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ROYAUME DU MAROC



# AL AWAMIA

REVUE DE LA RECHERCHE AGRONOMIQUE MAROCAINE



Institut National de la Recherche Agronomique

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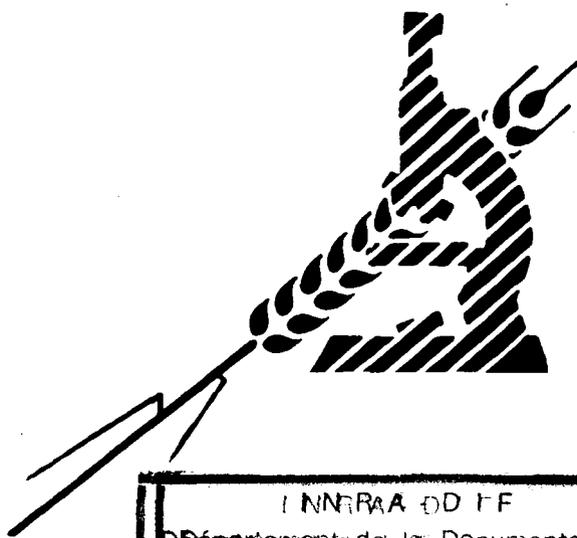
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REVUE DE LA RECHERCHE AGRONOMIQUE MAROCAINE



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## AGRICULTURAL RESEARCH SYSTEM IN MOROCCO

Hussein FARAJ \*

### *AGRICULTURALE BACKGROUND.*

In 1984, rural population in Morocco reached about 12 million/constitutes 56% of the total population (21.4 million). in the same year agricultural production accounted for 18.9% of the gross national production. Considering international trade, agricultural commodities represented 25% of total imports and 30% of total exports.

Total arable land in Morocco is about 8.3 million ha out of which nearly 90% is rainfed. About 28.5 million ha are semi-arid and forest regions suitable only for grazing. Between 40 and 50% of cultivable land receives erratic rainfall less than 400 mm.

Main field crops include cereal and food legumes which cover 91% of the total cultivated land. Cereals cover about 4.5 million hectares and average yield is about 900 kg/ha. Food legumes cover about 500.000 ha and yield averaged 600 kg/ha. Sugar crops are grown on 64.000 ha for beets and 16.000 ha for cane, with average yields of 40 tons/ha and 70 tons/ha, respectively.

Vegetables cover 200.000 ha of which 16.000 ha are developed for exports. Fruit trees (citrus, vineyards, date-palm etc.) spread over 360.000 ha.

Olives cover 314.000 ha and total production reaches 340.000 tons annually.

Forage crops cover 180.000 ha while range lands (grazing) are estimated at 28.5 million ha.

The main objectives of agricultural development are :

- To improve self-sufficiency ratio in major food-commodities.
- To improve agricultural exports.
- To increase revenues for farmers.
- To promote agricultural industry.

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\* Hussein FARAJ : Director Of National Institute for Agricultural Research (INRA)  
MOROCCO - Février 1988.

To achieve those major goals, a great deal of measures were implemented since independence. A large portion of total investment in agriculture was allocated to irrigated land : currently total land under permanent irrigation is about 815.000 ha. Considerable efforts were devoted to improve production in rainfed areas ( 7.4 million ha ) through integrated projects which include a package of activities covering production equipments, social facilities and farmers association.

Activities also covered improvement of essential needs of villages in rural areas such as water for various use, electricity and road construction.

Activities also include preservation of the natural environment by land management against erosion on 300.000 ha and by forestation of 17.000 ha annually.

For improving the size and the productivity of farms, a land reform strategy was implemented on 446.000 ha and land consolidation measures covered 614.000 ha.

Training and technical know-how is a special concern to authorities. Currently, the number of agricultural engineers is about 2000 while technicians reached 2700. All this was achieved after independence.

The use of more inputs to improve agricultural productivity is encouraged through different means : giving loans to farmers at low interest rates ; subsidizing certain farm machinery, fertilizers, high quality seed and farm chemicals.

Specific activities were undertaken to encourage and promote livestock production and animal products - e.g. meat, milk, eggs, etc.

All these measures were stimulated and complemented by a price policy and restructuring the trade cycle in favor of the producer and consumer.

This brief background on agricultural production and policies indicates the tremendous task which researchers have to address themselves to. The numerous diversity in crops and other agricultural commodities as well as the wide range of climatic conditions, require an ambitious number of research programs to satisfy the need of the agricultural sector in Morocco.

## NATIONAL AGRICULTURAL RESEARCH SYSTEM.

Agricultural research work in Morocco is assigned to a specific institute called the National agricultural Research Institute (NARI) - i.e. in French, « l'Institut National de la Recherche Agronomique », (INRA). However, other national institutes conduct research work relevant to agricultural development. A brief summary on the activities of various institutes will be given below :

*NARI (INRA)* : The bulk of agricultural research work in Morocco is done by NARI. The role and activities of this institute will be discussed in some details under the next major topic.

*Division of Forest Research (Direction des Eaux et Forêts)* : This research unit includes 10 scientists. Activities include forest establishment and management, introduction of exotic species, intensification of forests important for industry (Eucalyptus spp. for paper manufacturing), regeneration of local species (Cedraie, Oak, Arganerie), disease control, and wood technology.

*Experimentation Center (Centre des Experimentation)* : This is a department in the Ministry of Agriculture. It includes 15 scientists dealing mainly with determination of «crop water requirements» for irrigated crops (sugar cane and beet, soybean, alfalfa etc.). Irrigation parameters are also studied in these crops.

*Sugar Cane Center (Centre Canne à Sucre)* It is a part of a development agency for irrigation in the Northern part of the country. This unit (7 scientists) work mainly on the agronomy of sugar cane : fertilization, harvest cycles of vegetation, comparison of varieties, etc.

*Academic Institutes* : The main two institutes are the Hassan II Institute of Agriculture and Veterinary Medicine (I.A.V. Hassan II) and the National School of Agriculture (ENA) at Meknès. These educational institutes gather 400 professors who devote of their time on a wide range of research subjects relevant to major crops and livestock and covering all disciplines. Almost all research topics selected are relevant to development. Therefore, the two institutions are strong and efficient partners of NARI. Both have a specific agreement with NARI to cooperate in research and development and to coordinate their activities to avoid duplication of efforts.

*Faculty of Science* : Scientific faculties (like the faculty of Science in Marrakech) cooperate with NARI on the Saharian Project. It studies the biological process of disease infestation of date-palms by Bayoud.

Beside these research and academic institutes, we must complete the picture by the numerous research activities and contribution done by development agencies, private farmers, state farms and private companies. Some initiated very specific studies and experiments which were needed to achieve goals of economic importance. Such studies could not be treated by government institutions because their field of applications is very narrow. Involvement of NARI with such projects is unjustified because of other pressing priorities and lack of facilities.

In brief, the national agricultural research system consists of several research, academic, public and private organizations. However, NARI is the heart of these institutes with an official mandate to solve most problems facing the agricultural sector through applied research.

#### NATIONAL CENTRAL AGRICULTURAL INSTITUTE AND RESEARCH CENTRES

The history of agricultural research in Morocco started in 1919 when a « Service de l'expérimentation agricole » was established in Rabat as a division for agricultural experimentation. From that time, this institution has changed considerably in structure and mandate and led to the creation of National Agricultural Research Institute (NARI) early in 1981. NARI is a state institution with autonomous legal and financial systems.

Officially, NARI was passed by a law by the Parliament in Decembre 1980. Its mandate and objectives are as follows :

1 - to initiate and undertake applied research work scientifically and economically focusing ou crops and livestock.

2 - to initiate and conduct long term studies particularly the se dealing with natural resources and the improvement of crop and animal production.

3 - to develop, through its own resources or those of others, experimental studies dealing with introducing exotic crops as well as introducing new technology for animal production improvement focusing on processing technoly and utilization.

4 - to evaluate research work done for the benefic of public agencies.

5 - to spread technical information and documents produced by its own reseach programs as well as research conducted abroad.

6 - to provide technical and usefull information to the extension services and identify the most efficient procedure to convey such information to farmers.

7 - to commercialize results of research work and studies.

NARI is a governemantal institution governed by a Board chaired by the Minister of Agricultural. Members include representatives of the Ministry of Finance, Education, Health, Interior, in addition to appropriate representatives for farmers. The mandate of the Board is to decide on programs, budget and salary scales. A Technical Commission follows up on the decision taken by the Board.

In addition to the Board and technical Commission two main committees play a great in determing objectives and programs of NARI : The first committee identify long term objectives that will benefit the country through contacts with economic leaders and organizations. The second will help the director of NARI to evaluate programs and staff through senior scientists.

Several structural and functional changes were proposed for NARI after three years of interral review assisted by a survey done by ISNAR. The changes were approuved by the Board. After NARI reached its present structure. The new structure consists of seven main units and/or divisions dealing with management, seven additional multidisciplinary research departments and eight regional research centers. The managing units and divisions include :

- social fund,
- general inspection,
- computer and biometry department,
- information and training division,
- programming division,
- regional centers division,
- administrative operations division.

The « social fond » unit helps in solving social problems such as housing transportation, entertainment, etc.. through financial resources provided by the budget and participating staff.

The « general inspection » unit conducts inquiries on mismanagement when happened an provide recommandations on proper management.

The « computer and biometry department » must develop and undertake statistical analysis methods and computer facilities to assist analysis of research results as well as helping the managing staff in accounting for financial matters for both research work and administration.

The « information and training division » collects and documents scientific informations relevant to the research staff and must disseminate information for extension and scientific use. The same division is in charge of cooperation with national and international institutions.

The « programming division » assist scientists to set up the research priorities and programs based on informations from farmers, organizations, extension services and other research staff. The « needs of research » are determined and a multidisciplinary program is scheduled. The same division prepares for evaluating research results after two or three year, taking into consideration two main aspects : the progress to achieve research objectives and results relevant to farmers.

The « center division » has to carry a very difficult job. It should determine the adequacy and availability of facilities for research programs through the appropriate allocation of financial resources and manpower among eight regional centers. In addition it has to follow up on daily problems of the centers.

The « administrative operations division » deals with the administrative management of staff and finances. However, it is important that this division gives a high level of autonomy to central and regional research units to manage their own operations.

Each regional center consists of its own administrative units, experimental farm and « research and development » unit. Depending on the size of the program each center has one to four research stations.

The heart of NARI is made of seven departments dealing with multidisciplinary research :

- plant breeding
- plant diseases
- agronomy
- livestock
- food technology
- natural resources
- socio-economy

Departments and their facilities are stationed either at the headquarter or in the regional centers. Before the latest restructuring most departments and facilities were concentrated in Rabat because of poor facilities in the regional centers. The current is to restation staff to form a large regional multidisciplinary teams to concentrate on specific research problems relevant to the region. We consider that if on one region is very well studied through such a team, proper solutions will be available for farmers and the new improved technology will be transferred more readily. This explains why some departments are lead by researchers located in regional centers. Such as agronomy and socioeconomy in Settat. This also explains why some programs are ruled by regional programs like the « druland program » in Settat, « Saharian program » in Marrakech and « Citrus Program » in Kénitra.

To complete the picture of the organizational structure we must mention two coordinating committees : the program commission which determines the list of research operations for a discipline or a commodity ; and the regional commission which links reseach, extension and farmers to develop joint on-farm trials.

#### *CURRENT AGRICULTURAL RESEARCH.*

In order to give a brief review of current research work, we propose to « split » problem areas into crop commodities, farming systems and research discipline.

##### *Crop Commodities.*

Due to the major importance of cereal crops in the economy of many farms, research efforts were concentrated on yield improvement mainly through plant breeding in continous cooperation with CYMMIT, ICARDA, ACSAD and at some instance with Italy, France, USA and Tunisia. During the last 4 years, about 30 varieties were registered for bread wheat, barley and durum. Breeding methodes included introduction and multilocation, evaluation, of exotic germplasm as well as cultivars developed through hybridization and selection. The moste promising impact of the new varieties is expected in the very dry parts of the country where annual rainfall does not exceed 330 mm. We hope to have significant increase in production with the release of new barley varieties : TAMELET, developed by NARI, ACSAD 60 and ACSAD 176, provided by ACSAD and tested for the last g years. During the last season, triticale showed good tolerance to the severe drought and this will be extended to about 2000 farms next season. In wheat, an introduced variety from South Dakota proved to be resistant to the serious Hessian fly and this will be released to 300 farms.

Of course, traditional agronomic experiments are conducted on methods and dates of sowing, fertilization, weed control and other improved production technologies. Interesting results were in weed control whereby yield was increased by 30% as result of weed control in dry areas. A national campaign is launched each year on this point. In food technology, it was demonstrated that both triticale and barley can be used for bread making which is very interesting in Morocco since bread wheat and durum are the ingredients of bread. This may lower the amount of importation.

In food legumes, which are largely planted after cereals the most promising work was conducted on winter chickpea introduced by ICARDA. After 4 years of intensive experimentation, demonstration and multiplication, two varieties are to be distributed to farmers.

In ail crops experiments consist of testing sunflower, safflower, soybean and mustard. These crops are now cultivated by farmers on very limited areas and thus self-sufficiency ratio is only 5%. In the near future, stronger emphasis will be given to research on oil crops.

Olive trees had been experimented upon for a long time and results are now available on varietal adaptation for different agroclimatic zones as well as proper methods for pruning. Significant increases were obtained in yield through «regenerating pruning», disease control and in some cases use of small amounts of soil nutrients in traditional areas. Promising results are expected from improving traditional cultural practices.

Just after independence, the government concentrated on increasing the self-sufficiency ratio of sugar. Sugar consumption in Morocco is 29 kg per capita, which is among the highest in the world. Earlier studies during the protectorate period indicated a good potential for sugar beet production. Sugar cane, though was produced long time ago, was dropped as a crop. Due to concentrated research efforts with the help of GTZ, 72000 tons of sugar beets were produced in 1963 and were processed by the first sugar beet factory. With the increase in irrigated land, sugar cane production became economically feasible and 9000 tons were produced in 1971. For both sugar crops, the same improvement methods were followed: good varieties; better date of planting and harvest methods, weed control, fertilization, and disease control. As a result of these efforts, self-sufficiency ratio in sugar became 75%. Research on sugar cane will continue with emphasis on varietal resistance of sugar cane to frost. Livestock production accounts for 35% of the total agricultural cross production

The main production constraint is feed availability for cattle in the dry seasons particularly during summer. In irrigated land, several crops can be cultivated for feed production such as berseem, alfalfa, corn and sudan grass. In addition, great deal of crop residues are available such as leaves of sugar beets bulb of citrus. Under rainfed conditions, the feed problem is more difficult to solve. NARI, with the help of GTZ, decided to focus on forage research for rainfed areas. The area allocated to these experiments is considerably large to cover the different agroclimatic conditions. About 20 million hectares are devoted to grazing under various rainfall patterns ranging from 100mm in the North to less than 100 mm in the South. Most of the research is on on-farm trials (75% of the experiments). Different ways of improvement were suitable depending on climatic conditions : introduction of new crops, small additions of nitrogen, changes in rotation systems (medics).

Citrus production was emphasized immediately after independence. Between 1955 to 1975, citrus areas increased from 48.000 ha to about 72.000 ha. About 600.000 tons are exported annually, 75% of the total production. Main research objectives include increase productivity per unit area and reducing production cost. NARI produces disease-free root stocks and grafts. Another objective is to develop through selection earlier or later maturing genotype for better marketing prices. Other research work considers fruit qualities.

With other fruit trees, NARI focuses mainly on the improvement of traditional species like in almonds and apricots and exotic species like pistachio. Other fruit species which require considerable investment are experimented upon by the private sector and farmers themselves (banana,, apples).

Research on vegetables deals mainly with crops important to the export market such as tomatoes and potatoes. It covers varietal evaluation, disease and weed control. The main objective is enhance off-season production and reduce production cost. Competitiveness for trade with the EEC market increased as Mediterranean countries particularly Spain joined the EEC. With a loan from the World Bank, integrated activities were launched on green greenhouse management and production in association with researchers, farmers and traders. Within four years areas covered by greenhouses are about 1500 ha. Recently research is concentrating on identification of exotic crops with good marketing potential for the European Market.

NARI also carry out research on industrial crops like cotton and tea. In cotton, four varieties were recently released. Continuous

work is being done on identifying effective pesticides for the numerous disease and insect pests. Research on water-use efficiency is becoming very important due to drought. At the request of farmers, NARI began to look for early maturing varieties, plastic covers to enhance emergence, and effective desiccants to shorten the life cycle of the crop. In tea, NARI was requested in 1963 to investigate the possibility of growing tea in Morocco. The first experimental plot was planted the same year. Currently advanced experiments are conducted by « l'office de mise en valeur du Loukkos ». The production area so far does not exceed 200 ha on sandy soils and under forest trees. Because of specific adaptation, it seems difficult to spread tea production to other soil types and climates.

#### *Farming Systems.*

Two programs are implemented with respect to farming systems : the dryland program, based at Settat ; and saharian program at Marrakech. The objective of the first program is a identify crop species and genotypes adapted to areas where rainfall is below 300 mm ; and (b) to determine appropriate production technology and cropping system for such areas. The project began in 1980 in cooperation with USAID and a consortium of five Mid-Western Universities referred to as MIAC. The program deals mainly with cereals, food legumes, forage, fertilization, farming system, farm machinery and socio-economy. For cereals, the main aim is to control losses caused by Hessian fly. Chemicals are efficient but expensive and biological methods not certain. Thus the most practical method is genetic resistance. Sources of resistance were identified in introductions from the USA. A resistant cultivar is expected to be developed in 3 years through selection within segregating populations originating by hybridization of the exotic resistant genotypes and well adapted local cultivars. However, one variety introduced from the U.S.A. has a good level of resistance was put last year on the catalogue trials to be considered for registration.

Experiments on triticale conducted during the last four years indicated that the crop is very promising in semi-arid areas. A specific project on triticale started with CYMMIT.

Corn is grown by farmers as a spring crop in spite of drought considering the importance of the crop as a fodder even if grain yield is nil. Research is directed to identify varieties which can guarantee a minimum yield for the farmer under severe conditions.

In food legumes, we are trying to expand on lentil and

chickpea production as much as possible. Good hopes are expected in winter chickpea.

The forage program is concentrated on medic based on Australian experience adapted to local conditions.

Fertilization experiments conducted for many years on research station were inconclusive. However, changing the procedure and using calibration methods gave good results in the same kind of climates. Within two additional years of experimentation, the first recommendation could be given to farmers.

Long term experiments on farming systems deal with rotations : various kind of rotations are tested using fallow, continuous wheat, food legumes and other crops. The impact of various rotations systems on water-use efficiency is evaluated.

The farm machinery program is focusing on the need of small farmers who are the majority. All farming implements are developed and tested to be towed by animal power or small engines. A new type of sweep was developed and patented. Experiments on no-tillage are also being conducted.

Many socio-economic studies were conducted on farmers fields to determine the economic feasibility of improved practices. After sampling farms, some are taken as representatives to express farmers view points on many issues. The main objective is to understand farmers, choices based on availability of resources on their farms, market and price hazards, means and facilities offered by the public sector. After good and clear understanding of farmers, views, research objectives may be developed or modified to meet farmers needs. Many research are verified under farmers conditions. Socio-economic studies make research cooperate with extension agents and or directly with farmers themselves.

The saharian program and more particularly date-palm is currently focusing on Bayoud disease (*Fusarium* spp.). This devastating disease destroy 5% of date-palm plantations annually. The only control method is disease resistance being developed by selection. Since the early sixties, a complete survey was done on all plantations and trees which seemed resistant were collected in two experimental farms. About 3000 trees were tested and ten were promising with good fruit quality, thus recommended for multiplication. At Marrakech, a laboratory was established for tissue culture for propagation of disease-resistant trees. The program started in cooperation with France then followed by FAO.

*Research Disciplines.*

The various research disciplines of NARI are involved in all commodity programs and most socio-economic studies. Good coordination among these disciplines is essential for successful programs.

**RESEARCH PRIORITIES : PRESENT AND FUTURE  
STRATEGIES FOR RESEARCH PROGRAMS**

Identification of research priorities is affected to a great extent by political priorities. However, they are based on the interaction among researchers, farmers, extension agents, and market demand.

To determine research needs and priorities, NARI arrange and participate actively in meetings, commissions, committees and surveys.

*Plan Preparation Session* : Each five years a plan is drawn for all institutions, governmental agencies, administrative services, economical organizations, private companies and other organizations. For such session, NARI presents results and programs with an itemized budget. After being voted upon by the Parliament, the five year plan becomes a law. Each year the annual report of NARI is assessed with respect to the planned objectives and procedures.

*Board Meeting* : During the Board Meeting well balanced research activities and programs are discussed and approved particularly because these meetings are chaired by the Minister of Agriculture, with members including representatives of farmers, extension services, and national agencies for development.

*Budget Meeting* : Each year a special committee in the parliament study the NARI budget and expresses some recommendations for the program.

*Product Commission* : For each of the crops, there is a specific committee with representatives of NARI and Ministry of agriculture which evaluate the program and give advice.

In addition to these meetings, NARI organizes specific meetings with farmers and development and extension services : regional center annual meetings, field days on experiment stations, workshops on commodities and disciplines. All these meetings give NARI the chance to sharpen its research priorities and evaluate the quality of research work. The « outside needs » are well understood.

A more difficult job is to translate the various needs from research into efficient research programs. After trying several research approaches, programming by the objective method was selected as the most relevant and efficient. This approach was proposed by ISNAR and it is on the way of being implemented. Many programs were developed by objectives : cereals, citrus, dryland improvement, saharian program, forages, olives, oil crops, food legumes and fruit trees.

We cannot expose here the details of the various aspects of the approach but each scientist has to restrict his own program to a limited number of operations, no more than three. He has to fix a timetable for implementation and to specify means and facilities needed. The advantages are quite obvious : managers and staff know clearly from each other what can really be done and when.

In the near future, NARI will try to put all data on software in cooperation with ISNAR. The main problem areas or programs followed include :

NATURAL RESOURCES : SOIL  
 CEREALS  
 FORAGES  
 LIVE STOCK  
 OIL CROPS AND OLIVE  
 VEGETABLES  
 CITRUS  
 FRUIT TREES  
 SPECIFIC CROPS : COTTON, TEA, HONEY.  
 DRY LAND IMPROVEMENT  
 SAHARIAN PROGRAM  
 FOOD LEGUMES

Priority research programs include cereals, forages, livestock, oil crops and dryland farming.

#### ***IMPACT OF AGRICULTURAL RESEARCH ON AGRICULTURAL PRODUCTION.***

So far, there is no systematic data or information on the quantitative impact of research on national agricultural production. We think that it is high time to conduct a systematic study in this regard. Such information is extremely important for decision

makers. Due to the lack of resources, NARI is more keen to solve pressing problems facing the agricultural sector than to quantify the positive impact of research on agricultural development. A suggestion can be made here to carry out an « impact survey » by multidisciplinary team of national and foreign experts sponsored by FAO and or ISNAR.

However, several examples on the qualitative impact of NARI research were mentioned earlier in this paper. NARI and other institutes solved many problems facing farmers and agricultural production. For example, self-sufficiency ratio in sugar is currently 75% while in 1963, it was 0%. For traditional crops, the most obvious is the improved cultivars released by NARI along with a package of improved cultural practices. Improved cultivars are now used by many farmers in wheat, barley, cotton, faba beans, chickpeas and citrus. In wheat, the cultivar Nesma, developed by NARI in 1969, is spread throughout the country in almost all rainfed farms. Some of the improved cultural practices adopted by farmers include proper planting date, weed control, tillage practices, planting methods, etc. Early planting of wheat is adopted by more and more farmers alter year. As a result of experimentation by NARI and other public and private institutes, many exotic crops were introduced to Morocco and are now grown on large scale - e.g. sunflower, cotton, soybean, banana, apples,, tea, pistachio and others. No doubt, the impact of research on agricultural production is tremendous but there is an urgent need to quantify such impact..

#### *MAJOR CONSTRAINTS IN AGRICULTURAL RESEARCH.*

Major constraints facing agricultural research include limited and poorly managed financial resources, insufficient technical manpower and training, insufficient laboratory equipments and farm machinery.

##### *Limited and Poorly Managed Financial Resources..*

On the financial side, the total budget for NARI does not cover the expenditures required by research programs to meet the agricultural research needs of the country. Some essential programs were not initiated because of budget limitations. For example, up till now, NARI was unable to conduct research programs relevent to high elevation areas. Current programs financed only by NARI budget had to restrict and down on their activities. On the other hand, only very few programs supported partly by external resources have well developed activities.

Beside the small budget, allocation of financial resources is not well balanced due to reasons to be discussed later. Of the total budget (\$ 13 millions), a large portion (89%) is allocated to running expenses and only 11% to major equipment - i.e. development of future facilities. If such trend continues, this means that equipments will be obsolete and non-functional for both laboratories and farm-fields. Transport cost is very high which reduces the budget further more. Thus the equipment and facilities are not appropriate or relevant to the size of the institute.

About 72% of the running cost is allocated to salaries for 2000 permanent staff of which less than 10% are research scientists. Scientists salaries account only for about 20% of total salary cost. Thus the ratio between scientists and supporting staff is extremely low. This situation can be explained by both historical and socio-economic reasons. Historically, research in the past was conducted in many research stations (a total of 63) with non-scientific staff. When the number of the station recently reduced to 24, the permanent staff had to continue and therefore were transferred to the continuing research station. The cumulative salaries of non-scientific staff burdened the budget and created such a poorly allocated budget.

In addition, because of too many personnel and poor training, the job done by supporting staff is highly specialized. For example, a technician in a laboratory will only do one kind of analysis at a certain time of the year, such as N analysis. The remaining part of the year, a number of technicians will be inactive or with very low work load. Thus, many supporting staff are not utilized efficiently and most operations are labor consuming. In cereals, for example, there is a need for people to harvest, to thresh, to weigh and collect data, to analyze and to interpret results. Advanced technology in the USA will do all these operations directly in the field one by one machine. However, one has to keep in mind that machines save labor and increase operational efficiency are expensive and probably difficult to run and maintain properly.

In addition, the limited budget is not managed with maximum utilization efficiency. This is mainly because of two reasons. First, all decisions on expenditures are made by top level administrators at the head-quarters. Research stations neither have the say nor the freedom to purchase any research supply immediately when it is needed. Second, numerous steps and too many people are involved in processing purchase requests. As a result of centralizations and « red-tape », there is a lapse of long time between the time a request is made or certain supply item

is needed and when such item is provided or supplied. Even if money is available, many researchers are under the impression that it is unavailable. Sometimes, it is not the lack of the money but the problem is the possibility of using the money when it is badly needed.

#### *Insufficient Technical Man-Power and Training.*

As indicated earlier, only less than 10% of the staff are researchers. The number of researchers (165) is not sufficient to cover various needs and specializations in different agro-climatic zones. Because of insufficient staff, scientists are burdened by too much operations which are sometimes followed superficially.

In addition, the average work experience is only five years ; thus a generally young and inexperienced research scientist. However there are advantages for young scientists, being quiet active etc. The reason for having young scientists is the high turnover since salaries are low and thus the contunuity of scientists in NARI is affected.

There is a lack of high degree ( PH.D. ) holders since most scientists have M.S. or B.S. degree.

In the past, most scientists were concentrated in the headquarters and thus scientists were not directly involved in making day-to-day observations on their experiments planted in research stations outside Rabat. Their interpretations of results were based on date collected by others which may lead to misinterpretations. The lack of means of transport aggravated such a problem.

Other constraints relevent to man-power is the poor coordination and cooperation among multidisciplinary research scientists and among scientists from different agricultural organizations.

#### *Insufficient Laboratory Equipement and Farm-Machinery.*

As emphasized earlier, the size of the budget allocated to major facilities and equipments does not match the need and the size of NARI. In addition, research needs sophosticated equipments and machinery which are difficult to operate and maintain. Specialists for maintenance and repair are simply not available.

*Market availability* of certain supplies is also a serious problem. Because the scale of operations in research is small, special tools and supplies are not available in the local market. What is available is the commonly used agricultural supplies by commercial farmers i.e. common machinery and common che-

micals. Research needs are different and very difficult to find in most cases. Another problem in the complicated and timeconsuming payment procedure followed by NARI which makes merchants or companies not keen to deal with the institution. Usually, when they sell to NARI, they raise prices to compensate for the delay in payment. This also burden the overall budget.

Nationwide research requires a network of research station and laboratory facilities to cover different agroclimatic conditions. Thus the need to provide facilities for various locations will scatter the budget and facilities. The tendency of research stations is to try to have a complete set of all laboratory equipments and other needs thus decentralization.

Efforts are being made to solve major problems. We can not say that the problems were all solved. Most of these drawbacks were deeply studied by NARI itself and by consultants requested from ISNAR and the World Bank. These studies evaluated specific problems and made recommendations. Based on these recommendations, NARI, with the approval of the Board, developed set of measures and means to improve the situation. Some measures are being implemented. Others will be implemented in early 1988 which is an important date for NARI because it will initiate the next year plan which includes the implementation of the special project for research financed by the World Bank.

On budget management and utilization, two steps were undertaken to facilitate purchasing. (a) An advanced budget will be available to research units for direct purchases. (b) To shorten the procedure of purchasing, each regional center will be directly responsible for the payment with no intervention from the headquarters. For some centers, a cash section will be established to handle purchases.

To raise the amount of budget available to research, three approaches are followed :

- 1 - Cooperation with international or bilateral institutes to provide necessary equipments and machinery.

- 2 - Commercialization of research results. For example, NARI is given a certain percentage of the selling price of varieties it released.

- 3 - Research contracts with the private or public sector e.g. contract for virus-free disease grafts and soil mapping contracts.

To improve technical man-power, the following measures are being implemented :

1 - Improving the salary level to maintain good research scientists and attract new highly qualified ones.

2 - Sending good scientists for high degree training in needed fields of specialization.

3 - Adopting « programming by objectives » which facilitate coordination among scientists from various disciplines.

4 - Developing agreements with other national agricultural instituts for coordination at the national level - e.g. agreement with I.A.V. Hassan II and E.N.A. in Meknes.

5 - Developing agreements with international agricultural research centers and bilateral organizations e.g. ICARDA, CIMMYT, ISNAR, ACSAD, USAID, GTZ etc.

To improve the availability of equipment and farm machinery, efforts were made in order to :

1 - Reduce the number of experimental stations from 67 to 24. Thus more facilities are avialable per research unit.

2 - For better maintenance of equipemt and farm machinery, contracts are established with specific companies which will respond for a short notice.

#### *RESEARCH MANPOWER DEVELOPMENT.*

Permanent staff of NARI, according to training level, includes 165 scientists, 266 technicians and 1125 supporting staff. Scientists may be classified according to descipline as follows :

- Agronomy	: 41
- Horticulture	: 27
- Plant Protection	: 39
- Soil Science	: 12
- Machinery	: 2
- Livestock	: 8
- Food Technology	: 14
- Chemistry	: 2
- Biometry	: 3
- Statistics	: 1
- Economy	: 3

The number of scientists in each discipline depends on a number of factors : the priority given to each program, facilities, availability of university-graduates in each discipline. Recently, graduates are available in almost any discipline because of the emphasis given by authorities to encourage training and education. The problem is the availability of financial resources to support newly needed positions and to provide well equipped laboratories for certain disciplines.

One additional factor is the expected rate of growth of scientific staff to meet growing demands from research. As indicated earlier, most scientists are young and they need to work with well experienced scientists to gain experience in appropriate methodology and technical skills. For this reason, a reasonable annual rate of growth is about 20 scientists ( 10% of total staff ) which will be fixed for the next five years plan. As for other staff levels ( technicians and supporting staff ), we believe that currently there is no need for new positions.

#### *AGRICULTURAL RESEARCH INFORMATION AND DOCUMENTATION.*

Information and documentation are still not well developed in NARI which is considered as a major constraint in research work. After independence, a very efficient information and documentation division was established in cooperation with the French. All means and facilities were available. Two journals were started and issued regularly : « ALAWAMIA » and « LES COHIERS DE LA RECHERCHK AGRICULTURE ». Some scientific books were published - e.g. « Citrus in Morocco » and « Pests and Diseases of Citrus ». But when the cooperation left were buildings, equipments and supporting staff.

Because of the importance of information and documentation to research, considerable investments will be devoted to that division for the next five year plan. Supporting measures and activities include recruitment of specialists graduating from the « Informatist School-», training supporting staff, providing needed equipments including computer facilities.

More basic steps were already taken by creating the Information and Documentation Division with linkage to the National Documentation Center. Technical information was already released to extension services through « technical leaflets ». Still a large number of scientific papers submitted by scientists are waiting for publication. Lots of work need to be achieved. The library of NARI contains about 30.000 books, 24.000 reports and 1326 periodicals.

*INTERNATIONAL AND BILATERAL ASSISTANCE IN RESEARCH.*

International or bilateral assistance is an important way to improve and strengthen national research. Technical assistance or advice on highly specialized subjects can be very helpful in addition to the numerous opportunities for long and short term training to all levels of research staff : senior scientists to technicians. Working with well experienced scientists in specialized fields, young national scientists can accumulate considerable knowledge and experience. Through such assistance, essential equipments and facilities are provided particularly if not available in the national market. In addition, technical and up-dated information is made available to national scientists which complements the weaknesses of information and documentation available locally.

However, international assistance has some drawbacks particularly when the assistance given is too « generous ». National managers and administrators tend to over rely on such assistance for « the pouring » resources and facilities. Under such conditions, national staff would be working and programs roll smoothly with few problems. However, administration and assisted staff forget that golden days cannot be for ever. Eventually, when such assistance stopped or reduced considerably, the true life starts with financial problems to keep things running. Even training opportunities may be lost.

Now after years of experience with international assistance, the proper philosophy is quite known to avoid difficulties. The best way is to study carefully the assistance needed by the country. Cooperation contracts must provide very limited number of experts but strong training component to ensure that their experts will eventually be replaced by local scientists when the contract terminates. In Morocco, we have the chance to find in the « local market-» good graduates, supporting staff, common laboratory equipment and common farm-machinery. The plan is to prepare young national scientists to replace foreign experts as soon as possible. For equipment, a check list of lab facilities, farm-machinery and needed vehicles are prepared to complement the existing facilities and equipment.

NARI developed international cooperation with a lot of institutions : FAO, ICARDA, CYMMIT, CIP, AQSAD. Bilateral cooperation involved the EEC, Italy, Federal Republic of Germany, and U.S.A. Special projects are being implemented with ISNAR and the World Bank.

ICARDA has a strong cooperative program through a long term agreement which allows for specialized programs when needed.

Currently, two programs are being implemented : on food legumes and cereals. Two permanent experts are permanently stationed in Morocco with regional responsibilities. The two programs are built on the same principles : intensive exchange of germplasm, joint breeding program on selection of high yielding and adapted varieties, training components at all staff levels, workshops, field and laboratory facilities for specific operations. So far, chickpea cultivars are nearly released to farmers and some very promising varieties of barley will be released soon. A national workshop on food legume was held last year.

A similar contract will be signed with CYMMIT to improve triticale : one permanent expert, training facilities, exchange of germplasm, additional facilities. Of course, the cooperation on wheat and corn will continue.

The cooperation with ACSAD was launched through the « Wheat Project ». The main idea was to conduct the same set of experiments in four Arab countries. The components of the program included : varieties trials on research stations, demonstration plots on farmers fields, and seed multiplication. Scheduled for a short period of four years, the period was quite a success. All objectives were met and durum and barley cultivars provided by ACSAD are expected to be adopted by farmers. Now, the wheat project is over and a farming system project was stated two years back. ACSAD also provided assistance to introduce pistachio : providing seeds, grafts, consultants and training facilities for short period.

An EEC project dealt with the improvement of cereal food technology. The assistance provided to NARI included : large investment on equipments which were badly needed, short term training and the permanent experts for two years. The technology lab was completely re-equipped, four national scientists were sent for training for three months efficient system was set up to analyse flour and prepare bread.

Italy gave specific assistance to equip five research stations for multiplication of improved seeds. The main investment was put on seed conditioners in addition to equipments to complement existing farm machinery. Training sessions were conducted locally and abroad. An international seminar was organized and many documents including a film was prepared for the extension service. The executive agent was FAO and an expert was stationed in Morocco during the project.

The Federal Republic of Germany assisted NARI in many projects covering sugar crops (beet first then cane), plant diseases and oil crops. Now, a project is running on improving forages in rainfed areas. The assistance included four permanent experts, field and complete lab equipment, transportation means, and documentation. Five national scientists were allocated to the project and received intensive field training. Through the project, several activities were organized: workshops, attendance of international meetings, technical visits to other countries. Technical papers and special courses were provided for extension agents.

A long term project started in 1980 with USA in the most challenging region of the country. The main objectives are to improve yield in a zone where rainfall does not exceed 300 mm. The main crops include barley and those of range land. The project is a great challenge because drought is a permanent feature of the climate. Due to the large area covered by the project, even a slight increase in yield will have a big impact on national production. This explains why the project is for a long term and why large investment is devoted by both partners. The project is financed by USAID and executed by MIAC, an association of five universities from the Mid-West. A strong permanent staff was mandated to initiate the project with a long term training plan being implemented. About 40 scientists are to be degree-trained in the involved universities to obtain MS or PH.D. Young national scientists finish course work in 2-3 years in the States, then conduct their thesis research work in Morocco to fulfill the requirements for their degrees. The project provides complete lab equipments and farm machinery. National contribution includes construction of building for laboratories, storage and offices; equipments of three stations in the zone; and operational costs. Unfortunately, the project started in the worst climatic condition - i.e. the driest years. However, some results were already obtained to be spread to farmers. An extension of the project is scheduled this year. Each year, the project is evaluated by an international scientific panel and new ideas and technical help are provided to the project. Cooperation with the American Universities was useful for both parties particularly in cereal breeding. Exchanged germplasm was utilized by both partners. Moroccan scientists did good job in the Mid-West which proves that proper cooperation leads to good results.

To complete the picture on international cooperation, we must recall two very important projects with ISNAR and the World Bank.

ISNAR was requested to assist NARI for reorganization in structure, programming method, linkage with extension, improve-

ments of management, documentation and establishing a master plan for research. All measures were proposed after an extensive survey done in laboratories, administrative units, and experimental stations. After discussions, the proposals were presented to the Board which approved the reorganization after few amendments.

On the basis of the reorganization plans, the World Bank is ready to finance a special project for research that deals with four main programs : cereals, oil crops, forages, and live stock. The projects will provide farm equipments, scientific information, computer facilities and training. The project will start in early 1988.

#### *LINKAGE WITH EXTENSION.*

In the Ministry of Agriculture, extension service is the responsibility of the specific division called « Division de la Vulgarisation Agricole et de la Réforme Agraire ».

Extension activities are given to local agencies scattered throughout the country. There are 120 extension agencies in irrigated zones and 150 agencies in rainfed areas.

After independence, those agencies had a number of activities : extension of technical information, providing farmers with seeds, fertilizers, and in some cases doing services such as seedbed preparation. With evolution of the commercial network which is now spread to rural areas and the fact that most farmers have their own equipments the mandate of the agencies had to change to focus mainly on extension. A special program on extension will start early in 1988 with the support of the World Bank, at the time with the research project.

The extension agencies will be reorganized. The extension approach or procedure will be « training and visiting » which gave good results in other countries. It may be probable to encourage cooperative systems due to the small size of farm holdings and the large number of small farmers involved. In 1984, we estimated that a contact agent has to supervise 1740 farmers in rainfed zones and 195 farmers in irrigated land. An efficient extension job cannot be done without restructuring of farmers' holdings.

Concerning the linkage between research and the extension, many activities are initiated and followed up by NARI to strengthen such linkage. These activities include :

- 1 - Adequate research to meet farmers, needs.
- 2 - Preparing information for extension service and farmers.
- 3 - Training extension agents.
- 4 - Specific research contracts with regional integrated projects.

The first point was covered in details earlier. For preparation of extension information, NARI uses many ways : technical papers which summarizes data and results on crops, seminars where each discipline presents results and practical recommendations to farmers, field days, and field visits to experimental and private farms. Occasionally, NARI scientists are requested to review topics relevant to scientific subjects in order to be presented in courses organized by the Ministry to train extension agents. Recently, courses were organized for weed control, medics, and new cereals varieties.

Another way of cooperation is joint demonstration experiments on farmers fields. Demonstrations are conducted on a large scale throughout the country to cover 500 to 2000 farmers. Each year, evaluation is done by farmers, scientists and extension agents. News medias are sometimes invited to participate in the meetings so as farmers can directly broadcast their opinions and advice on the operations.

In some cases, when a regional integrated development projects is planned, NARI participates with short term contract limited to specific of direct interest to farmers. This method was adopted in the Middle Atlas Project. Within four years, good recommendations could be spread to farmers to feed cattle with additional grain and crop residues when the production of rangeland reaches at a dangerous level.

The main units involved in linkage with extension is the Information and Documentation Division which prepares all extension leaflets for extension agents. Regionally, the local Research-Development-Service keeps continuous contact regional extension agents.

## RECOMMENDATIONS

Recommendations can be grouped into two main levels : national and international. At the national level, important recommendations can be made in management, finance and man-power.

### *Management :*

- Research should be programmed by objectives to insure that research work is relevant to the overall development goals. Such method leads to efficient multidisciplinary approach.

- Decentralization and simplification of administrative procedures must be adopted for efficient utilization of available financial and human resources. This should provide an effective level of autonomous management to research units.

- Contracts should be developed with public and private institutions in order to contribute to development.

- The structure of research units should be simplified with emphasis on forming regional multidisciplinary teams.

- Cooperation should be promoted among other scientific organizations, national and international to « pool mental capabilities » to identify the most efficient way to achieve set goals. This can be done through formal contracts.

### *Finance :*

- is essential to seed adequate balance between budget levels and size of programs.

- Availability of budget be insured on time by various means, such as rolling funds.

- To secure more funds, services and results provided by the institute should be commercialized through different means - e.g. patented inventions, study contracts, commission on released seed.

### *Man - Power :*

- Competitive and attractive salary scales should be provided to maintain and attract high quality scientific staff.

- Promotion of scientists should be based on rational evaluation of their contribution and thorough selection.

- The role and number of supporting staff should be justified or rationalized.

At the international level, FAO should sponsor an international workshop on research in order to discuss means to encourage under-developed nations to allocate more financial resources for research. In addition, developed nations and international organizations will be requested to support such efforts. In under-developed nations, agricultural research is the last worry to administrators.

Such conference can also discuss a draft-proposal on « National and International Involvement in Research ». Such document will be adopted by participating governments, funding agencies, and international institutes.

We propose that each government involved will allocate a minimum of 1% of total agricultural gross production to research. At the same time, 10% of the budget of developmental projects dealing with agriculture should be devoted to national research. This can be done through specific contract between the funding organization and NARI. This rule will be followed systematically irrespective of the identity of the funding institutes, national or international.