MOROCCO INCREASE IN CEREAL PRODUCTION PROJECT

by

Dr. Edward B. Hogan, Team Leader
Consultant, NE/TECH/AD

Dr. William R. Furtick, Agronomist
Consultant, NE/TECH/AD

Dr. John A. Grayzel, Anthopologist
NE/TECH/SARD

TABLE OF CONTENTS

FORWARD

In October 1979, the Administrator of the Agency for International Development initiated an Agency-wide ex-post evaluation system focusing on the impact of AID-funded projects. These impact evaluations are concentrated in particular substantive areas as determined by AID's most senior executives. The evaluations are to be preformed largely by Agency personnel and are to result in a series of studies which, by virtue of their comparability in scope, will ensure cumulative findings of use to the Agency and the larger development community. This study of the impact of the Increase in Cereals Production project in Morocco was conducted in Nov., 1983 as part of this effort. A final evluation report will summarize and analyze the results of all the studies in this sector and relate them to program, policy and design requirements.

EXECUTIVE SUMMARY

I PROJECT SETTING.

The Increase in Cereals Production project was initiated in 1968 in accordance with the findings of a sector assessment finaced by USAID Morocco. The problem identified in the assessment to be addressed by the project was Morocco's net cereal deficit caused by an expanding population and stagnant cereals production.

The strategy to be used was based on experiences with increasing wheat production by the introduction of high yielding varieties and associated cultural practices used successfully in Turkey, India, Pakistan and Mexico.The technology to be introduced was to be provided by the International Center for Corn and Wheat Improvement, (CIMMYT).

II PROJECT DESCRIPTION.

The project was started before AID began to use the "logical framework" in project design. As reconstructed from documents and institutional memory, the project goal was to reduce food imports substantially and the project purpose was to increase wheat production by 600,000 tons. The project outputs were to be the adoption by farmers of a package of improved practices focused on the use of high yielding varieties of wheat and the project imputs were high yielding varieties of seeds, technical assistance and credit for procurement of inputs. While the project at signing did not include institution building, it was added to the project when implementation was started.

Elements which probably should have been taken into account but appear not to have been, include the following: 1) the introduction of improved moisture conserving tillage practices; 2) consideration and analysis of economic and social factors; 3) the unavailability of high yielding varieties of durum wheat; 4) the importance of the total farm operation to project strategy.

III PROJECT HISTORY

Originally the project had been conceived as one which would assist in increasing wheat production by increasing the amount and effectiveness of fertilizer use. However during the project approval process emphasis was shifted to the introduction of high yielding varieties of wheat and other elements became less important or disappeared from the project. This made it impossible to reach the target of increasing wheat production by 600,000 tons. High yielding varieties were available only for bread wheat and increasing total output by the amount specified would have required a 200 percent increase in bread wheat production.

Physical implementation started with the introduction of five high yielding varieties for multiplication. While initially the crop looked very good, excessive moisture late in the growing season caused a fungus disease, Septoria, which destroyed much of the

crop. However, in the drier areas, particularly on irrigated land, good yields were obtained. While the decision to move directly to seed multiplication rather than conduct trials was severely criticized by some, on balance the net effect was probably a plus. The scientists did draw back and go to trials and testing but farmers reasoned, correctly, that the late wet weather was not apt to occur very often. They saved what seed they could and replanted the next year with good results. Some of these varieties remain in use today and were used successfully in local breeding programs.

Major problems were encountered in trying to institutionalize research and extension services. While CIMMYT, in accordance with their policy, insisted on scientists being trained to staff institutions which would carry on research and extension activities after departure of CIMMYT scientists, the Moroccan government had other priorities. No agreement on this issue could be reached, CIMMYT withdrew from the project in 1973 and the institution building effort collapsed.

IV PROJECT IMPACT: FINDINGS.

The rural Moroccan social structure is characterized by considerable mobility with individuals moving off farm for alternate employment. However, these migrant workers usually continue to contribute income to the farm family unit and, if they accumulate sufficient resources may, in later life, return to farming. Land fragmentation is also a major factor in the farming community. To some extent the trend towards increasing fragmentation due to inheritance laws is being countered by a number of mechanisms, including land rental to form larger management units.

There are five important characteristics that affect farm management decisions. 1) The farm system, particularly on the traditional level, is risk management oriented. 2) Production activities are diversified so animal production is as important as crop production. 3) Crops are chosen to maximize total income rather than income from one activity. 4) Among cereal crops, bread wheat is the least important. 5) Because of extensive sharcropping and absentee ownership, farm ownership is not necessarily synonymous with the farm operating unit or the farm decision maker.

While the government sets a base price for wheat and buys grain, mostly from large farmers, most grain is sold in a basicly free market system. For many farmers a preferred option to selling grain is to utilize cereal crops partially as animal feed and then sell the animals. Farm decision makers also allocate labor in a manner which is calculated to maximize farm income. Thus labor can be allocated to the farm, to other agriculture work or to urban or overseas work. This process has increased the cost of farm labor and led to increased mechanization.

Services and supplies are obtainable by farmers from both public and private sources. While this system has its problems, availability of inputs has not appeared to be a major constraint to increased farm production.

Over the last twenty years there have been several attempts at

agricultural innovation in Moroccan agriculture. In 1958 a program to break the constraint on timely preparation of land was initiated. Plows and tractors were imported and used to prepare private land for a fee. In 1966 the government launched Operation Engrais to encourage fertilizer use, particularly by small farm operators. Finally, a major effort tc increase the use of water for irrigation brought 700,000 hectares of land under irrigation.

At the time the increase in cereals production project was started cereal farming was not generally mechanized and was characterized by a low level of inputs. These traditional practices included hand broadcasting and covering the seed with a shallow draft crab plow. Most land was left fallow every other year to grow weeds for animal feed and the weeds which grew in wheat fields were hand pulled and used for feed. Wheat straw was also used for animal feed.

Policies affecting wheat production included consumer and producer prices, subsidies, investment priorities and foreign trade and exchange policies. Consumer prices for wheat flour were heavily subsidized and producer prices were generally maintained well above world prices. Many agricultural inputs were subsidized but subsidies usually went to specialized groups. Often subsidies did not compensate for import duties and taxes. Within agriculture investment priorities were allocated to irrigated agriculture, not to dryland agriculture. Foreign trade policies appear to have favored imported wheat over domestically produced wheat and exchange rate policy decreased the cost of imported wheat to the government and the millers.

V PROJECT IMPACT: ANALYSIS

Project impact was limited by the choice of high yielding varieties as the focus of technology transfer because bread wheat was only 25 percent of wheat production. While problems were encountered during the first year because imported varieties were were adversely affected by Septoria, this was of minor importance in subsequent years and the technological package introduced proved to provide resonable yields. While the high yielding varieties were widely adopted by large farm operators and on irrigated lands, the technology adoption rate among smaller dryland farm units was much less. The problems related to getting traditional, risk prone, small farmers to adopt the new technology and the failure to establish the functioning institutional base necessary to assure adoption by these farmers.

While producer prices were generaly weighted in favor of wheat farmers, other policies were generally not suportive of adoption of new technology and increased wheat production. Government rhetoric was not made effective by coordinated policies to encourage wheat production. It is not clear whether this policy was adopted on the basis of analysis or in the absence of such.

The project did not bring about desired production increase but it had other positive effects. The project did make a contribution to the use of high yielding bread wheat varieties in Morocco and

provided the impetus for initiating a program for breeding improved varieties of both bread and durum wheat. There appears to have been some increase in wheat production over the past ten years and some of this may be due to the use of high yielding seeds and associated practices. Morocco has benefitted from a continuing relationship with CIMMYT which has been the major source of a flow of new plant material. While to date it appears that the major beneficiaries have been the operators of larger farms, use of improved technology is increasing among small farmers. The project does not appear to have had any negative effects.

Some other events during the period since project implementation started, not attributable to the project, should be noted. The consumer subsidy on wheat flour has led to shifts in demand which favor wheat consumption over other grains. Mechanization has increased substantially due to the movement of labor to off farm jobs. Ownership of land and farm management have been increasingly seperated. By and large there has been little progress in the development of effective supporting institutions since project termination. Finally, much of the farm machinery imported for use in dryland farming, decreases in legume production and poor fallow practices have probably had a negative effect on wheat production.

VI CONCLUSIONS AND LESSONS LEARNED

Many factors have influenced wheat production since the project was initiated. Some success was achieved despite failure to reach production targets. In addition, lessons learned from the project experience and subsequent events shold beneficcially effect future dryland farming development activities in Morocco.

Lessons learned include the following.

A. Producer price policy by itself is unlikely to elicit a positive respone in dryland farming if other policies are not supportive and farmers are, for a variety of reasons, not operating on an elastic supply curve.

B. The risk factor is extremely important and the project should include measures for risk management by farmers.

C. The relationship between livestock and cereal production is important to farmer decisions about farming practices and must be taken into consideration in proposing changes in production practices.

D. It is highly probable that there wil be a series of changes in the economic, social, physical and tecnological environment which wil either directly or indirectly affect achievement of project goals and purposes.

E. Government priorities need to be fully understood to assure that project priorities are consistent with them.

F. Without institutionalization of effective support systems, continuous examination and reexamination of technical, social and economic problems can not be successfully accomplished.

I. PROJECT SETTING.

The Increase in Cereals Production project was initiated in accordance with the recommendation of an agricultural sector analysis and strategy document, "Planning for Agricultural Development in Morocco" prepared by Stanford Research Institute. This study found that "the agricultural situation in Morocco is one in which production has been nearly stagnant in recent yearrs while population has been increasing rapidly".1/ The study concluded that the major development problem in Morocan agriculture was to increase production over the short term, the next five to ten years. To accomplish this the priorities established were "(1) initiating a systematic program to improve tne dry-land (rainfed) agriculture in Morocco and (2) completing and making operational the major irrigation facilities that are already under construction."2/ The USAID followed one specific recommendation of the report by initiating the Increase in Cereals Production project. The cereals project was coordinated with a regional cereals project, Wheat Improvement in North Africa.

The specific problem to be addressed by the program was described as follows in a memorandum to the Assistant Administrator, Africa Bureau requesting approval of the project.

"During recent years, average annual cereal production in Morocco has remained at about 1,230,000 metric tons, while the population has increased by 3.2 percent annually. This has resulted in Morocco becoming a net deficit country in cereals. In 1964, a 'normal' year, Morocco imported 272,000 MT's, although a net surplus occurred in 1960. The drought for the last two years has furthur aggravated the cereals shortage, raising Morocco's import requirement to 820,000 MT's for CY 1968. This project aims at eliminating fundamental weaknesses in the methods of cereal production, its target is to raise the average annual output by about 600,000 MT's or almost 50 percent of the production level of recent years."3/ The development of a strategy for assisting Morocco increase wheat production was strongly influenced by the success of the "Green Revolution" in Turkey, Pakistan and India. The strategy to be followed was as follows;

"A. Applied research to develop and introduce high-yielding varieties;

B. Improvement of production technology, use of fertilizers, better tillage methods, weed control. pure seed, etc.;

C. A broad extension demonstration program to teach farmers the new technology;

D. An adequate program to enable farmers to procure the needed production inputs; and

E. Comprehensive training of cereal agronomists to enable them to carry out on a continuing basis an applied research program to develop new varieties, to cope with plant disease and pests and to refine and improve the new wheat production technology." 4/

Central to the entire scheme was the involvement of CIMMYT and the utilization of their high-yielding varieties of wheat. "This project will be coordinated with a regional project to provide specialized research and training assistance in seed improvement. Negotiations are in process with CIMMYT, the Rockefeller sponsored International Center for Corn and Wheat Improvement in Mexico. CIMMYT is expected to provide assistance for both Tunisia and Morocco, including an exchange of information on seed results, training, etc., between CIMMYT operations in the two countries. CIMMYT plans have already been made for their operations in Tunisia, and Rockefeller and Ford representatives will be in Morocco early in February to discuss organizational details with the GOM and USAID." 5/

Thus, the project was established within a broader regional effort to deal with dry-land cereal production in North Africa and also included within its scope assistance to activities being undertaken by the GOM--the distribution of fertilizer by Operation Engrais and Contrat d'Assolements.

In addressing the issue of beneficiaries, it must be remembered that the problem which the project was intended to address was stagnant production and a high rate of population growth which in combination had led to increased imports with consequent adverse effects on the Mooccan balance of payments. To maximize production, the project was planned to focus on the wheat growing areas with 10 or more hectares of cultivated land. "Traditional farmers with less than 10 hectares would not be excluded from the program if they wish to participate but the major efforts will be on farms with more than 10 hectares." 6/ Thus the beneficiaries of project imputs would be selected from a group of farms which represented only 4.5 percent of all farms in Morocco, though it included 45 percent of cultivated land. 7/ The reasons for not focusing on the small farms were set forth explicitly by the USAID. "The traditional farms with less than 10 hectares of cultivated land will not be included in the program. This group is least motivated, makes up the bulk of the farmers and will require the greatest effort in introducing more productive methods. Since these farmers run small units which are widely scattered throughout the country, the economic return per additional extension agent would not justify the extra expense involved." 8/ Obviously the project was not concerned with which class of producer would benefit from the investment being made, but with reaching production targets at least cost. The concern here was with benefitting the nation not individuals.

II. PROJECT DESCRIPTION.

When the Increase In Cereals Production project was developed, AID had not yet initiated a system of project formulation which included the "logical framework". It is therefore necessary to construct from existing documents and such institutional memory as exists, the goal, purpose, inputs and outputs of the project.

The goal of the project was to increase agricultural production so as to minimize food imports. 9/ The purpose of the project was to produce a sustainable increase in wheat production of 600,000 metric tons in seven years, an increase in total wheat production of approximately 50 percent. The project output was the adoption by target farmers of a package of practices consisting of improved seed varieties, appropriate fertilizer applications, better tillage methods, seed drilling and weed control. It is important to note that institution building was not a component of the project as prepared by the USAID and approved in AID/W. The project did include some training to achieve project objectives but this training was not placed in the context of institution building. After the project was approved and agreed to by both parties, CIMMYT, with Mission support tried to, (in fact insisted on), include institution building as a part of the project. Project inputs consisted of high yielding wheat variety seed, extensive trials and demonstrations, participant training, credit for procurement of farm imputs, fertilizers, farm machinery, agricultural technicians and chemical weed control. Contract inputs were provided by CIMMYT and the Near East Foundation while the Peace Corps provided 40 volunteers to work in extension activities.

The strategy for project implementation was modelled after what were described as successful programs in Mexico, Turkey, Pakistan and India. The core of this strategy was the utilization of high yielding varieties of wheat developed by CIMMYT in their Mexican research or varieties developed locally from crosses using Mexican varieties. This strategy was supported by recommendations on increasing dryland grain crop yields in the Stanford Research Institute report 10/ and a 1964 Tennessee Valley Authority report. 11/ The strategy was also consistent with the cereals project being carried out in Tunisia. The strategy was soundly based on and consistent with the most advanced technology for dryland wheat production being utilized in developing countries.

While the strategy adopted by AID did, for the most part, incorporate the most advanced current technology, there are, ex post, at least four elements which probably should have been taken into consideration in developing the strategy, but that appear not to have been examined.

1. Moisture conservation through improved tillage practices. The scientists may have believed it unnecessary because the project was being limited to areas with a minimum of 350 mm of rainfall in a normal year. 12/

2. The project had no economic or social content. The only economic or social analysis contained in either the USAID propsal of AID/W revised PROP was an estimate of yield and value increases as the result of fertilizer applications contained in the USAID PROP. The project itself provided no inputs to deal with social or economic issues.

3. The fact that bread wheat was only one-fourth of wheat production in Morocco and that improved varieties of high yielding wheat were limited to bread wheat appears to have been overlooked. This meant that yields of bread wheat would need to be increased by 200 percent in order to reach the targeted increase in wheat production of 50 percent.

4. The strategy did not take into consideration the total farm operation. In particular the relation betwen crop and animal production and marketing and the effect of that relationship on farmer decisions was ignored.

While the project strategy did not provide for institution building when it was approved by the Moroccan and US governments, institution building was introduced into the project when a contact was signed with CIMMYT for the introduction and propagation of improved high yielding wheat varieties. CIMMYT had been involved in a number of programs involving high yielding wheat varieties, and they had developed a system which they believed was essential for a program which was to provide sustainable increases in wheat production through the use of improved seeds and optimum fertilizer applications. This system required that host country-trained scientific agriculturalists be assigned to work with CIMMYT technicians who would provide the scientific leadership necessary to institutionalize the research. This added-on strategy did not work as will be shown during the following discussion of the history of the project.

III. PROJECT HISTORY.

A careful reading of the documents strongly indicates that the project was originally conceived of by the USAID as a project to increase wheat production through the increased use of fertilizer. "The project will concentrate on wheat in those areas receiving 300 mm or more of rainfall annually as wheat production in the drier areas is too hazardous to economically justify fertilization." 13/

It was to expand on a part of the Operation Engrais scheme, adding advice on cropping practices and credit to the fertilizer program. A cereal breeding program was to be included, which was expected to produce improved seeds by the 1971-2 crop year. The use of improved seeds at that time was believed necessary to reach the target increase in production of 50 percent. 14/

In the event, the project strategy changed significantly between submission of a PROP in February 1967 by the USAID and approval of the project by AID/W in March 1968 and, apparently between approval of the PROP and signing of the first Project Agreement. When the PROP was approved, the strategy had shifted to "the same strategy that worked so remarkably well in Mexico and is currently being followed with outstanding success in Turkey, Pakistan and India." 15/

It was still anticipated that improved high yielding seeds would not be immediately available for distribution to farmers but the improved seed varieties had become the major focus of the project and other imputs were to be used to maximize yields from the new seeds. Credit for agricultural imputs, particularly fertilizers, however, did remain as part of the project. By the time the first Project Agreement was signed, financing for credit to procure fertilizer and other agricultural inputs had disappeared from the project and increasing output became a function of the introduction of improved varieties with yield to be maximized by the optimum application of other imputs. The USAID did continue to make local currency financing from PL 480 generations available to the Moroccan government to provide credit for agriculture imputs, but not as part of the project. 16/

The consequences of this were that it became impossible for the project to reach the stated target of increasing wheat production by 600,000 MT's, almost 50% of avarage production levels in the years immediately preceeding the project. The reason for this was that, by eliminating the broad fertilizer component and focusing on improved varieties of high yielding wheat, the project was limited to increasing the output of bread wheat because it was only for bread wheat that improved high yielding varieties had been developed. The project could no longer expect to influence production on 590,000 hectares as planned, because that much land was not used for bread wheat production. During the decade of the 60's, bread wheat hectarage averaged 421,000 ha. per annum and never exceeded 530,000 ha. Achievement of the 600,000 metric ton increase meant that average bread wheat production would have to increase by 200 percent, an improbable occurrence in mostly dryland wheat production.

Physical implementation of project activities started as scheduled in the fall of 1968 when 4,600 hectares were planted with five high yielding varieties supplied by CIMMYT from Mexico - Siete Ceros, Inia, Tobari, Penjairo and Norteno. The rains that crop year were reasonably good and expectations were for a good harvest, particularly for the Mexican varieties which in many places looked like they would produce 30 to 40 quintals/ha. compared to the normal 9 quintal/ha. produced by local varieties. However, there was an exceptionally cold and wet spring with little sunshine and the high yielding varieties, particularly Siete Ceros, proved highly susceptible to Septoria, a fungus disease, and yields in may areas were reduced to 0 to 5 quintals/ha. "However, good yields from other varieties, particularly Tobari, and Siete Ceros in drier areas, demonstrated the value of Mexican varieties under favorable conditions." 17/ Many of the farmers involved did suffer substantial losses and in September 1969 the Mission agreed to the use of PL 480 generated funds to compensate farmers whose yields from the Mexican varieties did not cover production expenses.18/

The decision to move directly to multiply the seed imported from Mexico rather than go through a series of trials has been subjected to severe criticism. 19/ While there was negative reaction because of the Septoria, on balance the positive elements may well have outweighed the negative ones. True, the project did draw back from plans to multiply and distribute the high yielding Mexican varieties. Work was concentrated on research, trials and demonstations. However, farmer reaction was different. In the fall of 1969 farmers planted 10,000 hectares with high-yielding Mexican variety seed they had saved from the 1968-69 crop. This included farmers hard hit by Septoria who had managed to save some seed, often damaged. In the following fall it was estimated that 60,000 hectares "were planted with high-yielding varieties of Italian (40,000) and Mexican (20,000) origin." 20/ Since that time Moroccan farmers have continued to grow the best of the originally introduced varieties. Siete Ceros has remained a highly popular wheat among wheat bread growners, particularly in the drier rainfed and irrigated areas.

Not only have farmers continued to use the original imported wheat varieties, but Morocco has continued to receive and use new material from CIMMYT for both bread and durham wheats. In addition, Mexican varieties have been used in the Ministry of Agriculture's wheat breeding program. It appears highly likely that if use of the high yielding Mexican varieties had been limited to trials during the 1968-69 year, seed multiplication for distribution to farmers would have been delayed several years as research workers tried to develop varieties resistant to Septoria. However, the farmers apparently reasoned, correctly, that in most years, the dry weather at heading time would mean that Septoria would not be a problem.

The second major problem faced by the project concerned plans by CIMMYT to institutionalize a research capability, including breeding, within the Ministry of Agriculture. Based on their

experience in several less developed countries, the CIMMYT leadership believed that training of scientists to staff and direct a going concern undertaking research was essential. These trained scientists would take over the program from CIMMYT and do the research and development necessary for self-sustaining high-yielding wheat production. The following spells out the CIMMYT position.

> Under the original agreement between the Government of Morocco, CIMMYT and USAID. the latter two agencies were to assist Morocco to achieve self-sufficiency in wheat production through the development of research and the training of young scientists.
>
> It was the purpose of CIMMYT to assist the Government of Morocco to develop a well trained corps of young Moroccan scientists, who would assume full responsibility for the program as soon as possible. Unfortunately, progress toward the goal has lagged.
>
> During the past three years, 14 young Moroccans at the Adjoint Technique level have been trained by CIMMYT in Mexico. Upon their return to Morocco, virtually all have been assigned to projects other than wheat. No Ingenieurs Agronomics have been included in the group that was trained in Mexico, a serious weakness since the engineers, rather than the Adjoints Techniques, are those that are destined for leadership in Morocco.
>
> CIMMYT has had three of its staff scientists stationed in Morocco during the past two years, working on wheat breeding and agronomic research. Unfortunately, contrary to the agreement, up to now the Government of Morocco has not assigned a single young scientist to work with Dr Aristeo Acosta, in the breeding program. Neither has an adequate number of young scientists been assigned to work with Francis Bedinger and William Hall in the fertilizer and agronomic research programs. The result is that no appreciable progress has been made toward building a Moroccan research team with competence, who will be ready to assume the responsibilities now being carried by the CIMMYT staff. 21/

The letter went on to state that because of demands from other countries for CIMMYT assistance that it would be difficult for CIMMYT to continue to provide staff in Morocco unless the current situation changed.

No such change occurred. The Moroccan Ministry of Agriculture did not quite see things the same way as CIMMYT. From the perspective of more than a decade later, it appears to have been a matter of priorities. CIMMYT had one priority, implementation of the project according to the system that had worked well for them in other countries. This meant, above all else, the assignment of scientifically competent professionals who had the qualifications, positions and incentive to take over the program when the expatriate technicians left. But, the Moroccans had a number of priorities rather than just one. These priorities included development of

irrigated agriculture, staffing research stations, assigning administrators in the Ministry, and manning Agriculture Work Centers and the extension services, etc. They assigned people in accordance with the priorities and this meant that the kinds of agricultualists were not made available to the project in the numbers desired by CIMMYT. It meant that the project could not attain CIMMYT's institutional aims. The available evidence indicates that institutionalization was not a Ministry of Agriculture objective. Rather, the Ministry wanted a group of external researchers and demonstrators who would develop and operate a wheat program based on improved varieties and fertilizers. In the event, the two positions were never reconciled. CIMMYT did not enter into a new contract and all CIMMYT technicians were withdrawn at the end of the 1972-73 crop season. However, it should be noted that some research on high yielding varieties was continued by an expatriate breeder employed by the Ministry of Agricuture. His work did produce some high yielding bread and durum wheat varieties but, unfortunately this capability was not institutionalized within the Ministry.

With the decision to close down the CIMMYT portion of the project, the Near East Foundation advisers were shifted to the Ministry of Agriculture extension service and continued to work on trials and demonstrations and to train extension agents at Work Centers in the techniques required for utilization of high yielding varieties. All project activities were completed by Dec. 31, 1975.

IV. PROJECT IMPACT: FINDINGS

A. The Agricultural Society.

1. Social and Community Structure

The complexities of Moroccan social structure transcend the needs of this paper. Several points are however of immediate pertinence.

First, is the dichotomy between the modern urban and rural traditional classes. In regard to this, the immediate physical location of the individual is not of paramount importance. There are many traditional rural people as migrants in urban areas as well as some sophisticated, highly educated rural personages. What is crucial is the locations of the principal economic, social, political and ideologic reference point of parties concerned. For example, a modern farmer, as with a modern urban dweller, finds a majority of his primary network of economic contacts (banks, suppliers, markets) among modern urban associates. In contrast, a traditional migrant worker may still be economically tied to his rural extended family household, his village (douar) and tribal faction. Naturally, the urban and rural classes, themselves, divide into numerous subgroups ranging from political elites to poor farm families with little access to production resources except labor and poor land.

A second, concomitant, factor is the mobility of individuals themselves. A classical process, now greatly speeded up, exists whereby individual rural identities are converted to urban identities, principally through the achievement of a combination of education and wealth. An important corollary of such status mobility is the physical mobility of people as migrant workers. Migrant labor, however, can function in either direction. At the same time as it can be the means for people to accumulate goods that permit them to give up rural life, the significant remittances sent home by migrants are a crucial factor in the continued functioning of the rural production system.

2. Land Ownership and Use

Much of the productive realities of Moroccan rural life are determined by the land ownership system, conditioned by Moslem law of inheritance which requires a measured dispersal of land among a large set of family members. More than any other factor, this has resulted in a seemingly endless proliferation of owership of a greater and greater number of smaller and smaller farms. Since the vast majority of smallholdings are unable to support their owners, what has developed is an extensive system of traditional absentee owners and sharecropping, whereby a large percentage of landowners migrate (seasonally or permanently) while remaining male adults farm both their own and others' land. In some cases the arrangements are purely business, in other cases they involve mutual support within a larger social group. The physical fragmentation of landholding is further exacerbated by the fact that farms have for reasons of agricultural technology been divided into geographically dispersed

parcels, somtimes 25 kilometers or more apart.

There have developed some mechanisms to counter land fragmentation. The most traditional was to recombine land through marriage alliances. Another is indivision, a process whereby the heirs never formally split up the inheritance so that each holds a specific share of a yet undivided parcel. The parcel continues to be farmed as a single entity; however, major management problems arise from the diffusion of authority over use that often occurs, especially since most of the owners are generally absent from the area. A third existing phenomena is the accumulation of land to create larger farms by urban residents or migrants. Often these people will make small purchases over time, with interim sharecropping arrangements, till at some point, usually when they are 45-55 years old, they may return to the rural area. Lastly, there is the process whereby the government and private individuals obtained the large farms that were re-appropriated from French colonial farmers after independence. These, together with some of the land purchased by migrants, form the nucleus of what is now commonly called the modern sector. Today it represents only a fraction of the population, but a significant amount of the land.

3. The Agricultural Farming System

Without in depth dicussion, one can easily identify several cardinal principles which were and continue to be characteristic of Moroccan farming systems. First, the fact that the system on the traditional level is risk management oriented. The farmer attempts to manage the farm operation in a manner which makes it possible to cope with variations in yield when they occur. Rather than seeking maximum production in any one area, the rural producer, in the face of uncertain rainfall, seeks to assure family security. This is achieved through extensive diversification of resource use. Land is broken up into dispersed parcels of different altitudes (e.g. on slope, on bottom land, on flat terrain) to adjust for variations in both the location and intensity of rainfall.

Second, production activities are diversified so that animal production is of at least equal importance as cultivation, while outside wage earning assures a minimal income.

Third, crops are chosen to correspond to the totality of management needs. Forage crops assume major proportions because of animal needs. Grain crops are chosen to meet the multiple need for human and animal food and other family security requirements. Weeds are given positive value as forage crops.

Fourth, among the grain crops, bread wheat is traditionally the least significant. Durum is generally preferred over soft wheat because of its better characteristic for cooking the traditional cous-cous. Barley, the most drought and disease resistant cereal crop,is the insurance that both man and beast will eat. Corn, which is planted two and a half months later than wheat is suited for late rains and provides fireplace fuel, human and animal food, and, in addition, results in reduced weed growth for the next years wheat crop.

Fifth, because of extensive sharecropping and absentee ownership, the farm owner is not necessarily synonymous with the farm operation or the farm decision maker. The problem is not only one of identifying the particular individual to interact with, but, equally important, knowing who benefits from the introduction of new technology.

There is, to be sure, a crucial difference between the highly diversified production system of traditional farms and the specialized production of the larger modern farms (over 50 hectares). On these, animal production greatly decreases in importance in favor or specialized grain production. However, even if their owners do not feel at risk of starving, they still play the probability game and usually plant diversified grains and legumes rather than a single bread wheat crop. Among the middle range farms, 20 to 50 hectares, there is an overlapping of strategies that stress diversified production with those turning towards specialization. Unfortunately, the crucial determinants and thresholds for decision-making in this regard have yet to be identified. Moreover, in terms of decision-making and makers, the larger and smaller farming operations are interdeterminant in at least two ways. First, because of the large number of absentee owners, it is farmers from the traditional sectors who often run the daily operations of the larger farms. The result is that they apply the practices that they know and which most benefit them, (for example, letting the weeds grow to feed their own animals, or not investing in land conservation). Second, as will be further explained later, the mechanical technology adopted by larger farmers more and more imposes itself on small traditional farmers who pay for custom services, since they themselves cannot afford large farm machinery.

4. Markets and Credit

Both public and private marketing and credit systems exist to service agricultural production. Both continuously intertwine and, at various levels, serve either the small or large farmers or both.

The government, through its National Cereals and Legumes Office (ONICL) sets a base price for cereals. It grades the cereal presented, and reduces the price if the grain is judged inferior. Transportation to its facilities, which are not that many, is the obligation of the farmer. For this combination of reasons, most of the grain ONICL purchases is from large farmers or intermediaries who purchase supplies from farmers at the local markets. In reality, a basically free market system seems to be in operation. Farmers themselves play the market in a not yet well understood process that involves buying and selling from personally held multiyear reserve stocks that they maintain.

Another crucial part of the system involves the conversion of grain to animal products. Animals are apparently most commonly sold at seed buying (November - wheat, March - corn), or harvest time (May). The characterization often encountered is that "animals are only sold when cash is needed". What is generally ignored are ways

the farmer manipulates his needs for additional funds. One major mechanism for this is the informal credit system, where funds are received from relatives or acquaintances or agreements are made to pay later for goods and services (e.g. mechanical plowing) received. The flexibility in the informal system is one reason small farmers have shied away from various government credit schemes which, while they charge less interest (8-10% versus 25-30%), only give a year or less repayment time, and demand repayment right after the harvest, when prices are lowest.

One theme that comes through most clearly in both the grain market and credit systems, is the farmer's awareness and response to the real costs of a transaction in terms of labor required, time and penalty. Thus he will sell his own bread wheat grain and buy flour, because it does not pay him to mill it himself. He will sell to an intermediary rather than either transport his own goods or risk down-grading at the buying office. He will pay higher interest to avoid severe penalties or to obtain flexibility. At the same time his operation will produce for autoconsumption only as long as it does not pay to rely on the market for either human or animal food.

5. Labor Migration and Mechanization

The different roles of labor in various farm production activities are probably as good, if not better, a standard of distinction than farm size. Generally, what is referred to as a small farm is really one of many operations of the labor pool of an extended family. This pool consists of all family members, and the problem is how to best allocate family labor resources to fulfill needs. The usual course is to send the young, better educated males off as migrant laborers, as they are the most likely to obtain work in urban areas or overseas. Older male(s) remain behind to manage the farming operation, or as hired help to others. This system however, is tilting more and more towards urban migration due to the combined material and economic opportunities available outside isolated rural areas. One result is the premium which must be paid for farm labor at peak periods (up to 2.5 times the minimum industrial wage). Yet, because the demand is limited to a short period of time, it cannot compete with urban employment. A major result of this is that the small farmer has turned more and more to mechanization. For this, he is dependent on paying for custom work to larger farmers, who have the capital to invest in tractors, plows, combine harvesters, etc.

The larger farmers invest in mechanization according to their own needs to increase farm efficiency and replace scarce labor. As a result, the technology of mechanization generally corresponds to large farmer and machine owner-operator needs, and is often not optimal for small farm operations, (e.g. too heavy equipment, loss of harvest grain to maladjusted harvesters, etc.). However, despite some of its disadvantages, mechanization is perceived by almost all farmers as an overall benefit. It makes up for lost labor; it actually frees labor to migrate (thus increasing net family income); and it removes time constraints in planting, due to its ability to

work hard lands before the first rains.

6. Institutional Setting

A myriad of governmental institutions impinge on the agricultural sector. In general, they seem to be characterized by lack of resources, poor collaboration and inefficient management. One consciously expressed factor in farmer decision-making seems to be a general acceptance of the unreliability of government services.

In general, the larger farmers, due to connections, seem the best able to take advantage of the benefits of such subsidised services as fertilizer, seed distribution, and credit. Not unexpectedly, limited regional services such as the custom mechanization services offered by government work centers (CT) largely benefit either large landholders or tradtional notables. In terms of seed multiplication this includes not only the sale of seeds but also the awarding of seed multiplication contracts.

One crucial aspect of Moroccan official institutional practices is their conformity to systems learned under French rule and influence. This apparently includes an orientation to creation of seed varieties that is significantly longer than American practices. Field research also tends to follow a more rigid mode, whereby the researcher basically gives direction to field personnel via written instructions rather than actually being responsible for all aspects of trial performance. Such differences are far removed from the Moroccan farmer, but were, and continue to be, an apparent cause of some differences between Moroccan and American counterparts.

In terms of general ideological orientation, most Moroccan officials express the opinion that government services of any kind should exist to make up for deficiencies in the private sector and not as a monopolistic constraint on it. While this has not apparently always been the case (e.g. fertilizer), in fact, it appears that, as with the farmer, the private sector functions fairly well in light of their immediate economic interests.

7. Historical Dimensions

Without entering into a debate over the relative importance of the overall environment, long-term social processes and unique phenomena in determining societal evolution, the fact remains that specific singular incidences do have recognizable effects and explanatory importance to understand why and when certain things occurred.

a. French Colonial Farmers

Prior to independence, Morocco's most productive farmers were French colonists who occupied 1 million plus hectares. The French basically took over the most productive areas, pushing Moroccan farmers inland to more arid zones. Today, most of the country's state and larger private farms occupy these areas as a result of re-appropriation. Two important consequences of this situation were, first, that the exodus of French farmers in the Sixties deprived the country of its most experienced modern agriculturalists to the detriment of production; and, second, that most of the modern large private and government farms occupy much of the best land,

which is one factor in superior yield performance over other more traditional operations.

b. Land Redistribution

As noted, the lands of former colonial farmers were re-appropriated by the government. These were re-distributed, some to government services, some to large private farming operations, and some to traditional small farmers. To accomplish this, the Moroccan government put into operation a program called "Terres Recupere", and assigned to it about 300 of its best agricultural technicians. This was precisely around the time the USAID project was beginning to be operational and in need of qualified counterparts.

c. Urban Growth and Consumption Patterns

The fuctional re-distribution of land also has occurred through the progressive expansion of urban areas; the accompanying growing urban population has been the major pressure group for subsidized bread prices. The government's importation of bread wheat for this group has also become the de facto determinant of the type of grain provided to rural consumers, all resulting in the acceleration of a changing consumption pattern from other grains to bread wheat.

d. Innovation History

There have been several major attempts at agricultural innovation during the last twenty years in Moroccan agriculture. Of equal importance to the technology itself is the process by which it was introduced and the influences of that process on technological acceptance or rejection. Four examples are of immediate relevance:

1) Mehanizationn: Morocco began in 1958 a program entitled "Operation Labour". It involved the introduction of tractors and plows and was primarily designed to break the constraint on the timely preparation of land. Government centers imported equipment which they then used on private property in return for a fee. Over the years, the process has been picked up by the private sector, both in terms of importation and fee for service activities, and has been extended to threshing and harvesting as well. The explosion in use of machines has demonstrated the vitality of the private sector. At the same time, the immediate benefits are being paid for by long-term detrimental effects due to the inappropriateness of equipment designed for deep plowing under humid European conditions to arid land agriculture, where shallow plowing/moisture retention techniques should be used. Besides the immediate benefits to the farmer in saving time and labor, mechanization is somewhat self-propelling, in that, if a farmer's neighbors decide to harvest their fields early, he must either do likewise or face severe damage from birds to his isolated field.

2) Fertilizer: The encouragement of the use of fertilizer was effected through price and importation subsidies. In 1966, overnment launched "Operation Engrais" to increase fertilizer use on dryland cereals. It covered 180,000 hectares and a survey indicated that, on the average, yields on fertilized wheat land were about 30 percent higher than on non-fertilized fields. In the following year

Operation Engrais was extended to 345,000 hectares with continuing good results. It is important to note that Operation Engrais was focussed on the small farmer. Average size of farms was about 3 hectares.

e.Irrigated Agriculture: Irrigated agriculture, while not the focus of this paper, must be kept in mind because of its effects on the availabilities of limited financial and human resources. Over the last twenty years, approximately 700,000 hectares of land have been put into irrigated use. To achieve this, the majority of skilled agricultural personnel, as well as vast sums of money, were directed to this activity. This has had a detrimental effect on the ability of the government to provide needed imputs or extension services to dryland agriculture.

B. Agriculture Technology

At the time the AID/CIMMYT Project was started in 1967-68, the production of cereal crops in Morocco was largely based on traditional Arab farming practices. Except for a limited number of large farms derived from the colonial era, farming was generally not mechanized. Of the cereal crops, bread wheat was the least important crop because it is less suited to the semi-arid and highly variable rainfall patterns that dominate most of the arable land patterns of Morocco. More than half the cereals grown under rainfed conditions were various six row varieties of non malting type barley. In the higher potential areas, due to deeper soils and/or higher rainfall, durum wheat predominated. Because of the European orientation of the French colonists that had farmed some of the highest potential land, they tended to favour bread wheat utilizing varieties derived mainly from Italy. The use of bread wheat on these higher potential sites continued after their departure because the considerably higher yield potential of the bread wheats more than compensated for the higher price received for durum wheat. Since the modernization of wheat technology in Europe took place largely after the end of the colonial era in Morocco, the technology had not yet transferred and thus traditional varieties and cultural practices persisted.

The traditional practices included hand broadcasting of high seeding rates after the first onset of rain about November or early December and covering the seed by plowing it into the soil with an animal- drawn shallow draft crab plow. This killed the young weed seedlings that germinated from the initial rainfall, and buried the seed at varied depths in the soil. The grain near the soil surface would germinate with minimum rainfall and, because early sowing yielded the largest crop, this early germination would ensure a good crop if rainfall continued to provide enough moisture to sustain the early growth. If there was delay in further rainfall, the early stand of grain would die but the deeper buried seed would still germinate when the heavier winter rains arrived and thus ensure some crop.

Because livestock, mainly sheep and goats, were, (and are), the predominant source of farm income, most of the land was left fallow

every other year to grow up to weeds to form a necessary part of the feed requirement of the livestock. During the late winter and early spring, the livestock grazed the roadside, waste areas and non tillable land (range). After this feed was used up, they were fed weeds pulled from the cereal fields prior to being moved onto the weedy fallow fields that were in full growth with weeds and volunteer grain. This sustained the animals until the grain fields were harvested and the animals then grazed the residual straw and weeds in the newly harvested fields. When this feed was consumed, the animals were fed the straw stacked up after the grain was threshed.

C. Economic and Policy Considerations.

1. Policies AfFecting Dryland Cereal Production and Marketing

The policy issues which appear to have been most important for the adoption of improved practices, including high yielding varieties of seed, and the expansion of output are price, subsidy, investment and foreign trade and exchange policies. Price policy in Morocco involves the government in producer and consumer price setting for wheat as well as some other agricultural products. The floor price for domestic bread and durum wheat is set by a public entity, "Office National Interprofessional des Cereals et Leguminouses" which also imports all wheat into Morocco. Floor prices paid to farmers have, for the most part, been higher than economic prices; i.e., border prices ajusted for interior transport costs. Retail prices for flour are fixed by the government substantially below the economic cost of the flour.

In 1980-81 the consumer subsidy was .417D per kilo based on the price paid for imported wheat and .878D based on the government floor price for domestic wheat. A kilo of wheat flour sold for 1.12D while the farm gate price was 1.35D per kilo. The amount of the subsidy cost to the government was minimized by relying largely on imported wheat to manufacture flour at a CIF price of .95D per kilo. Wheat milled for sale at subsidized prices is composed of approximately 85% imported and 15% domestic wheat. This gives an average subsidy price of .486D per kilo.

Agricultural input prices have been determined by a variety of import duties, other indirect taxes and subsidies. Often subsidies partly offset price increases resulting from import duties and other indirect taxes. High yielding varieties of certified seed are subsidized by government and sell below border prices. While the cost to farmers for certified seed is low, only a little more than 10% of seed used by wheat farmers is certified high yielding variety seed. A major reason for this is that most of the high yielding varieties available are for bread wheat which is only 25% of total wheat production. A second reason for the low usage rate is inadequate supplies.

Pesticides are not subsidized and are subject to import duties and other indirect taxes. Subsidies on farm machinery vary and all imported machinery is subjected to substantial taxation. Import duties and other indirect taxes on tractors total some 30% but this

is offset by a 25% subsidy on tractors acquired by Agrarian Reform Cooperatives and Farmers Associations. Combine harvesters acquired by these organizations carry a 20% subsidy. However, these machines are not subsidized for individual farmers. Other kinds of agriculture equipment carry subsidies ranging from 20 to 30% for all farmers.

Fertilizers, both domestic and imported, are taxed at a rate of 30%. Until very recently, large farmers could receive a subsidy of 20% if they followed a bi-annual rotation. However, this subsidy has been abolished. Farmers' groups receive subsidies on fertilizer up to 30% but individual farmers receive no subsidies on fertilizer. Overall, there is no consistent pattern of taxes or subsidies applied either to domestic or imported farm inputs.

During the period of project implementation and following, Morocco investment policy has emphasized the development of irrigated agriculture. While in Morocco financial and personnel resources were not shifted out of dry-land agriculture, first priority clearly was accorded to irrigated agriculture for new investments. Foreign trade and foreign exchange policies appear to have favored imported wheat over domestic production of wheat. The consistently overvalued exchange rate reduced the cost to millers and the Treasury of imported wheat and foreign trade policies emphasized exports of non-cereal agriculture products to Europe and the Middle East to generate foreign exchange. Of course, this foreign exchange could be used to import wheat.

2. Econonic Situation

Except for some work done on consumer and producer subsidies, there has been little or no economic analysis undertaken with respect to dry-land cereals production in Morocco. No economic analysis based on production data was undertaken during project implementation nor is there evidence that much has been done since the project was completed. The lack of economic analyis and farm level financial analysis with respect to yield, variations in yield over time, technology change, etc. was (and is) a major weakness, given the risk management concerns at both the farm and national level.

Based on policies and actions of the government it appears that Morocco has concluded that in the international markets its comparative advantage has been to produce non-cereal, mostly irrigated crops and to import bread wheat. With changing market conditions in the future related to admission to the EEC of two competitors of Morocco, Portugal and Spain, and the uncertainties with respect to oil revenues in the Middle East, the relative comparative advantages of cereals production vis-a-vis other crops may shift dramatically.

V. PROJECT IMPACT: ANALYSIS

A. Technological Factors Affecting Yield Increases

1.Varieties, Fertilizers and Seeding

The impact of the project on wheat production was limited by the the concentration on bread wheat which is the least important grain in overall cereal production in Morocco. Because of the strong preference for durum by many traditional farmers and the adaptability of high yielding variety bread wheat mostly to higher rainfall areas and as a rotation crop for irrigated perimeters, its potential was largely limited to large commercial farmers in certain geographic zones.

Major increases in cereal production in Morocco are dependent upon changing traditional agriculture. This would require changes in preparing the seed bed, seeding, use of fertilizer, weeding, fallowing and the livestock management/feed system.

The project was limited to the testing and introduction of CIMMYT developed bread wheat varieties that had not been fully evaluated for resistance to local disease and insect problems. These varieties were tested under various seeding rate and fertility regimes at different dates of seeding in selected geographic locations over a three-year period. Seed bed preparation, seeding, fertilizer placement and weed control were all based on use of latest machinery, technology and herbicides. They therefore examined the yield potential of the various varieties at differing seeding dates, seeding rates, fertility levels and moisture conditions under the influence of indigenous levels of disease infection and insect infestations. Weeds had been eliminated as a variable through proper control.

The initial year of full scale project activity occurred during an abnormally ideal climatic year for infection with the disease Septoria, which under such ideal conditions, can be disastrous for the yield of susceptible varieties. The newly introduced varieties ranged from highly susceptible to only moderately susceptible. The losses from Septoria were of minor importance in subsequent crop years. Overall, about 50-60 kg/Ha. proved an adequate seeding rate for the various locations and varieties. This is about half the traditional rate used for broadcast seeding. Except in areas with frequent climatic conditions favorable for Septoria disease, early seeding, November 15- December 15, proved superior.

Although several diseases were normally present, their level of damage was usually moderate and less than the 15-20% regular damage losses from insects, particularly Hessian fly. Fertilizer response tests were limited to nitrogen fertilizer and ensuring adequate levels of phosphorous. In general, the response was largely directly related to amount of available moisture. Some varieties were more responsive than others.

In summary, the project adequately identified the best varieties at different seeding dates, their response to nitrogen fertilizer under differing moisture conditions and the proper seeding rate.

These determinations were made under optimum conditions of phosphorous fertilization, seed bed preparation, seeding method and weed control. Yield response curves based on grain yield were plotted by year and in aggregate for all three years. Unfortunately, straw yields were not measured and reduced the economic usefulness of the data because straw is a basic component of the livestock feed system and often exceeds the grain in value.

Observations made on commercial fields noted the extreme severity each year of weed problems, particularly wild oats and that insect damage was more consistent and of greater magnitude than that due to disease. It must be emphasized that in the traditional farming system weeds played an essential role. The ordinary farmer integrated livestock and cereal production. Weedy fallow and the weeds in wheat fields were an essential element in the feeding cycle of livestock, ususally sheep.

2. Dryland Limitations in the Moroccan Situation

Because the bread wheat farmers are the large commercial farmers in the high potential dryland areas and farmers using irrigation, there was rapid and widespread adoption of the improved bread wheat varieties in spite of adverse results due to heavy losses from Septoria disease the first year.

The possibilities for realizing much of the higher yield potential of these new varieties are much greater under irrigated conditions where wheat is grown as a rotation crop with row crops than under rainfed conditions. As a rotation crop, bread wheat profits from the perennial weed control, reduction in annual weeds, break in the insect and disease cycle and residual fertility resulting from the cultivated row crops grown ahead of it. Because yields have been consistently high (5-9 ton per hectare) and wheat requires minimum irrigation (two irrigations before the peak season of water use) it has remained a major crop in the rotation system of irrigated perimeters.

The situation under dryland conditions is much more complex. The project was too short for it to examine the required changes in the farming system needed to maximize the yield potential. It also did not have a direct link to an adequate research and extension institutional structure which would have permitted farmers to realize the potential yield increases from using high yielding variety seed. By the time the farmers were able to get hiogh yielding variety seed, they had neither the project nor a residual institutional base to help them figure out how to use it. This left the task to them.

This period of new variety introduction coincided with some rapid changes in the farming community in Morocco and swift advances in dryland crop technology in the industrial countries. The major change in Morocco was brought on by rapid urbanization associated with increased cost and scarcity of farm labor. This resulted in rapid mechanization of the larger commercial farms initially and, ultimately, almost complete mechanization of the agricultural sector. Unfortunately, the mechanization of the semi-arid

agriculture of Morocco was patterned after the recent mechanization of the abundant rainfall agriculture of France rather than the new techniques developed specifically for semi-arid rainfed agriculture in North America and Australia. This led the farmers to use the wrong techniques with greater speed but not necessarily greater efficiency in terms of output. In addition some of the worst aspects of traditional agriculture were kept such as excessively deep plowing, broadcast seeding and weedy fallow. These prevented the ready use of new technology designed to selectively remove wild oats from wheat and control the deep rooted weeds that are highly efficient in removal of soil moisture. The higher potential dryland areas of Morocco have some of the heaviest infestations of various species of wild oats of the genus Avena and perennial weeds of the genus Convolvulus (bindweeds) and other similar species. These and other weeds were made abundant as a result of the weedy fallow system and they respond vigorously to improved fertility which is pre-requisite to achieving the yield potential of the improved varieties. Efficient control of wild oats with selective herbicides is dependent on easy charting of the density and growth state of the wild oats by the farmer. This is easy to do between drill rows of drilled grain, but almost requires a skilled botanist when grain is broadcast at heavy seeding rates.

Even the proper use of selective herbicides for control of the large diversity of broadleafed annual weeds has been made difficult because the herbicides should be used when the weed seedlings are very small, but it was traditional to weed just before flowering to get the maximum benefit for livestock feed. At this stage under improved fertility, the weeds will have used up most of the available moisture and be beyond the stage of ready control with herbicides that are highly effective only on very small weeds. Furthurmore, the grain is sometimes damanged if sprayed when it is more mature.

Efficient perennial weed control is based on weakening the plants through properly trained cutting with a sweep plow or rod weeder during clean tilled summer fallow, followed by treatment with herbicides after grain harvest during the crop year. This system will not work under the weedy fallow system which was (and is) used in Morocco.

In addition, the disc or cover crop plow that has been introduced as the universal tillage implement is ideal for drying out the soil to ensure loss of any residual moisture. This is exactly opposed to the best known principle of moisture conservation which uses only shallow tillage with chisel or sweep plows. These require much less power, fuel, are faster, cheaper and reduce erosion potential in addition to moisture conservation. Ironically they are much more similar in end result to the old animal-drawn crab shallow draft plow.

Therefore, the new varieties yield slightly more under traditional systems than those they replaced, but have much higher potential that cannot be reached without major changes in the

farming system. These are largely dependent upon finding acceptable changes in the feed system for livestock that are a pre-requisite for changing the system. Some large farmers have eliminated livestock and have adopted a modern dryland agricultural technology package with notable success, but they are still a minor exception.

At the time the AID project started intensive breeding research on durum wheats and barley were only beginning. Recent advances offer near assurance that suitable quality durum wheats that have at last equal yield standard to the best bread wheats are close at hand. This should result in a shift to durum which has a higher market price. The increased level of yield potential for barley may be even more encouraging. Therefore, there is a need for an institutionalized research and extension system that can direct the needed changes in the crop/livestock system required to realize a significant amount of the new yield potentials in the offing.

Many of these new higher potential bread wheats, durum and barley varieties have been long in the pipeline of the Moroccan research and input system, but because of failure to change from an obsolete catalogue system inherited from France, to the almost universal current systems of variety development and release, the Moroccan system has led to nearly a decade of delay in introducing new germ plasm and associated inputs to the farmers.

B.Policy Effects and Economics

1. Policies

It would have been possible for farmers to have adopted improved practices more widely and expanded the production of wheat within existing giverment policies. Farm gate prices were generally weighted in favor of providing incentives for wheat production. However, other policies were generaly not supportive of the farm gate price policy and did not provide the additional incentives which would have encouraged the adoption of new technologies in order to increase output. Clearly a comprehensive set of policies and practices is needed; i.e., reasonable incentive prices, physical inputs supplied at time and place neded, perhaps credit, and a system for providing farmers with cost reducing, yield increasing technology.

On balance, it would appear that policies of the Moroccan government were not favorable to the adoption of new high yielding wheat varieties and expandeing the production of wheat. While it is true that government had a declared policy of increasing production of cereals, including wheat, using both producer prices and subsidies to this end, other policies probably offset the positive effects of producer prices and subsidies. The problem with the product and input price system was that it required large budgetary outlays by government without stimulating increased wheat production. In addition to probable supply elasticity constraints in wheat production, the total wheat price policy of the Moroccan government may well have had a negative effect on wheat production. First, it must be recognized that only about 10% of total wheat production is marketed through government channels and is directly

affected by government price policy. The remainder of the wheat is either used on the farm or sold in non-subsidized local markets. In the local markets prices are typically lower than the support price immediately after harvest and above the support price for the remainder of the year. Second, the absolute price of wheat flour and the relative price of wheat flour and wheat have important consequences for cereals production and marketing.

The relatively higher producer price for wheat than for barley and the low consumer price for wheat flour tend to shift production and consumption from barley to wheat. As wheat flour consumption increases at the expense of barley, the attractiveness to government of minimizing subsidy costs tends to increase demand for imported wheat relative to domestic wheat. At the same time there is a tendency to substitute wheat production for barley production, often in areas that are marginal for wheat production. Wheat farmers can increase income by marketing more of their wheat and buying wheat flour. There are some fairly clear indications that farmers will sell wheat and buy flour, not only for human consumption but for animal feed. It also appears that farmers have shifted out of producing wheat by allocating labor to other agricultural enterprises or to non-agricultural employment as the price of flour continues to decline relative to other prices. Thus, at best, the divergent consumer and producer price policies have provided confusing and inconsistent signals to farmers with consequent adverse effects on cereals production in general and wheat production in particular.

Other government policies would appear to have had little positive effect on new technology adoption and production expansion. At best, subsidies on agriculture inputs do not for the most part fully offset price increases brought about by taxation. The combined effect of import duties, other indirect taxes and input subsidies is to increase the cost of farm inputs to farmers. Thus, government policy in this area is not likely to favorably influence adoption of new technologies using greater amounts of purchased inputs. Rather, it is likely that subsidies for the most part flow to those better off farmers who would use the inputs necessary to the new technologies anyway. In a similar manner, investment policies favoring irrigated agriculture have at least been partially responsible for the failure of government to assign higher priority to developing institutional support for the introduction of new technologies in wheat production. As noted elsewhere in this report, government priorities severely limited personnel available for institutionalizing within the Ministry of Agriculture the capability to carry out necessary continuing research, testing and trials of improved wheat technologies. Finally, foreign trade and foreign exchange policies favored importation of wheat and the allocation of resources to non-cereals crops.

2. Economics

Given the minimal economic analysis undertaken in connection with project implementation or subsequently on wheat production and

marketing, conclusions on the economics of new technology adoption unfortunately cannot be drawn. To what extent widespread adoption of improved wheat varieties would have provided significant economic benefits either to farmers or the national economy is uncertain. Some farmers clearly did believe they would profit from using improved seeds. This minority continues to use the improved seeds and associated cultural practices. For a variety of reasons other farmers did not use them and clearly government apparently did not believe according high priority to adoption of new technologies in dryland wheat production would contribute significantly to the wealth of the nation. It is not clear whether this policy was adopted on the basis of analysis or in the absence of such.

C. Relation of Project Factors Affecting Dryland Agriculture

As noted above, the original 1967 project paper called for a 50% increase in wheat production by 1974. This would have required increasing production to 1,860,000 tons by FY 1984. Since the boom harvest of 1978 produced over 2,778,000 tons, one could judge the project either an instantaneous success or irrelevant. In fact, the occurrence merely demonstrates that simplistic measures of success for highly variable systems can be completely inappropriate. In many instances, quantifiable data is unreliable and at best illustrative, and, if one wishes to be honest, one must rely on a synopsis of informed judgments of how interdependent factors seem to balance out. For the case in point, because the actions taken were so direct and simplistic (in the sense of attacking only one factor in a complex equation), the results seem fairly clear cut, and may be delineated as follows:

1. Positive Effects

a. New Seed Varieties:

The project seems to have made a significant contribution to the introduction of high yielding varieties of bread wheat and to have provided the impetus for initiating a breeding program for durum as well. New seed has to be renewed approximately every five to six years. It is estimated that approximately 40% of seed bought by farmers is certified high yielding varieties. Nasma is apparently the most popular bread wheat grown. Siete Ceros itself continues to be grown in irrigated areas. Among the most popular durum varieties are Jori and Coccorit, also CIMMYT stock.

b. Wheat Production:

Cereal production in general, and wheat production specifically has increased somewhat over the last ten years. Since this is true of barley as well as wheat, other factors than the introduction of high yielding varieties must be partially responsible. The situation is multifaceted. These factors and the apparent direction of their influence is presented in Figure 1.

FIGURE 1

PROBABLE EFFECTS OF VARIOUS FACTORS ON

MOROCCAN CEREAL PRODUCTION 1968 - 1983

POSITIVE FACTORS	TOTAL CEREAL PRODUCTION	NEGATIVE FACTORS
	Climate	Drought
	Land Distribution	Urban expansion - Fragmentation of holding (high cost of utilizatio poor economy of scale, general unprofitability)
	Farm Management	Increasing absentee Ownership, Sharecropping Limited mastery of new techniques (poor daily management, disinterest in long-term investments, Misapplication of new Technology)
	Labor	Rural Outmigration (Labor constraint)
+ Mechanical Plowing (Better timing for seeding, breaks labor constraints	Mechanization	Deep Plowing (Disc Plow over-exposes soil)
+ Less Legume Production (More land for cereals)	Crop Choice	Other crops (citrus, forage, sugar) (Loss of cereal land)
+ HYV Wehat Seeds (Greater yield per hectare)	Seeds	
Increased demand & value of straw & other byproducts	Aniaml Production	Increased Forage and Wee Production

- Less Fallow Land (Increased hectares for grain)	Fallow Practices	Less Fallowing (Increase in weeds, long-term decrease in soi quality)
POSITIVE FACTORS		NEGATIVE FACTORS
(Increased yields and overcomes labor constraint for hand pulling weeds	Herbicides	Reduced weeds for live-stock feed
+ Increases Yields (If used properly)	Fertilizer	Decreases yields (In drought year)
+ Increased Production (Per hectare)	Irrigated Ag.	Loss of Inputs to Dry-land Ag.
+ Encouragement High Input subsidies Farmgate Price	Government Policy + Practices	Consumer Subsidies (Reduced allocation of local resouces to produce bread cereal)
Breeding program, even though modest has identified improved varieties for local conditions	Research	Emphasis on irrigated crops has retarded development of dryland technology
	Extension	Concentration on irrigated areas has restrained information flow to dryland areas

The lack of precise statistics and controlled observations makes it difficult to give weighted value to these factors, but observations and opinions, including farmer acceptance, indicates high yielding varieties played some role. This, combined with the other positive factors noted, has not, however, been able to override the effect of negative pressures in a way which would have brought about significant increases in production. Apparently it has not been demonstrated that specialization in "modern" technologly for either wheat or forages is clearly superior to the sort of diversified production strategy employed by the general run of small farm operator.

c. Research Contracts and Awareness:

Over the last ten years CIMMYT, has maintained regular contact with Morocco, and has supplied new materials for testing. As such, it has been the main source of research input into the country and the major contact of its seed breeding program. The contribution has, however, been almost entirely in terms of contributing results of research rather than the creation of in-country research capability.

d. Beneficiaries:

Larger farmers, because they grow more bread wheat than smaller farm operations, and because they have more capital to invest in necessary accompaniments to high technology agriculture, (fertilizer, seed, machinery, herbicides, etc.), have been the major beneficiaries of innovations in agriculture, including the introduction of high yielding varieties. At the same time, the effects of the project are being felt more and more by smaller operators, not only as techniques spread but because, especially in the last three years, drought conditions have forced many small farmers to purchase seed on the market. The precise effect on income of high yielding variety use has not been established, though adaptation would seem to be indicative of profitability.

2. Negative Effects

While the project may not have lived up to expectations, no negative effects were identified. As explained below, the influence of the project on identifiable policies, practices or phenomena negatively effecting agriculture production appear basically neutral.

3. Neutral Effects

While the USAID project had little effect on the following factors, it seems wise to highlight them both because they are crucial elements in the equation, and because it should be understood what the crucial determinants are.

a. Grain Consumption Patterns and Prices: Traditional Moroccan grain consumption patterns have ben substantially altered , especially in urban areas, by the avaiability of cheap subsidized bread. It should be emphasized that the apparent effect of government procing policies has been to shift demand from other grains to bread wheat and to increase the total amount of grain consumed. However, government apears to have attempted to satisfy the increased consumption of wheat with imported grain rather than

instituting the policies and practices which would bring about increased production of wheat.

b. Mechanization, Rural Outmigration and Labor: While new HYV seed use generally comes with a package of technology that includes mechanization, the push to mechanization is already far advanced due to labor shortages caused by migrant labor. There is no evidence that mechanization is pushing rural labor out of jobs. The major determining factor is the pull of urban wage earnings.

c. Land Ownership: While most agricultural innovations in Morocco, including those introduced by the USAID/CIMMYT project, tend to reach a disproportional percentage of well-to-do rather than small large farms, the existence of large farms mainly reflects the continuation of pre-independence distribution patterns. The major change has been from French to Morocco ownership. As regards land ownership, any meaningful policy, including one favoring small farmers should, should seek to develop and maintain a system which provides the farm operator with the land resources necessary for utilizing improved technology.

d. Institution Building: The lack of any real institution building component was a major deficit in Moroccan government priorities. The situation has remained largely unchanged, with the exception of some recent activities that are beginning to try to belatedly respond to this need.

e. Associated Practices: Already noted has been the existence of several negative agricultural practices that have evolved over the last two decades; especially inappropriate deep disc plowing, reduction in legume production and increase in poor fallow practices. All these are counter productive to practices that should accompany high yielding variety use.

VI. CONCLUSIONS AND LESSONS LEARNED

The proceeding description and analyses have indicated the highly complex nature of the multiple factors which have influenced dryland cereals production in Morocco since the initiation of the AID project in 1967. Moreover, cereal production itself is part of a larger series of diversified activities which impinge on wheat production. All of these influenced the effect project activities had on on a dynamic development situation over time. The introduction of high yielding bread wheat varieties in Morocco produced some positive results. It did not, of course, lead to the spectacular increases in production indicated in project preparation and approval documentation. There were a host of factors which mitigated against achievement of such results, including, but by no means limited to, the fact that available high yielding bread wheat varieties could, at best, affect only 25% of the wheat crop. However, the use of these high yielding varieties has been firmly established among a significant portion of the wheat producing community, new varieties suited to growing conditions have been developed from imported Mexican and other varieties, a continuing beneficial relationship has been established between CYMMIT and Morocco and the complexity of problems which must he dealt with in order to have significant effects on production are better understood. In addition, lessons learned from the project experience and subsequent events should beneficially affect future dryland farming development activities in Morocco.

A.Producer price policy in and of itself is unlikely to elicit a positive supply response from dryland cereal producers for at least two reasons. First, as illustrated above, other policies such as government investment priorities policies may have offset the possible positive effects which might hava been obtained from maintaining prices paid to farmers above world market levels. Second, technical, environmental, social and economic constraints may limit farmers ability to respond to price incentives. Adequate price policy is a necessary condition for increasing dryland cereal production but it is not a sufficient condition. The ready availability of a cost effective production technology at the farm level was clearly necessary if farmers were going to be able to respond to price increases.

B.The risk factor is highly important and increases in importance as annual average rainfall decreases and average annual rainfall variation increases. In undertaking activities to increase agricultural production for dryland farming it is essential to understand how farmers manage, (co-exist with), risk. Farmers assess the probabilities of success or failure in making management decisions. If time honored risk management techniques are not compatable with moving to a new production function based on improved techniques, then risk management tools with a probability of risk avoidance acceptable to farmers must be included as part of the package of practices.

C.In attempting to bring about changes in dryland cereal production, it is necessary to understand the relationship between livestock and cereal production. Decisions by farm managers about the adoption of new cereals technology may be influenced as much or more by the existing animal production technologies and husbandry as by those for grain production. In calculating costs and benefits from the proposed introduction of new cereals technologies the value of the product as animal feed must be included as part of the calculation of economic or financial benefits. It is also possible that certain practices which are considered as negative factors for the production of wheat alone may become positive factors when livestock and wheat are considered as two components of a farm operation.

D.During the period of project implementation and impact it is highly probable that there will be a continuing series of changes in the economic, social, physical and technological environment which will either directly or indirectly affect achievement of project purposes and goals. These probable changes need to be taken into account when project accomplishments are being projected. In the Morocco situation there were a number of changes during the following project implementation which affected project impact.

1.Perceived, and obviously to some extent real, opportunities for employment at increasing wage rates in urban areas and abroad increased the cost of labor and affected farm resource allocation.

2.There was increasing seperation of ownership and management of farm enterprises.

3.The amount of higher rainfall areas used for production of wheat decreased as farmers sought to increase income by switching to production of non-cereals crops.

4.The use of farm machinery for cultivation increased substantially, particularly some form of contract or share machine operations, noticeably increasing the influence of tillage practices on crop production.

5.A continuing supply of relatively inexpensive wheat imports from the world market, except in th 1974-6 period, enabled the government to meet a perceived political requirement for supplying cheap flour to the urban population without undue reliance on domestic production of wheat.

E.Government priorities need to be fully taken into account. They must be fully consistent with project plans and objectives. In the Morocco situation attempts to institutionalize a wheat research capability within the Ministry of Agriculture failed because project and government priorities were incompatable. On a more general level, government priorities in agriculture were directed towards development of irrigated agriculture and producing crops which could enter into the export trade rather than towards increased wheat production.

F. Without effective institutionalization of research, information and an imput supply system it is impossible to sustain

the continuous identification or re-varification of the precise technological or socio-economioc problems and the development of solutions Those problems identified before a project begins can and will change over time. In addition, there is not likely to be an homogeneous set of, say, weed or fertility problems across large areas. This means that better location specific technological, physical, farm management and market information needs tobe availaable than appears to have been the case with the Morocco projects.

The lack of priority accorded to wheat production prevented implementation of a sustained institution building effort which is essential to the development and introduction of new technologies. Absent this kind of sustained effort, it is unlikely that either necessary continuous development and maintenance of technological progress will occur or that adequate information or input supply will be effectively available to farmers. Certainly this proved to be the case in Morocco.

FOOTNOTES

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2. Ibid., p.82.
3. Willard H. Meineke, Action Memorandum to the Assistant Administrator for Africa, AID, Washington D.C., Jan 15, 1968, p.2.
4. Non-Capital Project Paper, Morocco, Increase in Cereals Production, AID, Washington D.C., 1968, p.4.
5. Op.Cit., pp.1-2.
6. Op. Cit., p.5.
7. Technical and Capital Assistance Project Proposal, Increase in Cereals Production, USAID, Morocco, Feb. 15, 1967, p.7.
8. Ibid., p.7.
9. Planning for Agricultural Devbelopment in Morocco, Stanford Research Institute, Menlo Park Calif., March, 1966, p.1.
10. Ibid.
11. Morocco: Role of Fertilizer in Agriculture Development, Tennessee Valley Authority, 1967.
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13. Technical and Capital Assistance Project Proposal, Increase in Cereals Production, USAID, Morocco, Feb. 15, 1967, p.7.
14. Ibid. p.14.
15. Op.Cit., p.4.
16. Interview with Mohammed Hanafi and Arlen McSwain.
17. Ralph J. Edwards, End of Tour Report, USAID, Morocco,June, 1972, p.4.
18. Letter from USAID Director Philip Birnbaum to Mamoun Thini, Minister of Finance, Government of Morocco dated Sept 12, 1969.
19. See for example, F. J. Bell. End of Tour Report, USAID, Morocco, 1975, pp.8-12.
20. Ralph J. Edwards, End of Tour Report, USAID, Morocco, June 1972, p.5.
21 Letter from Norman F. Borlaug to Sbihi Abdelbadi,Minister of Agriculture, Government of Morocco, dated July 5, 1971.

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