of product for merchants to buy and a market in the new class of commodity producers who were not nearly as self-sufficient as the pre-irrigation peasant whom they replaced. When labor emigration to Western Europe began, remittances again interjected cash into the local economy which stimulated mercantile activity.

The great climatic and physiographic variation within Morocco allows for considerable staggering of harvest dates for a wide variety of commodities. Northeast is self-sufficient in some products, has a surplus

in others, and must import from other regions still others. The supply of the fruits and vegetables which are the main product for local merchants can be summarized as follows:

a) Potatoes (winter and summer).

These are sold all year round in the region and only in October and November do small consignments from Fez find their way to the Berkane market. They are also exported in small consignments to Casablanca and Tangier. This is a low value-to-bulk crop which tends to discourage large scale regional movements;

b) Capsicums.

The region is self-sufficient in this crop and there is little import or export.

c) Tomatoes.

The region is self-sufficient for up to four months and relies at other times upon imports from the Fez area and west.

d) Table grapes.

The region is strongly surplus and exports throughout Morocco;

e) Apricots

The region produces about a three month supply for local consumption. At other times they are imported from other places in Morocco.

f) Melons and water melons

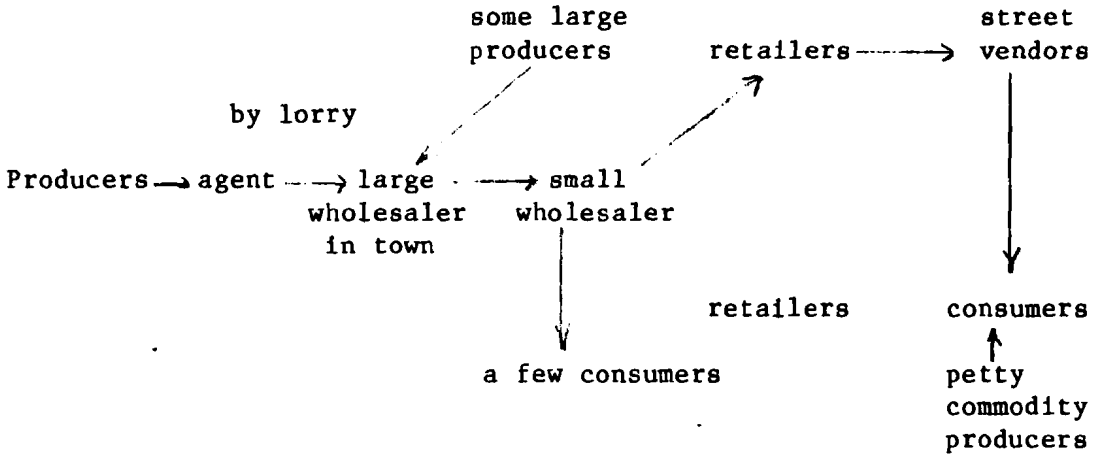
They are produced in the region during July and imported from the southwestern part of Morocco during May and June;

g) Citrus

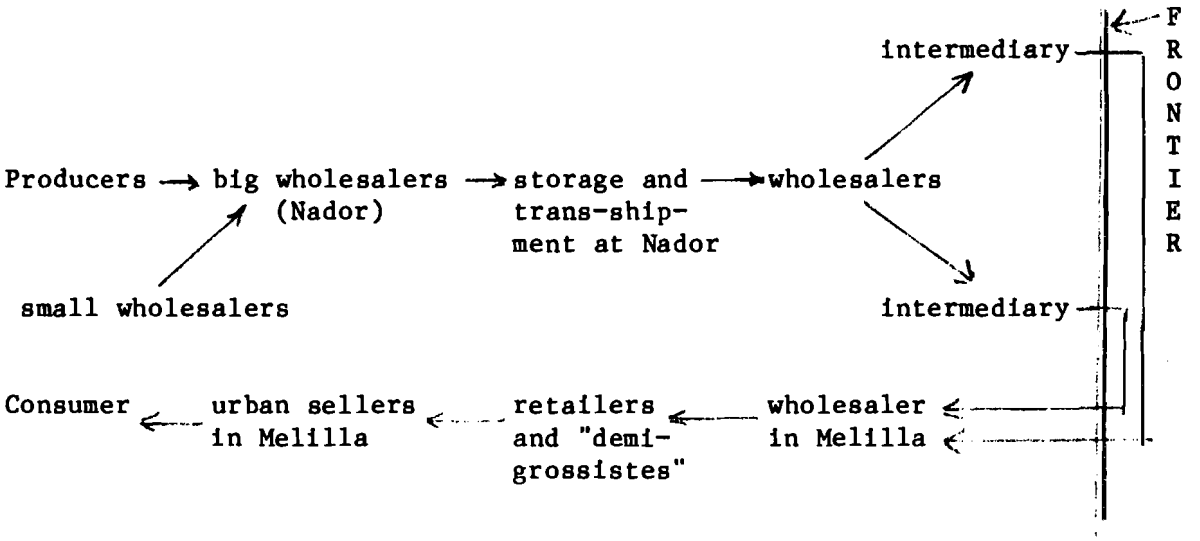
Clementines are grown largely for export; only a small portion of the total product, largely rejects, are marketed locally. The oranges produced locally are also consumed locally.

Merchants often tend to specialize in one or a few related crops and establish links at both the producer and consumer ends of the market.

The marketing network for locally produced and marketed agricultural produce that dominates the area can be pictorially presented as follows:



When the international boundary at Melilla is crossed, a different structure is involved to deal with the formalities of inspections, tariffs, and possible means of avoiding them. That network can be represented as follows:



For a few agricultural commodities--most typically eggs--prices are sometimes lower on the Spanish side of the border and the direction of the flow is reversed.

Merchants can conveniently, if conventionally, be classified as small, medium, and large. There are small merchants at both ends of the marketing chain. A few small operators buy directly from the small producers and sell immediately to small wholesalers, who in turn sell to small retailers in the towns and villages. There are no large retailers of agricultural products in the region. A small store front with a total floor area of sometimes less than 50 square meters with all sales handled by the proprietor or some relative is typical. The supermarket dependent as it is on automobile transit and home refrigeration has not come to the Moulouya basin.

The medium size merchant serves as a small wholesaler. He must have a light truck and some lock-up facilities in town where he can safely store commodities. He (or his agents if he is at the larger end of the continuum)

will purchase vegetables from the producers and either sell them to retailers or to large wholesalers who deal in interregional trade.

Each town and village in the region still has its open market place which daily attracts some sellers of agricultural produce for direct household use and which on one day a week is the site of a major market with itinerent traders dealing in housewares, some clothing, small quantities of jewelry and even a few locally manufactured firearms, joining with an expanded market in agricultural produce. Some producers market their fruit and vegetables directly in these open air markets.

The large merchants are those that deal in inter-regional trade. They must have at least one five ton truck and good storage facilities. There are only a dozen or so of these large merchants dealing in agricultural produce in the region. The biggest can turnover goods worth about 5,000,000 dirhams in a year and may have annual profits of 500,000 dirhams.

With regard to locally produced commodities with which this section predominantly concerns itself, the market is highly competitive. Almost all farmers have a choice of many middlemen to whom they can sell their produce and there is little evidence of attempts at collusion to manipulate prices. A whole group of middlemen (agents, small wholesalers, even street sellers) tour areas, usually in the morning, to purchase fresh vegetables. Other crops, particularly tree crops, but sometimes potatoes and dry beans, are purchased before harvest and a variety of arrangements are agreed upon between farmer and middlemen for the harvest, transportation and payment. Middlemen have certain advantages over the producers - a means of transportation, intimate knowledge of a complex market, greater liquidity and equipment such as scales, bags, boxes, etc. To the extent these

factors are important, traders tend to have some advantages in negotiations over the product, particularly for a parishable crop. But there is little evidence that the marketing structure discriminates against producers in favor of merchants.

It can thus be seen that the impact of the irrigation project on a social structure can be understood only in the context of the effects of other sources of change. Following independence most of the Europeans left the region. As Moroccans moved into the commercial activities they vacated, increased product from the irrigation project created the base for more commercial activity than had existed under the colonial regime. Some of those whose employment opportunities in Algeria were cut off found employment in the increasingly productive Moulouya irrigated agriculture. A few of the landless actually received land under the various reallocations. But the most dramatic change in social structure has been the disappearance of the self-sufficient peasant from irrigated lands and the emergence of the class of commodity producers. The most direct impact of the project has been on these households who actually farm the land within irrigated perimeter. Let us look at their resources, their activities, and their welfare.

The Welfare of the Farm Family

The irrigated region of the lower Moulouya is in the main a land of small, owner occupied farms. On the three plains only 17% of the households in our sample rented some of the land they farmed (only one household rented all the land it farmed). 7% of the households rented

out some of the land they owned to others. For 10-15% of the sample the legal status of ownership was very complex. As a consequence of inheritance and sometimes of various purchase agreements, some land was farmed "in association" with others. Some households must return a share of the profit to these "co-owners"; others receive income from land which they did not farm but over which they held some rights ownership.

There are some significant differences among the plains. Almost one-third (32%) of the farmers on the Bou Areg rent some land, but only 7% on the Sebra and 15% on the Triffa.

The typical farm is small. On the Triffa and Sebra two-thirds of the farmers have access to 5 hectares or less. On the Bou Areg, about one-third of the farms are 5 hectares or less, about one-third between 5 and 15 hectares and about one-third over 15 hectares. There are, however, a few large, privately owned farms. Our sample has one of 395 hectares. This farm with its professional manager and hired laborer makes up just over one-half of one percent of our sample and thus is very atypical. However, the four farmers of over 50 hectares in our sample control more land than the total of the smallest 135 farmers who farm less than 10 hectares (82% of the sample). Thus, while the large private farms are infrequent, they make up a sizeable fraction of the privately owned land within the perimeter.

While the typical farm is small, the typical farm household is large. It can be seen from Table 5.2 that the average household size ranges from 5.8 members among the small farmers on the Bou Areg to 19.2 members among the farmers who attend the 15 hectares on the Triffa. Among the 38 smallest farmers on the Triffa whose farms average 1.30 hectares the

TABLE 5.2

Basic Resource Endorsement, by size of holding.

Size of the Holding (Ha	Distribution of Household %			Average Amount of Land Operated (Ha)			Average Number of Persons Per Household		
	B.A.	Sebra	Triffa	B.A.	Sebra	Triffa	B.A.	Sebra	Triffa
0.25	12.2 (n=5)	6.7 n=2	40 n=38	1.49	1	1.30	5.8	12.5	11.3
>2.5--5.0	22 n=9	60 n=18	27.4 n=26	3.5	3.76	3.58	12.8	8.2	12.2
> 5--10	22 n=9	20 n=6	23.2 n=22	7.46	6.47	7.48	16.8	12.5	11.6
> 10-15	12.2 n=5	6.7 n=2	6.3 n=5	13.8	13	12.76	9	9.5	19.2
> 15-20	14.6 n=6	3.3 n=1	1.9 n=1	17.17	15.24	16	10.8	8	15
> 20-50	12.2 n=5	3.3 n=1	1.1 n=1	32.77	30	27	9.8	8	20
> 50-100	4.9 n=2	0 n=0	1.1 n=1	84	--	100	13.5	--	14
> 100	0 n=0	0 n=0	1.1 n=1	0	--	395	--	--	12
Total	100	100	100	14.85	5.99	9.54	11.8	9.4	12.2

n = Number of farmers in the category

average household has 11.3 members. For many farm households in the region, there are many mouths to feed for each hectare of land farmed.

In addition to the availability of productive land, access to means of transportation and traction are important for successful farming. Table 5.3 displays ownership of donkeys, mules, horses and tractors on each of the plains by three size categories. Donkeys predominate on the smallest farms while horses and mules are more prevalent of farms in the largest category. On the Sebra, which is the poorest of the three plains, the percentage of farmers using donkeys is higher than for the other plains. Half of even the largest farmers in that area use donkeys.

Ownership of tractors has become significant in the region. Over half of the farmers with over 10 hectares on the Triffa own them. On that plain even some of the medium and small farmers have tractors. The fewest number of farmers own tractors on the Sebra. On the Bou Areg 21.4% of farmers in even the smallest land category own tractors--a higher percent than for all categories on the Sebra and for all but the large farmers on the Triffa.

Two points should be brought out to aid in the interpretation of these figures on tractor ownership. First, tractors are labor substitute technology that add little or nothing to the productivity of the land. With a household averaging more than 10 members it is unlikely to make much sense for small farmers to own tractors. However, on the smallest farms on the Bou Areg the average household has only 5 people and the head of the household often has significant off-farm employment. Under these conditions it could be advantageous for a small farmer to own a tractor.

TABLE 5.3

Means of Traction and Transportation (animal and mechanical in % of farmers)

Size of Holding (Ha)	DONKEYS			MULES			HORSES			TRACTORS		
	B.A.	SEBRA	TRIFFA	B.A.	SEBRA	TRIFFA	B.A.	SEBRA	TRIFFA	B.A.	SEBRA	TRIFFA
0 - 5	35.7	55	40.6	14.3	10	12.5	--	10	2.6	21.4	--	4.7
> 5 - 10	11.1	66.67	45.45	22.2	—	13.6	33.3	16.67	--	—	16.66	18.2
> 10	5.5	50	22.2	66.6	20	33.3	27.8	—	22.2	44.0	—	55.6

Second, tractors are readily accessible for rent. It is very common for a farmer to hire someone with a tractor for jobs requiring heavy traction such as plowing.

Knowledge (or information) is another important resource for farmers. This is particularly true when new resources and new technologies become available. We have no direct measure of the knowledge farmers have about managing a farm and will use years of formal schooling as an imperfect proxy. Table 5.4 shows a strong positive correlation between years of schooling and size of holding. The larger the farm, the more years of schooling the head of household has. The table also shows that farmers on the Bou Areg have significantly more schooling (2.03 years) than their counterparts on the Triffa (1.36 years) and the Sebra (.27 years). Table 5.5 shows that while 60% or more of the farmers had no formal schooling, a small number on the Bou Areg and Triffa have had over seven years. (7.5% and 6.3% respectively).

Data on years of schooling can be more fully appreciated when looked at in relationship to the average age of the head of household (Table 5.6) The mean age is 48.6 and there is little variation. Thus the average farmer was born in 1930 and was of school age during the late 1930s and early 1940s. The Spanish and French colonial powers were not providing many resources for education in the colonial hinderland during those difficult years. It is interesting to point out that the highest average age is on the Sebra, where the educational level is lowest, and lowest on the Bou Areg where the educational level is the highest.

TABLE 5.4

LEVEL OF EDUCATION OF THE HEAD OF HOUSEHOLD

(Average years of schooling)

STRATA (ha)	Bou Areg	Sebra	Triffa	Total
0-5	1.07	.2	1.2	.97
> 5-15	1.7	.5	1.6	1.42
> 15-50	2.3	--	1.0	1.78
> 50	9.5	--	3.5	6.5
TOTAL	2.03	.27	1.36	

TABLE 5.5

(Percent of Household)

	Zero Education	1-6 years of schooling	7-13 years of schooling	College
Bou Areg	60%	23.5%	7.5%	0%
Sebra	73.3%	26.7%	0%	0%
Triffa	63%	30.5%	6.3%	0%
Dry Land	78%	21%	0%	0%

TABLE 5.6

AGE OF THE HEAD OF THE HOUSEHOLD (in years)

Strata	Bou Areg	Sebra	Triffa	Total
0-5 ha	50	53.5	46.7	48.6
>5-15 ha	45.4	47.0	52.4	49.5
>15-50 ha	44.5	55.0	40.0	45.3
>50 ha	43.0	--	55.0	49.0
TOTAL	46.7	51.9	48.4	48.6

Sources of Income

There are a number of sources of household income besides crop sales. The relevant data by size category for each plain are presented on Tables 5.7, 5.8, and 5.9.

On all three plains the majority of household income comes from farming (Bou Areg 63.6%, Zebra 70%, Triffa 75.9%). These aggregate figures, however, conceal some very interesting differences. On the Triffa over 75% of the total income came from farming for households on all size categories, and virtually all of that came from crop production on irrigated land.

On the Bou Areg, by contract, the small farmer (5 hectares or less) got only 24.5% of household income from farming. 60% came from commerce and 12.2% from non-agricultural labor. It was pointed out in Chapter 2 that

TABLE 5.7

BOU AREG

Sources of Household income. Composition of gross income by size of holding.

Size of land holding (ha)	Agricul. productn. (irrigated)	Agricul. productn. (dry)	Animal production	Subtotal All farm activity & rent	Wage Labour		Commerce	Remittances	Artisanal production
					Ag.	Non ag.			
0 - 5 n=14	23.0%	0.0%	1.4%	24.5%	0.4%	12.2%	60.0%	2.6%	0.3%
> 5 - 15 n=14	76.3%	0.6%	6.3%	83.2%	3.9%	4.4%	7.1%	1.3%	0.0%
> 15 - 50 n=11	42.5%	0.0%	21.5%	64.3%	0.5%	0.0%	29.3%	5.9%	0.0%
> 50 n=2	97.2%	0.0%	0.0%	97.2%	0.0%	0.0%	2.8%	0.0%	0.0%
TOTAL	51.6%	0.1%	11.4%	63.3%	1.1%	3.6%	28.4%	3.6%	0.07%
Total as proportion of Ag. income	81.5%	0.2%	18.1%	100%					

TABLE 5.8

TRIFFA

Sources of Household Income. Composition of Gross Income by Size of Holding.

Size of land holding (ha)	Agricul. productn. (irrigated)	Agricul. productn. (dry)	Animal production	Subtotal All farm activity & rent	Wage Labour		Commerce	Remittances	Artisanal production
					Ag.	Non ag.			
0 - 5 n=64	70.5%	1.6%	3.8%	76.2%	7.4%	8.9%	3.1%	3.6%	0.8%
> 5 - 15 n=27	67.8%	0.5%	7.0%	75.3%	0.7%	2.5%	17.3%	4.2%	0.0%
> 15 - 50 n=2	74.8%	0.0%	3.8%	78.6%	0.0%	0.0%	21.4%	0.0%	0.0%
> 50 n=2	(100%)	(.0.%)	(0.0%)	(100%)	(0.0%)	(0.0%)	(0.0%)	(0.0%)	(0.0%)
TOTAL n=95	69.5%	1.0%	5.4%	75.9%	3.3%	4.8%	12.1%	3.6%	0.3%
TOTAL AS PROPORTION OF AG. INCOME	91.5%	1.1%	7.2%	100%					

( ) = In our sample there is only one farmer who did not want to mention his other income therefore one should be careful in drawing any inference about the population based on this information.

TABLE 5.9

SEBRA

Sources of Household Income. Composition of Gross Income by Size of Holding.

Size of land holding (ha)	Agricul. productn. (irrigated)	Agricul. productn. (dry)	Animal production	Subtotal All farm activity & rent	Wage Labour		Commerce	Remittances	Artisanal production
					Ag.	Non ag.			
0 - 5 n=20	54.7%	3.1%	14.1%	71.9%	0.0%	9.2%	0.0%	18.8%	0.0%
> 5 - 15 n=8	57.1%	0.0%	2.3%	59.4%	0.0%	16.0%	6.0%	18.6%	0.0%
> 15 - 50 n=2	89.7%	0.0%	0.0%	89.7%	0.0%	0.0%	10.3%	0.0%	0.0%
> 50 n=0	—	—	—	—	—	—	—	—	—
TOTAL n=30	60.9%	1.6%	8.1%	70.7%	0.0%	9.9%	3.5%	15.9%	0.0%
TOTAL AS PROPORTION OF AG. INCOME	86.2%	2.3%	11.5%	100%					

these are the farmers who grow few vegetables and much cereal, of which very little is marketed. They also have the smallest household size, and a high percentage--over one-fifth--own tractors. This group stands in striking contrast to the other farmers in the region. Indeed it is more realistic to call them merchants who have a small plot of land which serves as a hedge against inflation, as a possible source of capital gain as land values near Nador soar, and as a place to raise some food for household consumption.

On all the plains and for all size categories, however, off-farm work (including commercial activity) is an important source of income. It accounts for 16% of income on the Triffa and almost 10% on the Sebra. Non-agricultural employment is more important than agricultural. Given the large number of people from the area who are on contract labor in Europe, it is interesting that remittances are not more significant. Only on the Sebra where they account for over 18% of total income for all farmers with 15 hectares or less are they important. On both the Triffa and the Bou Areg they account for only 3.6% of total income for all farmers.

These tables and sources of income also show an interesting breakdown of agricultural income. Over 80% of farm income comes from production on irrigated land on all three plains. Income from dry land farming is inconsequential. Income from animal production is highest on the Bou Areg where it accounts for about one-third of the income from farm sources for those with 15-50 hectares. On the Sebra it is the smallest farmers who rely most heavily on animals for income.

Changes in Land Holdings

With the majority of household income coming from farming and with the amount of irrigated land a significant determinate of income from farming, it would be interesting to identify trends in the pattern of farming.

Very little reliable data exist on the distribution of land holdings through time except a broad indication of the number of farms by size category. Taking data from earlier studies and comparing them with our present sample (see Table 5.10 for global statistics and Table 5.11 by individual plain), it can be seen that there is a steady decline in the number of farmers owning under 5 hectares except in the case of the Sebra which included the creation of a number of lotissments, discussed earlier in this chapter. The issue of illegal transfers of land and subsequent false reportage of landholdings is certainly a difficult one. However, without any evidence that illegal transfers involved a very different type of transaction with regard to the characteristics of buyer and seller of land, it can only be assumed that these transfers followed the general trend of legal transfers - a trend which has tended with the exceptions of the lotissments, to reduce the number of very small and very large farmers.

From the sample survey it is possible to obtain some idea of the changing significance of land transfers over time, but not possible to determine whether these transactions were leading to greater concentration of land holdings or to greater fragmentation. (See Table 5.12)

TABLE 5.10

CHANGES IN FORM SIZE

	1964	1972	1978 sample data
Less than 5 ha.	75%	70%	66%
5 - 20 ha.	23%	23%	28%
20 - 50 ha.	2%	4%	2%
More than 50 ha.	1%	3%	2%

The bulk of land transactions within the perimeter, according to the survey were in the period 1969 to 1974; with the biggest year being 1970, when a total of 405.50 hectares were transferred in the Triffa. No land was transferred in the Sebra and only 3.5 hectares in the Bou Areg in that year in the sample; but it must be recognized that a couple large land transfers could account for the Triffa figure. If land transfers occur infrequently, but when they do occur involves large amounts, our sampling would lead to an underestimate of land transfers.

In reply to the question, "How did you finance your purchase of land?" put to farmers who had bought land in the past, the vast majority merely replied that they had done it out of 'personal savings' (49 out of 77 = 64%), but an important minority borrowed money (21%), with 8% taking loans from the Credit Agricole, a bank or ORMVAM.

We can thus see that there is a market for land in the area, that voluntary purchases and sales are tending to reduce to number of very small and very large farms, and the little credit is used for buying land. If these trends continue the owner-operated unit will likely become even more dominant in the region than it presently is.

TABLE 5.11

Changes in Land-Holding Categories by Plain

	1964			1972			1978[1]		
	Triffa	Sebra	Bou Areg	Triffa	Sebra	Bou Areg	Triffa	Sebra	Bou Areg
Less than 5 ha.	67%	12%	84%	52%	45%	76%	NA	56%	75%
5 - 20 ha.	31%	59%	13%	30%	47%	22%	NA	39%	22%
20 - 50 ha.	1%	18%	2%	11%	5%	2%	NA	3%	2%
More than 50 ha.	2%	11%	1%	7%	3%	5%	NA	1%	5%

1978[1] ORMVAM Census records.

1978[2] Our sample data.

TABLE 5.12

Amount of Land Transferred (hectares)

Total perimetre	Bou Areg	Sebra	Triffa	year/period
4.70	-	-	4.70	pre 1951
127.06	50.90	8.33	67.83	1952-1962
87.75	30.30	26.00	31.45	1963-1968
506.26	54.50	26.50	425.26	1969-1974
38.00	36.00	2.00	-	1975-1978
	171.70	62.83	529.24	

Summary and Conclusions

At the beginning of the twentieth century the lower Moulouya region was a land of independent peasants and transhumant herders who had few needs that could not be satisfied from their labor on the soil. Population growth and the colonial intrusions stimulated changes in that traditional social organization. A large class of landless peasants developed whose major employment opportunities were in Algeria, on colon farms, or in the employ of the colonial power.

After independence things looked bleak in the Northeast as the Algerian border was closed and economic activity declined immediately following the departure of Europeans. With the development of the irrigation project tens of thousands additional households could be settled on the more productive land. The new small farmer, however, was not the old self-sufficient peasant; he was a commodity producer who grew a cash crop for the market and purchased many household needs. Additional employment opportunities were created for the landless laborers on the more productive land. Rising agricultural production and the increasing demand both for its product and for inputs for production gave rise to new commercial activities.

This does not mean that the region is a paradise. Many farms are too small to provide the large households with adequate support: many landless laborers still live a precarious existence. But real wages have increased. The region is much better off then it would have been in the absence of the project. While some have benefited more than others, we found no real losers from the project.

Chapter Six

Summary, Conclusions, Recommendations

The lower Moulouya Basin lies in the extreme northeast corner of Morocco. There are four plains in the basin that are irrigated with water from the Moulouya River, the Triffa, the Zebra, the Bou Areg and the Gareb (the Gareb is not covered by this analysis).

Irrigation began on the southern part of the Triffa plain in 1956 following the completion of a small diversion dam. A $23,000,000 loan from the United States in 1960 facilitated the completion of the main storage dam and additional canals. By the end of the 1960's the northern Triffa was under irrigation, water flowed to the Sebra and Bou Areg plains in 1970 and to the high Triffa in 1978 and 1979.

Background Information

Average annual rainfall in the region varies from less than 250 mm. to about 400 mm. It is highly variable both within the region and over the years. Historically, there have been two or three years of severe drought every decade resulting in crop failures and a reduction of livestock.

Soil conditions vary from near excellent on parts of the northern Triffa plain to rocky, inferior soils on the Sebra. The Bou Areg lies right on the edge of the Mediterranian. It has little elevation or relief and drainage can be a problem.

While settled agriculture is very old in the hills bordering on the plains, and was practiced in the northern Triffa and the Bou Areg from at least the 19th Century, the southern Triffa was used largely as grazing

land. The Sebra was inhabited by transhumant pastoralists and not cultivated to any significant extent until the advent of irrigation.

Modern irrigated agriculture began under the French colons in the 1930's. Six to eight thousand hectares on the right bank had been under irrigation for about twenty years by the time the water from the Moulouya was used on a significant scale. There is evidence, however, the ground water resources were being over-exploited.

The natural population growth is high - about 3% per year - and historical evidence suggests that the population has been growing rapidly since the end of the nineteenth century.

In 1956, when Morocco regained its independence, things looked bleek in the northeast. In response to a half century of population pressure, more and more marginal land had been brought under cultivation leaving agriculture precariously dependent on the weather. Employment in Algeria and with the colonial powers which had provided tens of thousands of men with a means of livelihood, was cut off. No alternative seemed readily available.

On the left bank of the Moulouya - the former Spanish zone - conditions were particularly discouraging. The Spanish had left little mark on the countryside. Few roads, little modern agriculture, and almost no social infrastructure (schools, hospitals, etc.) existed in 1956. On the right bank, French colons had developed a thriving irrigated agriculture on the northern Triffa, built a good road network, and established viable urban settlements. But the ex-colonial economic base was not large enough to provide support for the burgeoning population. There was considerable social and political unrest.

Two developments saved the region from either massive immigration to other parts of Morocco or a general poverty accentuated by periodic droughts and resulting famines. One was the Moulouya irrigation project; the other, the opening of contract labor opportunities in Western Europe, which attracted tens of thousands of men from the Northeast.

In this study the analysis of the impact of the irrigation project was focused on three major topics: (1) changes in production and productivity, (2) a benefit-cost analysis, (3) the more general socio-economic impact.

Changes in Production and Productivity

The irrigation project transformed the region from one largely devoted to cereals and pasture into a region in which citrus, market vegetables, and sugar beets predominate. Little citrus is grown on the left bank and few sugar beets on the right bank. Cereals remain a significant crop, but one grown largely by the smallest farmers who generally use them for home consumption. A significant dairy herd has arisen where none existed before. The numbers of sheep and goats, the traditional livestock in the region, remains at or above pre-irrigation levels.

Productivity has increased greatly. Yields in quantative terms have increased from one and one half to five-fold. More meaningfully, the net return per hectare in value terms has increased nine to thirteen times in current dirham or four to six times in constant dirham. There is great variation in the yields of all crops. Some of this variation is accounted for by the fact that a number of farmers are not irrigating their land.

There are, however, other factors operating which we cannot identify. There is no systematic relationship between size of holding and output per hectare.

Benefit-Cost Analysis

The benefit-cost analysis included only those variables that were readily quantifiable. When data were ambiguous or of questionable accuracy, conservative interpretations of benefits were made. The analysis does not include the benefits or costs of electricity generation or of the extention of the project to the Gareb plain.

If net present value is defined as the summation of incremental returns to farm managers, agricultural labor, and land owners, the benefit-cost ratio is 1.25 and the internal rate of return 10.5%. A breakdown of the benefits of the project indicate that almost two-fifths goes to farm managers, over one-third to farm laborers, and one-fourth to land-owners.

A sensitivity analysis indicates that the cost-benefit analysis is robust. It will stand aggregate data estimation errors of a 20% over-estimation of benefits or a 20% underestimate of cost without having the internal rate of return fall below 8%. If the opposite error is made, an underestimate of benefits by 20% or an overestimate of cost by the same amount, the internal rate of return would be close to 14%. The benefit cost ratio and the internal rate of return fall only sightly if the useful life of the project is reduced by 25%.

An internal rate of return of 10.5% in real terms for every year over the 56 year life of the project should be interpreted as a success. It is

unlikely that the returns on the average investment either public or private would be any higher. There is, however, another criterion of success that can be employed. Is the project yielding the payoff that was anticipated by planners and used as a justification at the beginning of the project. The benefit-cost analysis done by Hydrotechnic based on data collected in the early 1960's estimated a benefit-cost ratio of 1.68 assuming a discount rate of 4.5%. Our analysis would yield a benefit-cost ratio of 1.68 assuming a discount rate of 5%. However critical one might wish to be about the returns to the project, one must concede that they are about what was predicted before anything but the southern Triffa was actually being irrigated.

By normal standards of economic efficiency, the lower Moulouya irrigation project is a success. There are, however, other standards by which a major public investment should be judged.

Socio-Economic Impact

There are two broader types of effects of the project for which quantifiable estimates can be made and thus given an interpretation in relationship to the benefit-cost analysis. One of these is the welfare effects of the lower price of food in the region. Assuming that the population in the region would be about the same without the project, the increased supply of food, because of the project, would lower its price to consumers. Estimating these welfare benefits with reasonable but conservative assumptions and feeding the results into the benefit-cost analysis yields a benefit-cost ratio of 1.31 and an internal rate of return

of 11.10%. About 5% of the total net benefits in the project would under these assumptions accrue to consumers. Because food purchases make up a higher percentage of the budget of lower income families, this consumer benefit falls more heavily on the poorer sections of the community.

Another secondary but important beneficial effect of the project has been to stimulate the development of agricultural processing firms. There are about 25 in the region that employ 50 or more workers at peak production periods and an equal number of smaller ones. In total almost 10,000 workers are employed, including many women and children. Over two-thirds of these workers are seasonal.

There has also been a more profound impact of the project on the social structure of the region. For centuries the rural sections of northeast Morocco have been the home of self-sufficient peasants or transhumant herders, producing largely for household consumption. High rates of population growth from the end of the 19th century contributed to a rise of a landless labor class. The colonial intrusions, particularly the French, introduced capitalist farming and a significant amount of merchantile activity into the region.

The self-sufficient peasant has virtually disappeared from the irrigated perimeter. He has been transformed into a commodity producer who produces a limited range of crops for a market and purchases most household requirements. The increased labor intensity of farming under irrigated conditions has provided more employment for agricultural labor and the land reform program, which has been going on since the beginning of the project, provides land for about 1,000 families, which assuming a household size of 7 to 10, directly affects 7,000 to 10,000 people.

The great increase in marketable agricultural produce from the irrigated perimeter combined with the departure of European merchants in the 1950's created many opportunities for Moroccans to move into mercantile activities. There is now an active merchant class in the region.

A very few Moroccans got control of former colon estates and continue the tradition of capitalist farming in the region. Other ex-colonial land is now controlled by state farms. The vast majority of farmers on the irrigated land, however, own their own small farms (less than 5 hectares), employ largely household labor, and produce a cash crop for the market. While the majority of household income comes from farming, a significant share comes from off-farm labor or commercial activity.

The small farmers on the Bou Areg constitute a significant exception to this generalization. The largest part of their household income comes from commercial activity and they use their irrigated land largely for cereal production for household consumption. While the total amount of land involved is small, these farmers are not using the irrigated land at anything near its potential.

Summary Assessment

To summarize our assessment of the impact of the project requires some hypothetical reconstruction of what would have happened in the region in its absence. Except for 6,000-8,000 hectares in the northern Triffa which probably would have remained under pump irrigation, the land in the region would have been devoted to dry land farming and grazing. Assuming that an

hold, about 800 to 900 families could presently be on the land that is now irrigated, excluding the Northern Triffa. Assuming ten people per household, this would mean 8,000-9,000 would be supported on approximately 45,000 hectares, now irrigated by water from the Moulouya and which would not in its absence be irrigated with ground water. As the relatively self-sufficient peasant household producing largely for home consumption is the norm today in the dry lands around the irrigation perimeter it is safe to assume that if dry land farming continued today on the plains, the peasants would have produced largely for home consumption.

On the privately owned irrigated land, there are now about 7,500 households. Again, assuming about 10 members of each household, there are about 75,000 people supported on the irrigated land. (Note that we are excluding the land held by the state farms in this analysis). Assuming that about 1,500 households would be on land irrigated by ground water this would leave 6,000 households and 60,000 people on land that would support only about 8,000 to 9,000 under dry land conditions. Thus there are about 50,000 more people directly supported by agricultural production than would have been the case in the absence of irrigation. Average income is roughly the same as it would have been in dry land farms of 50 hectares. Since off-farm employment by members of peasant households was significant even before irrigation, we assume that off-farm income would have been roughly the same percentage of household income for dry-land farmers as it presently is for farmers on the irrigated land.

There are thus a large number of people directly dependent on farm ownership and management that are significantly better off now than they

would have been had there been no project. But there are others that benefit from the project also. Under the dry land agriculture that probably would have prevailed in the absence of the project, there would have been little employment for agricultural labor. Further, the major agricultural processing industries like the sugar plant and the dairy operation would not be there. Citrus packing would be at a much lower level. Wineries, however, would probably have employed more.

Assuming that the population would have been about the same size in the absence of the project, food would have been more expensive and probably of lower quality. The combination of potatoes, dried beans, fresh fruits and vegetables and milk, presently produced in the region, make up a potentially good diet. As the sheep and goat population - the major source of animal protein - has not declined, that part of the diet probably has remained about the same.

This scenario is based on two assumptions that should be examined. One is that the population in the region would have been about the same had there been no project. As the natural rate of population growth has been high for generations, we see no reason to believe that it would have declined in the absence of the project. Some people have moved into the area from other parts of Morocco who probably would not have come had there been no project. Others probably would have left because of the absence of local employment opportunities. How many we do not know or care to risk an estimate. But being unemployed in a Bidonville outside a major Moroccan city has little attraction compared with being unemployed in the Moulouya Basin.

It is difficult to say how the large scale emigration to Western Europe would have affected local population size in the absence of an irrigation project. On the one hand, the remittances have contributed to relatively well off economic circumstances of the region. Families supported by emigrant workers probably have the financial resources to move if they so desired. On the other hand, it would seem unlikely that dependents would wish to move to another part of Morocco and leave friends and family while a major bread winner is off for extended periods.

The second assumption is that there would have been little improvement in the productivity of dry-land agriculture in the absence of an irrigation project. One might argue that at least some of the resources which have gone into the irrigation project would have gone into the improvement of dry land agriculture. In our opinion, it is unlikely that there could have been much improvement and totally unreasonable to expect that the returns on such an investment would be equal to the returns from the investment in irrigation. The minimum average rainfall in the region could with appropriate farming practices maintain a reasonable dry land agriculture, if there were little annual variation and if the rainfall came in the right months of the year. However, there is considerable annual variation. The absence of rainfall at the right time leads to complete crop failure two or three years in every decade. There is little that can be done to improve dry land agriculture in those years when virtually no rain falls. We thus think it is unlikely that there could have been any significant improvement in dry land agriculture particularly on the Zebra and southern Triffa plains.

The region as a whole is considerably better off than it would have been in the absence of the project. Furthermore, there are no discernable loosers from the project in the region. Land owners within the irrigated perimeter are obviously better off, and those who farm on the periphery have not been hurt. Farm laborers have more employment opportunities and higher wages. New jobs are available in agricultural processing industries. Consumers have benefited from the lower price of food.

We conclude that in both economic and social terms, the lower Moulouya irrigation project has significantly benefited the region. Only one question remains. The project was supported by public funds. While the Morrocan taxpayer footed the bill, the beneficiaries have largely been private individuals, households and firms in the region. We are in no position to provide any answers to the question of whether this has been a justifiable transfer. That would involve an analysis of public policy in Morocco that would go far beyond this study. Anyone who wishes to speculate about an answer should keep two facts in mind. First, to the degree that the economic activity in Morocco is taxed, the region has returned more to the public coffers than it would have in the absence of the project. Second, the Moulouya irrigation project is only one of a number of publicly financed irrigation projects in Morocco which in turn are only part of the total package of public works financed from tax revenues. While many in the Northeast have benefited from public funds that came in part from tax-payers from other parts of Morocco, many in other parts of Morocco have benefited from public works that were supported in part by revenues collected in the northeast.

It is on the success of the project that we wish to focus, and it is too the reasons this success that we now turn our attention.

THE REASONS FOR THE PROJECT'S SUCCESS

We have identified four major reasons for the success of the project.

1) The potential gains in efficiency in agricultural production in the region were enormous. Before irrigation over half the land in the presently irrigated sectors was either in cereals or used for grazing. Cereal production was a high-risk undertaking. Long term averages suggests that a total crop failure occurs about one year in four and a good crop is harvested about one year in four. Two years out of four farmers do slightly better than get their seed back. In years of light rainfall, the animal herds must also be cut back significantly. The best reconstruction of preirrigation agriculture in the region outside of the Northern Triffa indicate that gross revenues barely exceeded the cost of production.

The coming of large scale irrigation made it possible to switch to more productive crops and to more efficient animal husbandry. With the threat of drought removed from the irrigated lands, output per hectare could potentially be increased, not just marginally, but by many times.

The natural conditions in the region clearly created the potential for a successful project. Other factors, however, had to be in operation for this potential to be actualized.

2) By the time the waters of the Moulouya were harnessed for large scale irrigation, the farmers--largely French--in the Northern Triffa had had twenty years of experience with relatively large scale irrigation in the region. Most of the farm labor, of course, was Moroccan. Furthermore, Moroccan farmers in the hills around the plains had practiced irrigation for a century or more. Thus there existed in the region by 1956, a reservoir of agricultural laborers who were experienced in irrigated agriculture with many of the crops, most notably citrus and market vegetables that were significant throughout the region after 1956. Thus, the techniques of irrigated production were known to a large number of those who farmed the irrigated land. As the land under irrigation expanded in the 1960's and 1970's, it was relatively easy to increase the skilled and semi-skilled work force.

In other words, this project did not suffer from low output during the first five or ten years while farmers were learning a new set of skills.

3) The project appears to have been well managed. It is difficult to come up with hard evidence in support of this point. The most conclusive is the impressive record of keeping construction very close to plans over a long time period. In the early 1960's, general plans were presented for a construction program that would lead to the completion of the project (including the Gareb plain) by 1978. In fact, the project should be essentially completed as planned in 1980 or 1981. Even the projected year to year capital expenditures and construction were rarely more than two years behind schedule. When the normal problems and uncertainties of any large scale hydrolic construction are complicated by the uncertainties of

international financing, it is a tribute to the managerial skill that the project is only two years behind a schedule devised over 15 years ago. Had the capital expenditures been made when they were but completion delayed for five years (i.e., with irrigation beginning on the Sebra and Bou Areg in 1975 and on the high Triffa in 1983) the conclusions of our benefit-cost analysis would have been different.

In addition to the national potential of the region, available human resources made a major contribution. These resources include the reservoir of farmers skilled in agricultural production and the managerial skills which kept the construction of the project on a resonable time table.

4) But even the presence of the physical and human resources required for efficient agricultural production does not guarantee success. There must be a demand for the product and the infra-structure of marketing available to satisfy the demand. This translates into market access for farmers which, on one hand, provides monetary incentives for product sales and, on the other hand, provides access to purchased inputs so necessary for increasing productivity (biological, chemical, and mechanical technology). The remittances from the workers in western Europe helped maintain irrelatively high purchasing power in the region. The proximity of the urban centers of Oujda and Melilla both accessible because of the good road network helped maintain a high demand for the produce from the irrigated area.

The marketing structures in the region are reasonably efficient and move the product from the producers to the consumers without a great deal of waste and spoilage. The contacts in Western Europe which date from the

colonial period were expanded through government marketing institutions and a significant amount of the clementines produced in the area move efficiently into Western European markets.

RECOMMENDATIONS

The project is a success. One of the reasons is that it is reasonably well managed. This is not to say, of course, that it could not be equally well managed with fewer civil servants and other resources. But, it is to say that ORMVAM has done most things right as far as economic productivity is concerned. It is probably aware of some of the areas where improvement is needed. Thus these recommendations should not come as any surprise.

One of the striking findings from our survey is the great variation in yields among farmers producing the same crop. Some of this is accounted for by differences in soil quality that can only partially be overcome by improved farming techniques. In other cases, the proper policies and actions should contribute to increasing the productivity of the less productive farmers, and thus increase total output of irrigated agriculture.

Recommendation One. A small number of farmers are not irrigating their land because of problems of design, engineering and maintenance prevent them from getting water. ORMVAM should carefully examine the reasons why farmers cannot get water, and where economically justified modifications can be made they should be undertaken. Technical engineering matters were outside the scope of this study, thus we have no specific recommendations to make in this regard.

Recommendation Two. A number of farmers are not irrigating their land because of the lack of money. Some claim they cannot afford the capital improvements necessary to fully exploit the potential of irrigated production. Others feel they cannot pay for the more expensive inputs--improved seeds, fertilizers, pesticides and hired labor required. The evidence we have clearly indicates that the marginal productivity for many farmers is rising, and that money should be borrowed, if necessary, to meet necessary capital and operating costs. Evidence from our survey indicates that farmers are very reluctant to go in debt to meet either investment or operating costs. Even land purchases are financed heavily from personal savings rather than from borrowing.

Because of the failure of the farmer to use credit, they are foregoing some investments and avoiding certain desirable operating expenditures until they have accumulated sufficient cash reserves. This suggests weaknesses in the credit institutions in the region. Personal savings of farmers are accumulating, remittances are flowing into local banks. The banks, however, are apparently not lending in sufficient quantity to farmers. An analysis of the bank credit institutions and their lending policies was not a part of this study. However, some suggestions can be made.

One of the reasons why some farmers borrow too little is that they pursue strongly risk adverse strategies. Given the history of agriculture in the region, this is very understandable. The extension services, however, should place a greater emphasis on teaching farmers the advantage of borrowing to secure the inputs required for more productive farming.

A willingness to borrow is not sufficient. There also must be a source of reasonable credit. There has been a dramatic increase in the number of commercial banks in the region in the past 15 years. Their loan policies, however, do not appear to meet the needs of the thousands of small farmers in the region. This may be understandable. Small loans cost about as much to process and service as large loans. Commercial banks are less willing to make these more expensive loans. Effort should be made to make credit available to small farmers on a reasonable basis. As we did not study credit institutions in detail we have no specific recommendations to make. We urge ORMVAM to look into the credit problem and to take steps to initiate an appropriate program.

Recommendation Three. Some of the low yields show up on farms where a significant proportion of the land is devoted to cereal production for home consumption--an inefficient use of the irrigated land. This is a particular problem among the small farmers on the Bou Areg plain who receive most of their income from commercial activity. While their under-utilization of the land may be rational from the point of view of some personal calculus, the social benefits of the project would be increased if the land were more fully exploited. We do not recommend any draconian measures such as confiscation, forced sale of the land, or even administrative orders directing changes in cropping patterns to deal with the problem. Rather, we recommend policies that would change the personal calculus of the farmers. If, for example, the cost of holding land were increased (e.g. through a land tax) the farmers would find it in their self-interest to farm it more productively or sell it to someone who would. Managers at ORMVAM should become more aware of the reasons for the decision farmers are

making that lead to under-utilization and introduce appropriate policies to modify the incentives that lead to that behavior.

Recommendation Four. There is a relationship among the age of farmers, their educational level and their productive efficiency. If certain adjustments are made to exclude farmers who have significant off farm income, older farmers with less education are less productive. As the average age of the farmer is rather high (almost 50 years) one can expect some changes in the coming decade. Extension activities to improve farmers' skills (including not only just farming skills, but also such things as effective use of credit) should concentrate on younger farmers and on those who are likely in the next few years to take over the management of farms.

Recommendation Five. ORMVAM is pricing water at far below its opportunity costs. Farmers are thus receiving a subsidy not only from the initial capital outlays, but also in their operating costs. ORMVAM should consider increasing its charge for water with the aim over a long period of time of pricing it at its marginal cost. If the price of water were raised, production patterns should change with the economic efficiency of the project improving. Changes in water prices, however, must proceed slowly and be coordinated with improvement in credit institutions and the willingness of farmers to borrow. If increased water charges and improved credit facilities are not coordinated, the increased charges might drive the farmers into cutting use too much and moving to less efficient production of traditional crops such as cereals. But until producers are forced to buy water at its opportunity costs, the project will be economically sub-optimal. For example, citrus requires fairly large volumes of water. The underpricing of water induces farmers to allocate

more land to citrus production than would be the case if water were priced at its true marginal cost.

Recommendation Six. As income and urban population in the region continue to increase the demand for the more preferred foods, namely meat, will surely increase. Currently, farmers in the perimeter have developed arrangements with farmers outside the perimeter for livestock production. Feed is grown in the perimeter while livestock are often kept in herds outside the perimeter for livestock production. With the demand for livestock products expected to increase, an opportunity exists to improve the economic welfare of farmers living outside the perimeter, especially if actions can be taken to encourage and make more effective the arrangements between these groups of farmers producing livestock. This action may include the availability of credit and extension efforts focussed at livestock management and improving the breeds of livestock. The action may also include the development of physical facilities such as livestock holding pens, sales facilities, slaughter and cold storage facilities. Certainly, these arrangements and their potential economic benefit require more study.

In addition to these recommendations, there are some suggestions we wish to make. Some of these deal with areas where our study is incomplete, and we have evidence of a problem but little basis for recommendations. Others include areas where our value judgements are involved. We will not impose our own values, but suggest areas where values might be reexamined and the policy implications of this re-examination considered.

The most serious lack of data in the study concerns the state farms. As was pointed out in the introduction, most of the data we collected from several sources was so inconsistent as to be useless. The little we have confidence in suggests that the state farms are less efficient producers than private farmers. Serious consideration should be given to transfering ownership of some of the land to small farmers through sales with long term credit provided. What remains in public ownership should be used for more experimental programs. The development of new crop varieties appropriate to the region, and experiments with new production techniques are projects that could pay off handsomely. As there is an abundant supply of labor in the area, these experiments should not be directed towards a labor saving technology, but towards a technology that increases the productivity of the land. There could also be experiments with new institutions. While farming cooperatives have not been noted for their economic success, some experiments might be conducted with cooperative forms of organization. This could facilitate the exploitation of some economies of scale in, for example, the collective ownership of expensive equipment, and also facilitate a solution to the credit problem. At the same time, innovated institutional arrangements could avoid the obvious inefficiencies that are now involved in the state farms.

We could not live and work in the region without becoming aware of some of the problems of equity. A few farmers have less than one hectare of land, and a few have over 300 hectares. About 60% of the farmers farm less than 5 hectares; about 2% farm over 100 hectares. But the 60% control 15% of the land, and the 2% control about 40% (the land owned by state farms

was excluded in making these calculations). Farm laborers, particularly those who are employed on a day to day basis, live a precarious existence. Their lot is not an easy one.

One should be concerned about the equity implications of these figures. This is not to say that the project has created problems of equity compared either to what existed before the project, or what would exist in the region had there been no project. The agricultural laborors wages have increased 200% in real terms in a decade largely because of the project. Farm managers have received almost two-fifths of the project. Labor about one-third and land owners about one-quarter. The owner operators who use household labor have received benefits in all three of these categories. Absentee landlordism is not a problem in the region, and with 20% of the benefits accruing to land owners, one cannot argue that land owners as a class received an inordinate windfall from the project. Yet a small number of large land owners did receive very large windfalls. While one can argue that the equity situation has been improved as a direct result of the project, one can also suggest that it remains a problem in the region. We have made recommendations on how the productivity of the project can be increased. It is hoped that some of the returns from this successful project will be used to continue to improve equity.

Bibliographic Note

There are unpublished reports that deal (at least in part) with the lower Moulouya irrigation project. We have taken much of the data from the 1950's and 1960's from these studies which have been referred to frequently in our study. They are described briefly below.

1. Office National des Irrigations, Avant Projet (January 1965). This is the basic study of the region undertaken before the construction of the main storage dam and most of the construction on the left bank and on the Northern Triffa. This report covered in detail the geographic, technical, social and economic aspects of the lower Moulouya irrigation project. In its final form it was bound in a number of volumes. In 1978 we were unable to locate a copy of the original. In 1970, however, one of the researchers had picked up a personal copy of most of the volumes. We found it an excellant, useful study.
2. Hydrotechnic Corporation, Review ONI Preliminary Project Report (March 1965.) This was a summary and review of the Avant Projet. Some technical analysis not contained in the Avant Projet is included in this report. The benefit-cost analysis contained in this study used a methodology that, as far as could be determined, followed that we used more closely than the one done in the original Avant Projet.
3. Office National des Irrigation, Plan Quinquennal 1960-1964. This is a planning document but it reports data for an early period. The SERESA survey cited in Chapter Two was reported in this document.

4. Stanford Research Institute, Analysis of Selected Programs for Moroccan Agricultural Development (October 1966). The Study compared a program of selected projects to improve dry land agriculture in Morocco with an expansion of the lower Moulouya irrigation project. Its conclusions were generally sceptical about the development of the left bank.

5. Hydrotechnic Corporation, Lower Moulouya Agro-Commercialization Projet. (1972). Vol. I, Inventory of Available Data was particularly useful for production data on the 1960's.