

THE IMPORTANCE OF AGRICULTURE  
IN THE DEVELOPMENT PROCESS:  
AN AGRICULTURAL MODEL  
FOR TUNISIA

BY

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## PREFACE

A model for the Tunisian agriculture was developed, validated and then tested for different options and actions that could be undertaken in this sector. This model was conceived to serve as a basis for a close analysis of the sector and could serve as a starting point for the planners in adapting a development model for the agriculture, especially emphasizing the full use of the available potential and deriving the comparative advantage that best serves the welfare of the community.

This study is dedicated to my family, to my friends old and new and to everyone who lended me a helping hand.

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## CHAPTER I

### INTRODUCTION

For over two decades, economic development meant economic growth and was measured by the rate of growth of the GNP. But economic development is not only the growth in the GNP: In fact, it involves so many other objectives such as autosufficiency in food, a more equal distribution of income, a reduction in the underemployment. Economic development is therefore multidimensional, and a growth in the GNP does not necessarily result in the achievement of these objectives. Actually, the reality brings out the opposite: Did not BRAZIL for example achieve a very high GNP growth without despite all achieving any of such objectives as reducing poverty, malnutrition, starvation and underemployment?

Therefore, new dimensions were given to economic development which is now more oriented towards the achievement of objectives for economic and social development.

Right now, the process of development is a process at the end of which such objectives as reduction of poverty, malnutrition, underemployment and a review of the income distribution to realize more equity among the different social classes, are achieved .

The economic development process as defined above involves the agricultural sector as the pillar of the overall process, because it is this sector that undergoes the most important transformation, shifting from a traditional sector to a modern and integrated sector in the whole economy.

This vital importance given to agriculture in the development process is induced by certain facts that reality provides. First, the dependency of the majority of the LDCs' populations upon the agriculture from which they earn their income. Second, an income redistribution could be realized with a more productive rural employment. Third, the population keeps growing, implying more needs to satisfy and an increased demand for food to respond to. This results in increased food imports and increased import dependency. To a certain extent, this could be avoided if domestic food production could increase and offset this increasing demand. Fourth, resulting from the previous remark, this increased domestic production could create opportunities of exports for some locally produced goods, which would help to offset the deficit of the balance of payments.

Finally, last but not least, the results of different policies emphasizing industrial growth were not very convincing and this disillusion was the starting point for a renewed interest for the agricultural sector and its role in

the overall development process as a development stimulating sector.

This dynamic role attributed to the agricultural sector is justified because in the LDCs' economies, not only this sector employs most of the population but also it is the most important one. The problem is that people employed in this sector have very low income which is itself derived from their low productivity. This low productivity is seen as being the most important factor holding the agricultural sector from developing and taking off which in turn, contributes to the overall underdevelopment of the economy. Actually, some economists have even stepped further to assume that the agricultural underdevelopment is the most important factor responsible of the underdevelopment of the whole economy. It should be specified however that this is surely true for agricultural societies in which agrarian forces have remained very important and very powerful.

In all LDCs, the agricultural sector is characterized by typical features of underdevelopment: low incomes, low input output and productivity levels, unskilled labor force, underemployment of the labor potential, unbalanced distribution of income etc...

During the development process, this sector should be given priority, so that it is able at least to realize a

selfsufficiency for the population whose incomes depend on the agricultural output.

This priority to be given to the agricultural sector is justified by the fact that different mechanisms and interactions exist between the agricultural sector and the other sectors of the economy. Therefore, a developing agriculture can help remove the inhibiting factors that keep the economy in a stagnating stage of underdevelopment: As mentions S.R. SEN (40)" In fact, it is one of the characteristic features of an underdeveloped economy that its agriculture has reached some sort of quasi equilibrium at a low level of productivity from which it is extremely difficult to raise it ..."

This is obvious especially when one thinks of the integration of the different investment and technical patterns with this low productivity pattern of the sector. A vicious cercle process is generated because any attempt to change one of these patterns separately results in a backwards pull by the other patterns involved in this process, because they are adapted to it in a certain way, not in another.

The extrapolation of the whole agricultural economy from these interlocking circles appears to be the only solution for S.R.Sen (40) to be able to disturb this quasi equilibrium

attained and create new conditions for the sector to increase its productivity levels.

Another economist, J. Bacchler ( cited in reference 40), notes that the industrial revolution of the nineteenth century would not have taken place if the agriculture did not realize the progress that it achieved at that time, in the nineteenth century. These progresses were the results of improvements realized a century ago, in the eighteenth century. They allowed an increased productivity per capita which in turn allowed the creation of an agricultural surplus to be used by the growing industrial sector.

Unluckily, the economic planners in the LDCs keep ignoring this evidence: that there can be no successful industry without an agricultural surplus to be invested in it.

In fact, the following study aims to reemphasize the crucial role of agriculture in economic development. It was conceived as an attempt to make recommendations on the agricultural sector development of Tunisia given its resource endowments. This study is divided into seven chapters: After the first chapter of introduction to the subject, chapter two will provide some insight about the role of agriculture in the economic development process and a brief outline of this role as conceived by economic literature.

Chapter three centers the attention on the agricultural sector in the LDCs, the problems inhibiting this sector's development, the applied and often inadapted policies and also the characteristic features of underdevelopment of both the sector and the economy as a whole. In chapter four, the Tunisian agricultural sector will be presented along with the problems which paralyze it. Chapter five is the heart of the thesis and presents the model which will be worked with. The testing of the model will be treated in chapter 6 while chapter 7 will consist in the different conclusions derived from the simulation of AGRARIA, its results and its limitations.

## CHAPTER II

### AGRICULTURE IN THE ECONOMIC DEVELOPMENT PROCESS

The role of agriculture has always had an important share in the economic literature and has always been considered as a pillar for economic growth; While reviewing some of this literature, W.W. Rostow ( cited in reference 40 ), appears to be one of those who initiated a debate about economic growth and for whom an increase in the agricultural product resulting from a growth in agricultural productivity is essential to realize a sustained economic growth. This growth is then supposed to lead the economy to the stage of taking off, which is considered as being the initial stage of the economic development process. Any underdeveloped economy has to go through a certain number of stages on its path to economic growth: W.W. Rostow describes the first stage, which is the traditional society, as mainly an agricultural society characterized by primitive and elementary techniques of production, limited resources, unskilled labor force and a social structure based on the ownership of land.

On the other hand, another economist, W.A. Lewis (cited in reference 33 ) presents his two sector model which



assumes that the industrial sector develops thanks to the transfer of a surplus of low productive labor force from agriculture to industry such that for the same wage as in agriculture, these low productive workers become productive economic agents. This surplus in manpower is created in the agricultural sector ( also called subsistence sector ) because according to W.A. Lewis ( 33 ) these workers contribute to the agricultural production with a proportion less than the requirements for their own subsistence.

For W.A. Lewis, the non agricultural sector is the "dynamic element" which absorbs this surplus generated in the subsistence sector.

However this assumption is weakened by the following observation that the transfer of the surplus from one sector to another is not automatic: job opportunities are not offered automatically as more workers transfer to the industrial sector. This is also sustained by W.W. Cochrane (10) who finds this model of a dubious validity because it has " one overriding limitation ": it simply doesn't deal with the problem of initiating the development process within the agricultural sector. The model deals only with reallocating labor from a stagnant agricultural sector to the non agricultural sector, while the main question and issue of how to get the agricultural sector to move is not dealt with.

For one reason or another however, this evidence has

been forgotten by the economic planners of the LDCs and the role and priorities to give to the agricultural sector was underestimated. Some economists argue that it's very hard to break up the chains that keep the agricultural sector underdeveloped, but what could possibly be done is to develop all industries closely related to the agricultural economy so that the development of these sectors could pull up the agriculture itself: then rapid growth would be generated and by a feedback mechanism to the other sectors, an overall take off would take place.

L. Malassis notes (33) " the role of agriculture in the development is not limited to being a reserve of manpower ". The agricultural sector actually is expected to generate the surplus on which the whole development process is based. It actually finances the development of the economy because this surplus or agricultural savings will be invested in the other sectors to promote their production.

Another important contribution of the agricultural sector to the development process is foreign exchange composition: imports of agricultural goods could be reduced and promotion of agricultural exports could help the country reduce raw material imports .

L. Malassis classifies the different contributions of agriculture to the over all economic growth as follows:

- increased food production and agricultural productivity contributes to the economic growth.
- serve as a source of labor for the industry in which the labor force becomes more productive.
- serve as a source of savings because if agricultural exports exceed agricultural imports, then enough resources are generated that can be later on used for capital goods purchases.
- it serves as a customer for the industrial sector by buying industrial goods and therefore stimulating the growth of the industrial sector.

Further in this context of the renewed interest for the role of agriculture in development are some propositions by Johnson and Mellor (21):

- first, as demand for agricultural products increases, an increase in food supply becomes necessary. This involves an overall economic growth because it involves all structures of the economy.
- second, increased agricultural exports could do so much by increasing foreign exchange earnings and reducing balance of payments deficits. This however could turn into a dependency of exports on a certain number of products and would involve the risk of fluctuations of these product prices on the international market.
- third, as noted before with L. Malassis (33), the

agricultural sector is a reserve of labor to be used by the expanding industrial sector.

- fourth, rising agricultural productivity means increase agricultural output which in turn means increased revenues for the farmers.

- fifth, the prime objective of the agricultural sector remains to squeeze out a maximum amount of surplus for investment.

Several economists however would rather consider the industry as a leading sector in the process of development. Their argument is as follows: as population increases, the labor force increases. But the creation of new job opportunities cannot be undertaken with the same rate of growth of this labor force. These new people looking for jobs in agriculture and not finding any will remain unemployed unless employment is created outside agriculture (ie.industry) .

Meanwhile, economists that give priority to agriculture justify their choice as follows:

- agriculture is vital because it feeds its population.

That's the main function: supply food to answer the nutritional needs of the whole population.

- furthermore, agriculture contributes to the equilibrium of the balance of payments by more agricultural products

exports, but also to the equilibrium of both the balance of investment ( by increasing farmers' income and therefore savings and investment ) and the balance of employment (by transferring labor to industry).

Also, going back to the classic economic theory, earth appears as the main source of wealth: it was supposed to create the surplus (ie. net product ) necessary, once invested , to promote the growth of the economy.

The design of an appropriate strategy for agricultural development requires nevertheless an ultimate and perfect knowledge of the sector, its characteristics and its resources.

This last consideration is very important and will be expanded in the next chapter. It should be recognized however that, prevalent in economic literature, agriculture has always been considered as a vital element in the economy. Its role is seen as essential whether as a leader of other activities or as benefiting from other activities that initiated the development process.

It is also agreed upon that an agricultural development strategy is not a separate element but is rather integrated in the general development strategy. Therefore, allowing the agriculture development will raise the whole economy to higher levels of productivity.

## CHAPTER III

### THE AGRICULTURAL SECTOR IN THE LDCs

To understand the situation of the agricultural sector in the LDCs and be able to study the inhibiting factors that stop it from developing, we need to take a closer look at the magnitude of the problems that agriculture undergoes in these countries.

In most of the LDCs the rapid growth of the population is an essential reason for which the nutritional situation is alarmingly getting worse. The inequity of the income distribution contributes to worsen the poor's situation. All of this is due essentially to the shortage of food supply.

There is no relationship between the continuously increasing needs of the population and the limited market supply that faces a limited purchasing power.

Precisely, this limited food supply is nothing but a production problem. When it comes to define it, low productivity, low growth rate of the production and underemployment of the resources characterize it closely enough. However, several other factors contribute to this problem like the structure of the sector itself, the absence of modern devices of production, the price policies, the unskilled manpower...etc.

This structure in particular yields low levels of

production, is characterized by low productivity and low efficiency in production.

### The Low Productivity in Agriculture

In the LDCs, the productivity has two dimensions: productivity of the land and productivity of the labor force, both of them settling at low levels.

The low productivity of the sector is an inhibiting factor that keeps it from developing. It also contributes to the low incomes of the population employed in the sector, limiting therefore capital accumulation and thus investment.

This low productivity has some different roots: the disadvantageous structure of the sector, the lack of modern technology, inadequate price policies and an unfavorable infrastructure.

### The Structure of The Agricultural Sector

In the LDCs, development depends largely on the agricultural sector. In all these countries, several structural aspects of the sector are observed:

1. Agricultural employment: The agricultural sector employs up to 50 % of the population in certain countries. In 1976 in Africa, around 66 % of the working population was employed in agriculture. They however derive relatively low incomes

from the sector.

According to Pinstруп- Andersen (37), the rural population accounts for " a decreasing percentage of the total population in developing countries ". This is mainly due to the migration of the rural population outside of the agricultural sector, seeking for better earning opportunities. However, as the creation of job opportunities cannot grow at the same rate as the labor force does, high rates of unemployment are observed.

2. The farm size: Most of the farms are small ( between 2 to 10 ha ). This characteristic contributes to increase the risk on any investment introduced to these farms, therefore investors are discouraged. On the other hand, the introduction of modern factors of production to a large number of small farms is difficult.

3. The land tenure system : It does not provide security for loans and the investors are unwilling to invest when the uncertainty is that sharp.

The structure of the agricultural sector in the LDCs described above combined with some other factors act as an inhibiting factor to the development of the sector.

#### Other inhibiting factors

1. The lack of technology: We can notice that in the LDCs, there exists a limited use of modern technology in the



agricultural sector because this sector is mainly traditionnal. Besides, even if a new technique is introduced to the sector, the unskilled labor force will minimize its beneficial impact because of their inexperience. Sometimes, the new device itself is badly suited to the needs of the sector or badly adapted to the soil conditions due to the lack of any previous study.

2. Agricultural policies: These policies are the tool that the government uses to make interventions in the sector. Certain economists state that these interventions and suitable modern technologies are the solution to the problem of productivity. According to others however, these interventions only add to the problems of the sector. For example, low food prices imposed by the government to keep the inflation down might improve the welfare of the poor people and make them able to afford these commodities, but it also contributes to a lack of incentives for the farmers to produce. Many governmental policies have such trade-offs. As an example, the fact that the production for exports is being promoted at the expense of the basic food production in most of the LDCs.

3. Price system and Infrastructure: Whenever the transportation facilities are inefficient or the transportation costs too high, no exchange of goods can take

place between one region and another of the country, therefore the local market is relatively limited characterized by a stable demand for food production. On the other hand if the food prices are held at a low level, the income of the farmers will be relatively limited and this will result in a limited demand.

All these different features of the agricultural sector in the LDCs described above contribute to hold back these countries at early stages of development. Agricultural research should be given more importance by the government; thus, the agricultural sector development is also a question of political will.

#### Agriculture for Exports

If the agricultural output is exclusively devoted to the agricultural population, then it is a subsistence agriculture. If it is not, that is if more than fifty percent of the output is sold, then it is said to be commercial. Besides providing the agricultural population with enough food to meet their demand, the agriculture has also to generate enough surplus to be exported. The problem with the LDCs is that they end up encouraging this market-oriented agriculture economy to generate a maximum of exportable commodities, at the expense of the domestic food production; actually, it is mainly replaced by imports of

food commodities. W. Mint ( cited in reference 33 ) develops this idea further and identifies two phases of agricultural development passing from a stage of subsistence economy to a stage of commercialized agricultural economy.

- First, the new orientation towards the stage of commercialized agriculture will start with developing, along with the old crops, some newly introduced export crops with no differentiation between them.
- Then, during the second phase, there is a tendency towards a specialization of the activities oriented towards exports at the expenses of the subsistence production.

#### Technological Innovations

The introduction of new technologies in the LDCs grows at a low rate due to the fear from the risk of taking chances, lack of credit opportunities, lack of motivation and incentives, farm size and insufficient human capital, resources, equipment, transportation, facilities and inputs.

In their survey " adoption of agricultural innovations in the developing countries ", Feder-Just and Zilberman (17) note that in these countries " an immediate and uniform adoption of innovations in agriculture is quite rare. Besides that, the adoption behavior is a function of the time variable and of the socio-economic group to which the farmer

belongs.

In their survey, Feder-Just and Zilberman (17) provide a general framework to analyze " the adoption and diffusion processes of agricultural innovations in LDCs". They differentiate between the aggregate adoption and the industrial adoption of a given technology: the adoption process starts at the farm, at a certain industrial level such as the newly introduced technology is used to a certain degree. Then comes the second phase at which it diffuses to the aggregate level. The diffusion process is defined by T.W. Shultz ( cited in reference 33 ) as " the process of spread of a new technology within a region." The level of adoption depends upon the extent to which the new technology has been used.

It can actually be measured by the degree of use of the new technology. What about the decision of adoption? Most economists assume that it is derived from the maximization of either expected utility or expected profit under the constraints of availability of resources and of credit. Adopting a new technology is constrained by the following variables:

- the size of the farm: the adoption of a new technology on a farm is directly dependent upon its size because the risks are higher as the farm is smaller.
- uncertainty: every innovation is characterized by a kind

of risk that is hard to measure. It is either related to the unfamiliarity of the farmer with the new technique or to other exogenous variables such as weather uncertainty or availability of the necessary inputs...etc.

Gafsi and Roe (15) in an economic study about Tunisia noticed that " the farmers would rather welcome domestically developed varieties than an unfamiliar important variety".

- labor availability: whether the new technology is labor intensive or labor saving, introduction of a new technology must be consistent with resource availability to avoid possible shortage in labor.

- credit constraint: some economists argue that credit availability is a pre-condition for the adoption of a new technology.

- the supply constraint: The availability of the inputs required by the new technology should be taken into consideration by the farmer to avoid shortages of inputs once the production process is started.

#### The Importance of Agricultural Research

In the developing countries, the main problem in agriculture is the low sectoral productivity. The research appears to be part of the solution to the problem since its role is to study it precisely and develop the necessary

policies to increase the productivity in the sector. However in reality, most LDCs allocate limited resources to the agricultural research. R.Piciotto (36) notices that of the roughly five billion dollars that are spent annually on the agricultural research worldwide, only two billion dollars are spent by developing countries. Agricultural research involves costs therefore it is considered as some kind of agricultural investment which will result in the creation of new technologies and the introduction of innovations which ease the constraints on production and facilitate it. However, given the fact that no innovation or technique is ever definitive nor universal, research is always needed to keep improving agricultural production: It is continuously renewed and continuously improving for the better.

Agricultural research contributes to economic growth by increasing the output, thus salaries and incomes and the standard of living of farmers improves.

In Figure 1. Pinstруп- Andersen (37) present an illustration regarding the potential outcome and implications of agricultural research. To be effective, any research needs the support of both an adequate public policy and an institutional change integrated in the development plan of the country. This will help the research to contribute to economic growth.

If used to its full potential, the contribution of the

agricultural research to the economic development could be immense; it helps improve the nutritional situation and increases agricultural productivity. This will in turn lead to a self sufficiency in food production and reduce the dependency of the economy upon food imports.

In Pinstrup- Andersen 's study, four measures ought to be taken to allow the agricultural research to contribute to the development process:

1. an increased public investment in research.
2. an adequate management of the research.
3. guide the research in such a way that it is as efficient as possible, considering all kind of factors that would interfere with the adoption of a given technology.
4. accelerate the adoption process of innovation by introducing certain measures. These measures vary from country to another because of such factors as history, culture, resources and the available level of technology.

Thus, agricultural research appears to be vital for the country's development plans. Many LDCs proceeded to the creation of research centers, their problem is how to make them effective.

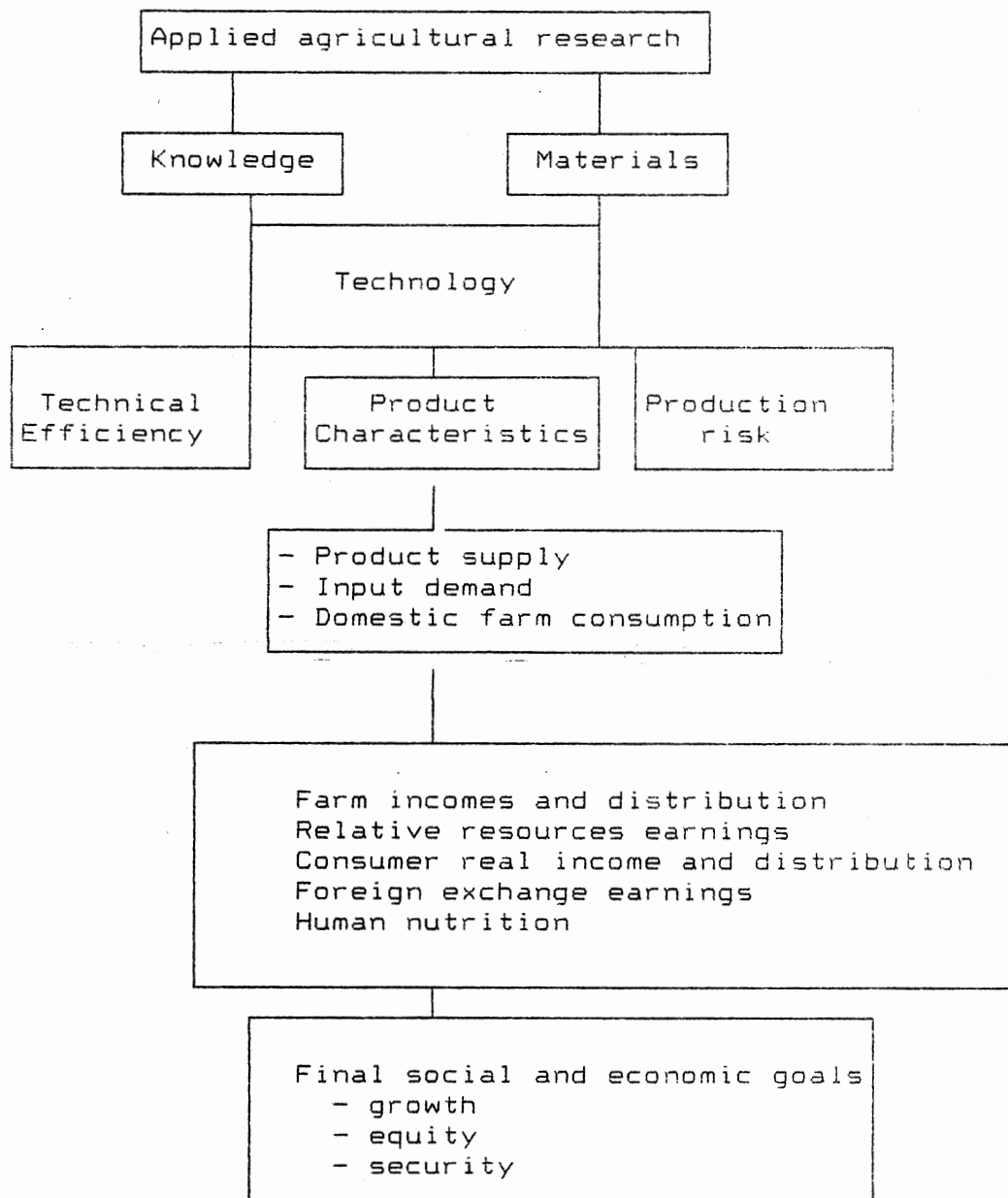


Figure 1. Implications of agricultural research



## CHAPTER IV

### THE TUNISIAN AGRICULTURAL SECTOR: RESOURCES AND STRUCTURE.

#### Overview of The Tunisian History

Before getting into the study of the Tunisian economy, a brief summary of the evolution that the Tunisian economy underwent from the time it was under French domination is quite helpful to understand its actual structure .

In 1881, Tunisia became a French protectorate. The new Europeans settled in the northern part of the country facing the mediterranean sea, which is also considered as being the most fertile region of Tunisia.

The French establishment created a modern administration to take care of introducing a modern industrial sector in the economy. This sector would be dealing with the exploitation by French firms of the natural resources of the country. These actions didn't contribute to the overall development of the country; Actually, these activities accentuated the regional disparity already emphasized by disparities in fertility and climate.

Therefore a certain duality was created:

1. Duality of the economy given this modern sector and

the remaining of the economy.

2. Regional duality because the north became economically and socially more developed relatively to the southern part of the country.

The Tunisian economy became literally an integrated part in the french economy until the independence of the country which brought a relative autonomy considering the fact that even after the independence both economies remained interrelated.

As for the agricultural sector, the state proceeded to a gradual take over of the lands previously owned by the colonists, then nationalized the previously installed cooperatives of production even though they were contributing for a big share in both the organization of the sector and the cooperative movement in Tunisia.

Thus, the foreign agricultural sector was eliminated. National cooperatives were then created to undertake the space left by the radical elimination of the French cooperatives.

None of the government programs to create national cooperatives have ever succeeded since then. Ghazi Duwaji (15) explains this failure by the fact that these associations never originated from the necessity for the farmers to be reunited but they were rather imposed on

them.

### Agricultural Cooperatives in Tunisia

The main cooperative experience the country went through was the creation of the cooperative system in 1962, this was ended by policy makers after seven years of experience. Cooperatives were created because they were seen as the principal tool in developing agriculture. According to the development plan of 1962 -1971 , these productive cooperatives were to diversify and intensify the crops so that cereals are no longer the main crop as it used to be practiced under the French domination.

The development plan of 1962-1971 aimed to achieve four main objectives:

1. Decolonization.
2. Reform of the available structures.
3. Selfdevelopment.
4. Promotion of the human being.

As for the agriculture, several objectives were also set such as:

1. Maximizing the agricultural production to the limit of the available potential in the sector.
2. Diversifying production.
3. Developing the commercial flows of agricultural

products to the different markets, internal or external.

4. Integrating agriculture in the whole economy so that it helps the other sectors to develop.

Their main functions were summarized in several law articles:

a. The main function of a cooperative is to provide the farmers with all the technical devices and economic possibilities to facilitate their production.

b. The cooperative is imposed to all land owners who are within its perimeters. Whoever is not willing to enter the cooperative will have either to sell his land or to rent it to the cooperative.

c. The capital of these cooperatives is constituted by the members contributions.

Compared to what these cooperatives were supposed to produce, the outcome realized was very low. Actually, these post-independence cooperatives came up with an even lower cereal production than the previously French-dominated cooperatives. However, they succeeded in realizing a diversification of the crops: industrial crops and olive plantations were added to the cereal cultivation.

The productivity per hectare, as noted before, is low while the costs are relatively high, including the equipment

cost, the salaries. The unskilled labor force and the multiplicity of different technologies within one sector are some of the reasons why these costs are so high.

These cooperatives failed to achieve their goals for mainly three reasons:

1. Lack of motivation and incentives of any kind to stimulate production efforts.
2. The farmers were acquiring an employee mentality because they were not involved in the decision making process and therefore they felt less and less concerned.
3. Also, this reform was never happily accepted by the farmers but they had to submit to it.

#### Tunisian Agriculture

The Tunisian economy can hardly be considered as a homogeneous unit but rather as a dual economy with a main emphasis on the industrial and manufactured sectors. Another characteristic of the Tunisian economy is its direct link with the French economy. The French markets are the most important markets for the Tunisian supply of products for export. In return, the biggest part of imports comes from France.

A third characteristic of the sector is the very big importance of the agricultural share in the Gross National

Product (GNP): 24 % in 1972, 19 % in 1978 and finally 15% in 1980. Despite its decreasing share, the sector remains important because it employs over 35 % of the population of the country while 47 % depends on it for livelihood.

However many problems arise in this sector :

- As many as 45 % of the rural population receive very low incomes.
- 30 % of the agricultural labor force is unemployed.

The government is fully aware of the importance of such a strategic sector as agriculture : In the plan of development for 1962 - 1971 , these following long term objectives are presented:

1. Move to self sufficiency in food production.
2. Increase agricultural exports .
3. Increase the income level of the tunisian farmers .
4. Generate a bigger surplus in agriculture destined for the investment needs of the growing industry.

Many reasons however contribute to keep the productivity of the agricultural sector at a low level, such as the structure of the sector itself, the limited natural resources access to credit, and the unskilled labor force.

#### Constraint 1: The Structure of The Sector

The public and the private sector share all the available agricultural farms. Most of them are small. This translates the low credibility of these farms because the smaller their size the less efficient and the more vulnerable to weather conditions they become.

Another consequence of this subdivision into private and public which characterizes the agricultural sector is that the lack of security and the high risk involved in cultivating these surfaces make the farmers unwilling to spend more money on new kinds of technology.

Another fact resulting from such a structure in the sector is the denial of credit distribution to those farmers who don't have land titles which are usually required as a guarantee for potential investors.

Also it should be noted that small farms imply an intensive activity on a relatively small surface, therefore risks of erosion and desertification are even greater.

As for the public sector (10 % of the farm land ), it is characterized by the existence of government owned farms. They are mainly composed of productive cooperatives and state farms. These cooperatives are not very efficient despite the large government transfers they benefit from. This is mainly due to the lack of incentives of any kind and lack of motivation of the farmers. In fact, even in case of losses,

the workers suffer no penalties regardless of the performance of the cooperative.

Land reform is therefore badly needed at this stage and a decision should be taken about creating incentives to produce and in motivating the farmers.

#### Constraint 2: Natural Resources

1. Land: Over a total area of 16.4 millions of hectares (mha), only 8.6 mha are arable land that can be used for agriculture and crops, which is relatively not of much importance. Besides, most of this land is located in the low rainfall regions that receive less than 400 millimeters of rain per year. The area of arable land divided by the total rural population gives a ratio of 2 ha of arable land per rural person which is an important constraint for the agricultural sector's development because this implies the fact that these lands used for crops are highly intensively used which makes them less productive in the long run.

2. Erosion and Desertification: An intensive use of a land will generate an accelerated process of its erosion and desertification. In fact, erosion destroys around 25000 acres every year taking away all the fertile potential of the land. Climate factors like heavy rainfall or strong winds are the



main cause of erosion.

The government is very aware of the phenomena and in each planning proceeds to provide a certain amount of money to be invested in the protection of the arable land because it's rare and therefore precious.

Most of the farms have a small size which is a disadvantage for the viability of the farm. The biggest farms are found in low rainfall regions because bigger surfaces are needed to expand the crops and generate the same income as a small farm located in heavy rainfall regions. Actually in Tunisia, the scarcity of agricultural land added to the continual expansion of the rural population led to the use of marginal lands previously used for grazing.

3. Rainfall and Climate: In Tunisia , only 33 % of the total arable land benefits from enough rain ( at least 400 millimeters per year ). This factor is very important for agriculture because irregular or insufficient quantities of rainfall increase the probability of risk for the realization of the output or the crop planned to be achieved. Since the farmer's revenue is what he gets from selling his crops, any variability in production induces a high variability of his income. Therefore, according to the climate and the weather conditions the farmers realize gains or losses, and the more variable the weather is, the bigger the losses are. Since

everything is related to each other, this uncertainty in generating sufficient revenues will lead to an unwillingness to invest in new technologies from fear of further losses. The irregularities in rainfall are an important factor in taking a decision about choosing a crop pattern and using certain inputs. The farmer's income variability will him to avoid any costly new technique even if it could improve his income in one year average.

Irrigation is being increasingly introduced to regions with insufficient water supply. In such regions, the irrigation issue is vital. Irrigation receives more than 50 % of the total agricultural investment because expanded irrigable land would permit a larger production of different crops ( fruits, industrial crops like sugarbeet, vegetables... ) which cannot grow without significant quantities of water. These new irrigated farms would yield high outputs and as they are labor intensive, would also contribute to lower unemployment in the rural population

### Constraint 3 : Input Subsidies

The use of modern and advanced inputs by farmers owning small farms is relatively low. This is mainly due to two reasons :

- The infrastructure available to take care of the transportation of these inputs and the difficulties encountered in the supply of these inputs make their use unpopular among the farmers.

- They will result in a greater risk of losses because not only their adoption is very costly but also a misuse of these inputs could be more harmful than beneficial.

As for all the machines and all new agricultural techniques used in the sector, their supply is very limited and the demand cannot be covered by the available agricultural organizations. The lack of a suitable infrastructure limits the supply of inputs because the distribution centers are long distances from farmers: there are in fact 270 distribution centers spread out in the country while there should be at least 2500 of them to supplement all the farmers in all the country. Also, these centers of farm input supply should be able to advise the farmers about the most profitable use of inputs and provide them with the most efficient technologies to be used. which is not really what has been observed. This has not happened.

#### Constraint 4: Limited Access to Credit

In Tunisia, credit is provided by the national bank of

Tunisia ( BNT , partly governmental), by private banks and also by l'Office Des Cereales which provides credits to cereal farms.

Credit is the main material source for financing agricultural projects and investment. When unable to obtain credits from the banks, certain farmers will finance their investment through traditionnal money lenders and input suppliers. These investments however suffer from high losses induced by the inefficiency of the banking institutions providing these agricultural credits: the main characteristic that appears in the credit system is the fact that those who benefit from it are mainly the largest farms, cooperatives and the state farms.

Some of the problems of the loan and credit system in Tunisia are as follows:

- First, and as noted before, the inexistence of property titles is a disadvantage for those farmers who cannot provide a guaratee or security to the banks when asking them for a credit or a loan.
- Also, the loan process doesn't have the necessary accounting services to determine the costs of the credit operations: this puts the credit banks in an insecure situation .

- Another factor which constrains the credit distribution is the subsidy by government of loans with no risk insurance; the loan's recovery is therefore low and the banks suffer from losses on these agricultural loans with low interest rate. Therefore a reform of the credit supply process appears to be necessary. A reform that would give to small farmers the opportunity to benefit from these credits and also that would stimulate the banks in providing these credits.

#### Constraint 5: Human Resources and Lack of Technical Skills

The lack of technical skills was more sensitively felt after the French agricultural ingeneers who were taking care of the agricultural sector left the country. Specialists, technicians and high skilled workers are needed to improve the productivity in the sector.

In 1980, around 1,076,000 workers were employed in the agricultural sector, most of them as part time workers. The development of human resources and human potential in agriculture has to assure the education and the training of the workers.

More awareness and knowledge would open up new horizons towards the realization of agricultural development in developing countries like Tunisia, especially that most of

the rural population is unskilled and illeterate. In increasing the number of agricultural technicians, however, the problem of the adequacy of the education to the needs of the country is worth rising. Besides that, while most of these technicians have been hired only by the public sector and not by the private sector, it can be somehow guessed that as long as there exist small size farms where most of the labor force is family tied, even a skilled technician won't be hired if he's not a member of the family.

Constraint 6: Price Policies as a Natural  
Constraint To The Development of The Agriculture

The difference that exists in revenue between the agricultural sector and the rest of the economy is well known.

15 % of GNP is shared by 35 % of the total active population of the country such as 44 % of the population have a revenue less than the minimum wage revenue; This gap between rural and urban revenues became alarming from 1975 to 1980: the average expenses per capita increased by 4.5 % for the urban population against 1.5 % for the rural population. Therefore, the agricultural activity generating low incomes was becoming less and less attractive to people. Actually,

it became more a marginal than a primary activity: in 1980, 40 % of the farmers started some other activities outside agriculture. When it comes to the small farmers owning less than 5 ha, this proportion becomes 52 %.

Another factor contributing to these low agricultural incomes remain the irregularity and uncertainty of the mediterranean climate on which 75 % of the crops depend ( dry crops ).

The agricultural price policies were the main cause of the situation of the revenues described above, because different policies end up sometimes in contradictions with their objectives. For example, these policies want to provide low income farmers with affordable food products. They also establish prices such as to encourage the farmers to increase their production. Considering the price of wheat as an example, the government has to pay a considerable amount of subsidies to the producers and processors because the fixed price of wheat (aiming to keep the bread price low) is contradictory with the objective of this policy to motivate farmers towards an increased production of wheat. Therefore, the government has to pay subsidies to the farmers to compensate their losses.

Another price policy sustained by the government is to

fix the input prices in order to increase productivity in agriculture. On the other hand however, taxes are applied to input demand. As a result, subsidized products are encouraged at the expenses of the taxed products. Besides, these subsidies or financial transfers tend to decrease the revenues the farmers withdraw from the production for exports.

The Tunisian government however doesn't fix all the producer's prices: this is only done with the most important products such as cereals, olives, sugarbeets, wine, dates, beef, milk... while for others such as sheep meat, fruit, fish, vegetables...prices are free.

As for the labor use, it is taxed by a minimum wage. The law fixes this minimum wage as higher than the opportunity cost of labor.

A recent study performed in Tunisia about the effect of price policies upon the income generated by agricultural products showed that input subsidies tend to increase farm income but fixed prices and price control policies tend to decrease it.

A suitable price policy is more than vital therefore to increase farmers' revenues, it's necessary to alleviate the constraints holding the agricultural sector from achieving a self sustained growth of the sector. Lately, contracts mutually agreed by both processing enterprises and farmers



fix the producers' prices.

### Agricultural Exports and Imports in Tunisia

Tunisian exports do not observe a constant trend. They undergo ups and downs. Imports however keep increasing to satisfy the increasing demand due to the steady increase of the population. The deficit in the agricultural balance of trade keeps also increasing since 1966.

At this stage, it is obvious that the agricultural sector is neither able to contribute to the economic growth nor to offset the deficit of the total balance of payments.

#### 1. Exports:

The main agricultural product exported from Tunisia is the olive oil, which ranks Tunisia as second in the world exporters of olive oil after Spain. Exports of wine are also an important part in total agricultural exports. Sometimes, they even reach the same level of importance as olive oil exports.

Tunisia was facing an increasing demand for its exports of citrus, fruit and vegetables, especially from Europe. These exports however fell down since Spain and Portugal were admitted to the common market organization and thereby their products became competitive to the tunisian products. As a

result the common market became more and more restrictive towards these latter.

## 2. Imports:

Cereals have the most important share in total food imports ( it reaches sometimes up to 50% of food imports ).

The government is trying to increase the production of domestic cereals to substitute to cereal imports and at the same time to fit the needs of the population.

In these last 20 years, there was an introduction of high yielding varieties of wheat and of new technologies to intensify these productions.

## Possibilities of The Agricultural Sector

### 1. Irrigation

Irrigation is a primordial issue to be considered for the agricultural sector growth. In fact, investment in irrigation occupies a large place in the total agricultural investment ( around 60% ). Before the independence of the country, the french colonists tried to develop a structure for irrigation, means to convey water to the plantations...etc, but later on, by the late 60's and the early 70's, new technological devices were introduced and more and more investment was allocated to improve the irrigation structures.

A good policy for irrigation should stress the fact that improved irrigation would unmistakably increase both crops and farmers' incomes. This way, incentives are created to invest in irrigation which the farmers are generally unwilling to do due to its high cost.

The distribution of water should be regular and technically advanced so that the farmers do not have to gather in groups to be able to distribute the water contained in an outlet that is set for every given area. This system other than creating conflicts between the farmers, can also contribute to the waste of water and to an unequal distribution of the water resources between the farmers. A national program of management reform and maintenance of the irrigated perimetres is therefore recommended.

Also, in order to encourage the fuller use of irrigated land in Tunisia, a land tax should be imposed on whoever doesn't proceed to irrigate his land. The full use of the available irrigation potential should be given priority.

As for the adoption of irrigation projects, a full economic study is necessary to evaluate every project, its contribution to growth in this sector, the costs involved, the possible outcomes, how needed the project is and how efficient it is.

Many measures have been undertaken for that purpose and a project for extracting water from deeper than 1400 meters was realized in the southern part of the country.

## 2. Research and Farm Technology

Appropriate research programs should be developed nationwide.

Research is the pillar of any new technology and development. A successful research would provide studies of any investment project and would contribute to look for suitable and practical answers to the needs of the sector. It would also provide practical management training to the farmers, new methods and productive orientations and more appropriate technologies to the needs of the sector.

A suggestion could be given to improve the already traditional technologies, relying on potential resources that could turn to be productive such as solar energy powered pumps for example.

The problem in Tunisia is that agricultural research is mainly oriented towards scientific considerations and hardly deals with the real problems of the farmers. Besides that, the budget allocated to research is very reduced relatively to other investment categories.

A main point ought to be made here: there is a desperate need for regional research centers in different regions

because the central research center of the capital cannot satisfy all the needs of the country.

To every region should be allocated a research center to study its specificities. Research is nothing else than some kind of agricultural investment: to benefit from its results, more credit and importance should be given to it.

### 3. Diversification of The Production Process

Diversification of the product is also very important and should be encouraged so that in addition to cereals, some industrial crops are introduced and export products are developed.

On the other hand, crop rotation are to be changed to obtain a higher yield of the land. In fact, new fruit tree crops were introduced in the northern part of the country receiving more than 400 millimeters of rainfall per year.

### 4. Credit Availability

Credit is at the center of farm investments because it is the main financial source for these investments.

The Tunisian credit system is well adapted to the biggest farmers because they are the most productive. Thus, the main point is to create the possibility for the smaller farmers to benefit from these credits too.

As cited before, the Tunisian credit system has

undergone a reform with the introduction of new credit sources such as public enterprises . To promote arrangements between a processing firm and farmers would be beneficial to both: the firm would provide the credit in exchange of a part of the output realized by the farmer.

On the other hand, leasing of machinery and animals would help small farmers that cannot afford to buy all these necessary equipments. Recently, a national fund of guarantee has been created to develop credit operations and also to involve the commercial banks in the process of financing the agricultural sector. Consequently, short term credits have all been provided by the cereal banks while a project for the creation of a development bank is considered to sustain the long term credits.

##### 5. Price of The Agricultural Products

The main tool for the orientation of the production is the price policy of the agricultural products. If the price is an incentive for the farmer, he will produce whatever has the largest remuneration.

For the most important products the government fixes the prices while for the rest of the products prices are submitted to the free market fluctuations. The distribution network is the weakest point for these latter because it doesn't secure the farmer's concern in selling his

products with prices that make him motivated.

Price policy could also be used to motivate the farmers towards a production for exports by decreasing their tax burden for example. There is also an urge for both a quality control system and an adequate agro- transformation industry.

#### 6. Input Supply

This supply encounters all kinds of constraints especially the inadequate structure of distribution and transportation accessing to all parts of the country. Therefore, incentives and encouragements should be created for wholesalers to install their input supply centers even in the farthest part of the country.

#### Conclusion

Actually, several possibilities of reform are offered to the agricultural sector. They would improve the stagnant situation in which the agriculture is. These measures however need time and money of which the Tunisian government doesn't dispose.

The latest reforms undertaken in the country are anyway encouraging and their renew of focus on the agriculture as a priority to develop will hopefully lead to more effective results.

## CHAPTER V

### AN AGRICULTURAL MODEL FOR TUNISIA

The following model has been designed to serve the Tunisian government's interest. Its purpose is to estimate where the sources of the greatest potential for economic development in Tunisia lie. A quantitative method is therefore needed to determine the binding constraints to the agricultural sector development.

After a literature review and a brief overview of the tunisian economy and agriculture are presented, a first section will be devoted to the basic structure of the model while a second one will deal with its mathematical structure presenting at the same time the different sources of data involved in the study.

#### Literature Review

Several attempts to build up a developing model for an underdeveloped agricultural sector were conceived. The world bank research efforts within this context ought to be recognized.

The CHAC model by John Duloy and Roger Norton is the starting inspiration for the Tunisian model, AGRARIA.

In their study, J. Duloy and R. Norton chose to deal



with the mexican agricultural sector. They present a detailed analysis of the agricultural sector exploring the relationships between sector policy and economy wide development strategies.

CHAC was part of an overall economy model for the mexican economy. It was an integrated part of the whole economy planning model. It describes a particular form of market equilibrium, in terms of prices and quantities, with corresponding representations of producers and consumers behavior.

Another model by Alvin Egbert and H. Kim focused on agricultural development in Portugal. It is a spatial equilibrium programming model which has been developed assuming that the economy can be divided into separate geographical regions.

The choice of a given analytical framework to be adopted for sector analysis depends on a certain number of factors such as the available data, the objectives pursued by planning, the nature of the political system and also the structure of the economic system.

The lack of data will restrain the size of AGRARIA. Also, depending on whether it is a free market economy or a planned economy, different analytical frameworks will be needed. For a free market, a behavioral structure of the model including producer's and consumer's behaviors is

necessary, while in a planned economy subject to a strong government interventions, fiscal and monetary policies will be important.

The Tunisian economy is characterized by a certain degree of intervention of the government, especially in the agricultural sector. However, the sector is not property of the state since both private and public farms exist in the country.

The model used for the analysis will be using the general framework of the spatial price equilibrium and linear programming of Paul Samuelson (39).

The objective of the model will be to determine an optimal crop production under the constraints of input availability, foreign exchange limitations, land availability ... etc. The total production of the agricultural sector will also be maximized under the same constraints.

#### Basic Structure of The Model

AGRARIA is an aggregated model in the sense that the crops of the Tunisian agriculture were aggregated into six classes of major crops because of insufficient data relative to every particular crop.

AGRARIA is specified to generate a vector of sectoral outputs.

The crops included in the model are annual crops (short cycle crops) plus tree crops and livestock (long cycle crops). Forestry and fishery will not be included due to lack of data.

Another disaggregation of the model concerns some of the inputs: for example, labor is specified seasonally because its supply is characterized by seasonal trends.

The market is seen as being competitive even if there exists government regulations and policies through subsidies, financial transfers and price support. These will be considered as basic interventions in a competitive market.

The factor inputs included in the model are labor, and land constrained respectively by labor availability and irrigated land availability. The commodity inputs are chemicals, irrigation water and machinery.

The production activity involved in the model can be regarded as a combination of inputs in fixed proportions.

The constraints of this model relate to predetermined conditions such as scarcity of resources, limited access to credit, a given technology to the producers, a given income level to consumers...

On the demand side, some factor supply functions are perfectly inelastic (land: endogenous price), others are more elastic (ie. chemicals and capital for which prices are exogenous).

The technology consists in an efficient combination or input mix including land, water and labor in fixed proportions.

The supply of factors relates to supply of water, land and labor. These input supplies are assumed to be infinitely elastic.

#### Data Base For The Model

The most inhibiting factor met in building this model was the lack of relevant data. Therefore it has been resorted to a further simplification and abstraction of reality by increasing the number of assumptions.

Different sources of data were provided:

- For the input technical coefficients: they concern labor, capital, machinery... Land and water use per unit of output, credit and chemicals needs per unit of output are included in the model.
- The production technique of cropping is assumed to be a fixed coefficient production function, that is for a given level of output there exists a fixed proportion of capital and labor.

The data used for this model were derived from the agricultural reports of the Tunisian Ministry of Agriculture. Official statistics elaborated by the government were also

used ( 30 ).

### Mathematical Structure of AGRARIA

- Material balance equation: This equation states that the total demand of the country for agricultural goods cannot exceed the total supply of these products. Therefore, the total use of agricultural goods on consumption, exports and primary inputs within the agricultural sector, should not in any way exceed the total supply of these products which is provided by the local production and the imports.

$$A'X + E + C = M + X \quad (1)$$

$$\Leftrightarrow (A' - I)X + E + C - M = 0 \quad (2)$$

$$\Leftrightarrow AX + E + C - M = 0 \quad (3)$$

where

A is the input-output coefficients matrix (6,6)

E is the exports vector (6,1)

C is the consumption vector (6,1)

and M the imports matrix (6,1)

- Input equations:

$$\text{labor:} \quad L X = L^{\wedge} \quad (4)$$

$$\text{chemicals:} \quad CH X = CH^{\wedge} \quad (5)$$

$$\text{water:} \quad WT X = WT^{\wedge} \quad (6)$$

$$\text{machinery:} \quad MAC X = MAC^{\wedge} \quad (7)$$

$$\text{Irrigated land:} \quad SI X = SI^{\wedge} \quad (8)$$

where

LX = matrix of the requirements for labor of each kind of crop ( one labor skill ). (1,6)

CH = " " " for chemicals " " (1,6)

WT = " " " for water " " (1,6)

MAC= " " " for machinery " " (1,6)

SI = " " " for irrigated land " (1,6)

The other vectors  $L^{\wedge}$ ,  $CH^{\wedge}$ ,  $WT^{\wedge}$ ,  $MAC^{\wedge}$  and  $SI^{\wedge}$  simply represent the total available resources (ie. limited supply) of respectively the labor force, chemicals, water, machinery and irrigated land variables (1,6).

The input equations state that the total use of the inputs entering the production process as requirements cannot exceed the available quantities of these inputs.

- The objective function: Several simulations of the same equations were realized but under different objective functions.

The options were:

- max  $X_i$   $\Leftrightarrow$  maximize the production of each crop

where  $i = c, a, m, e, l, i$  designating the different crops.

- max  $\text{SUM } X_i \Leftrightarrow$  maximize the total agricultural output

- max  $(E - M) \Leftrightarrow$  maximize the net imports of the different crops.

- max  $C \Leftrightarrow$  maximize the total consumption of the different crops.

- max (SUM Xi + E - M)  $\Leftrightarrow$  maximization of the net production that can be used locally for the final demand.

#### Conclusion

The model previously presented has been run under different objective functions and the results will be presented in the following chapter.

## CHAPTER VI

### VALIDATION AND TESTING OF AGRARIA

Within this chapter, the model presented in the previous pages will be validated for 1980/81 to check its accuracy and validity and see how conclusive and useful it can be to economic planners in evaluating different economic alternatives and development plans.

Inevitably and unluckily, the model building is subject to the limitation of data availability, limitation of its reliability too. Therefore it should be kept in mind that this abstraction of the reality has left out many considerations that should be actually included since they belong to the complex reality. Hopefully however, the assumptions that have to be made before proceeding to simulation will not oversimplify the model.

#### Assumptions of The Model

- The domestic demand will be assumed to grow at the same rate as GNP.
- The labor force will be assumed to grow at the same rate as population does.
- Risk or reaction of the producer to income availability is not included in the model due to data



deficiency.

- Internal exchange and costs of transportation have also been abstracted from the model.

#### Validation

The model was analysed for one period of time, and was simulated with data from 1980. The differences between the real numbers and those obtained here result from the method of aggregating data. In fact, aggregating leads to results with significant errors and therefore highly aggregated models would be misleading for all development planners because there is the risk of taking the wrong decision if based on mistaken and unreliable data. Nevertheless, these results shed some light on the more appropriate method for sector planning.

The testing of AGRARIA is meant to derive some significant results concerning the alternatives offered to the sector given its binding constraints.

The testing analysis will provide information regarding the sectoral production.

The agricultural labor supply was characterized by a seasonal trend and it was assumed that rural urban migrations will absorb rural population growth so that the number of rural people remains constant over the period under study.

## Results

As expected, the results of AGRARIA are different from the outcomes in the official documents, given the facts that the model is oversimplified. However, the analysis and the trends shown by AGRARIA coincide with the trends the sector has been showing. The numbers in themselves might be different but their significance and meanings once analysed are still valuable. The emphasis is put on the dual solution of the problem.

The binding conditions resulting from the simulation of AGRARIA meet the inhibiting problems of the tunisian agricultural sector.

### 1. Cereals:

When we try to maximize the output of cereals under the constraints of AGRARIA model, one binding constraint appears in the dual solution of the problem: machinery and agricultural devices.

This is projected in reality by the fact that most of the farms are small or of a medium size, and their owners cannot afford to buy modern agricultural equipment even if the introduction of these modern devices would substantially increase the productivity of the farm. Actually, more than 60% of the irrigated lands are small farms which size is less

than 50 acres, and besides there's either a lack in the appropriate equipment or whatever there is is too old. Therefore, the main recommendations that could be given and applied to favor the optimization of the cereal production are the following:

- Improve the stocking capacity of the cereal producers.
- Make it easier to acquire agricultural machinery by developing credit lines to the cereal producers who can afford to buy these devices.
- Install distribution centers for machinery that can make everything needed by the farmer available to him.
- Develop a program to rent the machines to whoever farmer needs it.
- Reinforce the numbers of the technical advisors at the service of the farmers.
- Reinforce the number of technical assistants and mechanics specialized in fixing agricultural machinery.
- Standardize the equipment available to the farmers because what is observed is that inadaptable trademarks are used at the same time while very different.
- Establish a research program relative to the use of land and agricultural equipment needed by such and such soil conditions.

2. Treecrops, olive trees and Livestock:

The maximizations of the tree crops and livestock productions are bound by the labor constraint.

- The tree crops need a sustained attention and care from specialized farmers, but the reality of the tunisian agriculture is other than that.

Bad care of the olive plantations and the tree crops has led to a very low productivity. Besides, the farmers tend to specialize in such or such crop without making sure the soil is suitable for it or not. Specialization is the result of the farmer's personal taste.

The labor force is characterized by a high rate of absenteeism, while the farmers themselves who are supposed to supervise the workers tend to be insufficiently motivated. Another factor inhibiting the tree crops production is the deficit in water which affects about 60 % of the farms. The investment in this project would have had involved high costs besides it required a contribution of 3 % of the whole amount from the farmers which they cannot afford.

The most important recommendation to be given in this case is to organize a better advisorship for the farmers. They need to feel motivated and also be able to supervise the labor force on the farms. Unskilled labor is the main category of the agricultural labor force in Tunisia as in

other underdeveloped countries. Therefore, an agricultural policy based on the technical aspect of the labor force should be emphasized.

Besides the motivation of the farmers should be reinforced by providing them with short terms credits.

As for the workers, the minimum wage in the agricultural sector is very low and it doesn't motivate them to make any further efforts, therefore the wage level should be reconsidered.

Besides, the choice of the kind of crop to plant is the main stimulant for the farmers regardless of the natural vocation of the region or the soil. So what also needs to be done is to encourage research to determine which kind of plants suit each kind of soil.

As for the livestock production, the major part of it is within the farmers that have not enough land therefore the livestock is fed with natural vegetation.

The most important recommendation is a further integration of the livestock in the agricultural farms: the other thing that could be done is the reconversion of some of the marginal lands that cannot be used for the cereal crops in the northern part of the country.

### 3. Vegetables and vegetable crops:

Through the simulation of AGRARIA under the successive

objective functions: max  $m$ , max  $l$ ,  $m$  for vegetables and  $l$  for vegetable crops one common binding constraint appears: chemical resources.

The chemical resources are insufficient relatively to the needs of the sector. Therefore a major part of these chemicals is imported. The imports of these chemicals added to the local production supply the sector with its needs; However, these chemicals are used in a "polyvalent" way, in other words a given kind of chemical is used for any kind of crop regardless of its special specifications.

Besides, the chemicals' distribution network doesn't indeed supply all the farmers because it can only reach certain regions.

#### 4. Industrial crops:

The binding constraint on the industrial crops' production remain the water resources and irrigation.

In Tunisia, water is subsidized by the government but the farmer still underuses it: 3000 to 4000 m<sup>3</sup> instead of the required 6000 to 7000 m<sup>3</sup> per acre; the farmer tries to share the few financial capacities that he owns over all the factors of production. Hence, developing a financial program to the farmers to cover the charges of some factors of production will leave some alternative to the irrigation issue, encouraging the farmers to invest in irrigation.

Particular efforts are being made by the government to address this issue and the mobilization of the hydraulic resources is now part of the development strategy for the agricultural sector.

5. Other simulations under other objective functions:

- Max total agricultural output

The binding constraints are labor and chemicals which summarizes the major needs of the sector and of each of the five aggregated crops. The main recommendations to be given in this case remain:

- to supervise the farmers and the workers with assistance and advice. Specialists should be available any time to give advice and information, especially concerning the use of chemicals and machinery.
- develop an educational program for the unskilled labor force to increase their productivity and teach them the farming skills.
- the necessary equipment should be made available to the farmers under easy conditions like credit possibilities or rental possibilities. Besides, all chemicals should be within reach of the farmers .
- also, mechanics and specialists should provide the farmers with the best advice concerning taking care of the equipment used.

- price policies should be revised as for the chemicals which are imported and not fully subventionned.
- the labor needs to become motivated, therefore the agricultural minimum wage ought to be revised.

AGRARIA was also optimized under the following objective functions:

- max total agricultural exports - imports
- max total agricultural output + exports - imports

These two simulations came up with binding constraints from all 6 aggregated crop production besides binding constraints from labor and chemicals. This should be of no surprise given the fact that little care is given to the agricultural products for export. Besides, they suffer from the same insufficient resources: unskilled labor, inadequate and insufficient chemicals.

### Conclusion

These results and comments derived from the simulations on AGRARIA summarize the situation of the agricultural sector in Tunisia. One of the major problems is the unskilled labor force that is not specialized in the use of modern machinery and chemicals. On the other hand, the agricultural economy is relatively dependent on agricultural imports so that financial resources are rather invested in the industrial



sector. However, a renewed interest seems to arise concerning the tunisian agriculture and more resources are dedicated to the sector.

TABLE I  
RESULTS FOR MAX c AND MAX a

Maximization Results	Cereals c	Tree crops a
Actual production 1980	206800	701420.45
AGRARIA results	241822	572051.7
Binding constraint	mach	labor
Input resources		
labor	33179	33179
chemicals	14714	14714
water	1478.5	1478.5
machinery	1499.3	1499.3
land	3952.4	3952.4
AGRARIA use of inputs		
labor	11075.47	33179
chemicals	7496.5	5720.517
water	217.0463	1372.924
machinery	1499.3	1258.514
land	2660.048	3952.4

TABLE II  
RESULTS FOR MAX m AND MAX e

Maximization Results	Vegetables m	Livestock e
Actual production 1980	200219.38	815128
AGRARIA results	223617	868562.2
Binding constraint	chem	labor
Input resources		
labor	33179	33179
chemicals	14714	14714
water	1478.5	1478.5
machinery	1499.3	1499.3
land	3952.4	3952.4
AGRARIA use of inputs		
labor	11963.21	33179
chemicals	14714	
water	1475.862	173.7121
machinery	201.2553	420.0285
land	3952.4	3952.4

TABLE III  
RESULTS FOR MAX 1 AND MAX i

Maximization Results	Veg crops 1	Indust crops i
Actual production 1980	115350	154570
AGRARIA results	230627	168011.4
Binding constraint	chem	water
Input resources		
labor	33179	33179
chemicals	14714	14714
water	1478.5	1478.5
machinery	1499.3	1499.3
land	3952.4	3952.4
AGRARIA use of inputs		
labor	6711.245	9509.443
chemicals	14714	1730.517
water	668.8182	1478.5
machinery	1176.198	420.0285
land	3952.4	3952.4

TABLE IV  
RESULTS FOR MAX AGGREGATED  
AGRICULTURAL OUTPUT

Maximization Results	Aggregated agricultural output
Actual production 1980	753480
AGRARIA results	923533.4
Binding constraint	chemicals and labor
Input resources	
labor	33179
chemicals	14714
water	1478.5
machinery	1499.3
land	3952.4
AGRARIA use of inputs	
labor	33179
chemicals	14714
water	669.2229
machinery	1315.463
land	3952.4

TABLE V  
RESULTS FOR AGRICULTURAL  
( EXP - IMP )

Maximization Results	Agricultural Exports-Imports
Actual production 1980	254300
AGRARIA results	683925.6
Binding constraint	chemicals, labor and output
Input resources	
labor	33179
chemicals	14714
water	1478.5
machinery	1499.3
land	3952.4
AGRARIA use of inputs	
labor	33179
chemicals	14714
water	668.8182
machinery	1314.772
land	3952.4

TABLE VI  
RESULTS FOR MAX AG OUTPUT  
+ AG ( EXP - IMP )

Maximization Results	Ag output + Ag( Exports-Imports)
Actual production 1980	1007780
AGRARIA results	1607426
Binding constraint	chemicals, labor and output
Input resources	
labor	33179
chemicals	14714
water	1478.5
machinery	1499.3
land	3952.4
AGRARIA use of inputs	
labor	33179
chemicals	14714
water	668.8182
machinery	1314.772
land	3952.4

## CHAPTER VII

### CONCLUSION AND SUMMARY

The analysis of agricultural development strategies is basically problem oriented: It starts with identifying the policy options for agricultural development that meet the economic and social development goals.

Then the constraints to the agricultural development within the general development process are identified so that such goals as increasing production, employment, resources use and self sufficiency can be realized.

The different strategies for the development of the sector will serve as a base for the analysis of the development process and as a contribution to the planning process for this development.

With AGRARIA ( see Tables page 65 through 70 ), one of the simulations attempted to determine whether there was self sufficiency in food products realized by the foreign trade in agricultural commodities. This simulation concluded that chemicals and labor were a binding constraint to this development. However, the fact is that with more detailed data and a deeper analysis, it could conclude if the sector had a comparative advantage in trading such or such commodity.



Therefore, the use of such a linear programming model as AGRARIA could suggest much more detailed results if only it was not oversimplified and restricted by data availability and reliability. The AGRARIA method therefore only applies as an approximation to the agricultural sector reality. The linear programming framework provides a mathematical method to determine the feasible linear combinations and identify the best one that produces the maximum with the optimal use of scarce resources.

Limitation of time, resources and data led to the fact that the model was not developed to its full capacity. The assumptions are very simplifying and therefore constrain the model reliability. Several sub agricultural sectors were not included such as forestry and fishery.

Nevertheless, once the model is conceived it can be improved hopefully by adjusting to each disaggregated crop a specific demand function, by gathering more significant data, by introducing more investment activities and also by specifying a supply of labor function of wage labor.

The results obtained are significant but not definitive nor infallible. They can be improved by the user according to the sources of information he will be using. These results are just adapted to the range of data used and the possibilities available to them for functioning. The results are as good as the quality of the data used allows it.

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