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Analysis of Agricultural Production for Selected Crops: Wheat, Cotton and Barley

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Foreword

This paper aims to contribute to the continuous process of supporting the Syrian development and modernisation process by enriching public availability of documentation on agricultural economics and policy studies conducted at the National Agricultural Policy Center (NAPC).

The studies and research activities carried out at the NAPC involve the preparation of papers to consolidate the outcomes of on-going researches which provide a reference for future follow-up. The collection of such documents in the NAPC allows sharing with a wider public research results susceptible of further analysis and elaboration.

Syrian agriculture is characterised by a variety of geographically and socio-economically differentiated production systems. Available information on the structural articulation of these systems is scanty. This is of special concern in assessing the potential response of the Syrian agricultural production and supply to the on-going process of domestic liberalisation and increasing integration in the international markets.

In order to contribute in filling the perceived gap, the NAPC launched the process of conducting the fist systematic supply and demand study for agricultural commodities in the country, with the support of the FAO Project GCP/SYR/006/ITA - Phase III, funded by the Italian Government.

The study lasted for about three years was conducted by the workforce of the Agro-Food Systems Division and led by Mr Carlo Cafiero, FAO International Consultant, under the supervision of the Project CTA, Mr Pirro-Tomaso Perri, and the NAPC Director, Mr Atieh Al-Hindi. In the implementation of the study, the division was supported by the Project Agricultural Economist and the FAO consultant, Ms Ilaria Tedesco.

The study work started by a preparation period that lasted for a year aiming at collecting all relevant information for the study. This information has been all summarised and presented in their relevant commodity outlooks and bulletins, which have been consistently published by NAPC.

From the beginning, the study was divided into two major parts: the supply part that analyses the agricultural production at the farming system level and the demand part that considers the commodities passing down their chains reaching their final users. This paper reports the first results of the analysis of the agricultural production for the most potentially important annual crops: wheat, barley, and cotton, while the analysis of the consumption is published in a separate paper.

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Acronyms

ACB	Agricultural Cooperative Bank
AHG	Al-Hassakeh Governorate
GCASR	General Commission for Agricultural Scientific Research
GECPT	General Establishment for the Cereal Processing and Trade
CMs	Cubic meters
CMO	Cotton Marketing Organisation
GOS	Government of Syria
KTB	Al-Khabour and Tigris basin
MAAR	Ministry of Agriculture and Agrarian Reform
MI	Ministry of Irrigation
NAPC	National Agricultural Policy Centre
SAC	Supreme Agricultural Council

Introduction

The Syrian Arab Republic has a highly diversified climate and territory in which a considerably diversified agriculture has evolved over time. In a recent study, six major farming systems zones were identified to provide a broad representation of Syrian agriculture, ranging from the coastal highly intensive irrigated production systems in the western coast, to the pastoral and agro-pastoral rainfed systems of the arid East (Wattenbach, 2006).

Such diversity in farming systems, however, is not reflected into an equally diverse production, in the sense that most of the value of agricultural production is due to a small number of major crops. This situation is the result of many years of strategic centralized planning by the Government of Syria (GOS) which pointed to wheat, cotton, and barley and few other crops as the backbone of agricultural production in the country. This planning have had over time the consequence that agricultural outputs have not been always obtained from production activities on the most suited territories, with natural resources being utilized to less than their full potential, especially water.

In the meantime, Syrian farmers operate in an environment prone to high rainfall variation with low average annual rainfall, with the exception of the coastal and mountainous areas. Consequently, irrigation sector has an important role in Syrian agricultural development especially in reducing the effects of rainfall variability and enabling high-yielding varieties to express their output potentials. Therefore, although the irrigated areas account only for about 30% of cultivated areas, the agricultural output heavily depends on them, since irrigated areas produce 100% of summer crops and 45-70% of winter crops depending on rainfall variability across time. Therefore, the GOS has put in place many interventions to increase the irrigated agricultural area, which indeed has increased steadily in Syria over the last decades, almost doubling since 1985 (NAPC, 2005).

The main objective of the Syrian agricultural policy was, until mid 1980s, to achieve and ensure self-sufficiency in some food strategic food commodities, particularly wheat and cereals legumes, as well as guaranteeing some surplus for export from cotton, which is the second main provider of foreign currency after petroleum for many years. This has pushed for large-scale public investments (mainly in land reclamation and irrigation projects) to fully exploit natural resources, coupled with price policies for inputs and outputs aiming at stabilizing markets and motivating farmers to participate in achieving the national objectives. This, although was partially successful in achieving the national goals in the short-run, introduced serious market distortions which led to inefficiencies in the use and allocation of resources and has over time proved ineffective in ensuring high levels of sustainable self-sufficiency. Although Syria became self-sufficient in wheat from mid 1990s, at the same time it wasn't able to supply some other products domestically such sugar, maize and vegetables oil.

Moreover, this partial success has been at the expense of sustainability of some natural resources especially water and land. Water use in agriculture accounts for 85% of its total use and, even more important, it is mainly used for water-intensive crops, especially cotton and wheat, since these two crops require much water to yield acceptable levels of output in the context of the Syrian agro-ecological conditions. Therefore, they have significantly contributed to the water deficit problem in the country especially in the north-east of the country where their negative effect on water balance is obviously observed in the area of Al-Khabour and Tigris basin (KTB) (NAPC, 2005). Furthermore, soil deterioration has been observed in some parts of the country (e.g. in Al-Ghab and Der-ez-Zor) where the strategic crops have been intensively grown.

The policy reform program, introduced in the nineties, aimed at reducing market distortions, thus ensuring increased efficiency in the use of domestic resources. Initially, input subsidies were reduced, producer prices were augmented and planning intervention started being less rigid. Subsequently, trade liberalization started in the same period. Crop diversification policies were also promoted and increased attention was given to the comparative advantages of Syrian agriculture. The concept of self-reliance has been gradually substituting the concept of self-sufficiency, implying a more active participation of the country in international trade. Agricultural trade expanded and played a more important role in achieving food security. Therefore, the GOS, in light of the general policy orientation to adopt the social market economy, has executed a series of economic and institutional reforms to enhance the integration with the world economy, to ease the implementation of the assigned agreements and to prepare for joining the WTO.

Given that more reforms and policy changes are expected in the future, it is obvious that the direction of the reform is to reduce further Government interventions and/or reformulate the existing policies in a way that allow the market forces to play a leading role in the economic development process.

Based on above, and given the relative importance of the three crops (wheat, cotton, and barley) for the Syrian economy, the major objectives of this research are to:

- describe the evolution of these three crops demonstrating their importance in terms of output and use of resources,
- describe the set of policies affecting the production of these crops
- construct an analytical model that represents Syrian agricultural production. Such a model would enable us to predict the impact of any policy incidence on the supply of these crops and their demands for factors of production.

Therefore, the paper is organized in five chapters. The first one is devoted to describe the evolution of these three crops in terms of area, yield, output, and the distribution of their production across the country. The second chapter provides an extended summary of the set of policy affecting the agricultural sector in general and the production activities of these crops in particular. The third chapter is dedicated for justifying the choice of the analytical method, explaining the basic elements of the model, and showing its theoretical and practical limitations. The fourth chapter gives a detailed description of the model in practice with the data used in the analysis, while the fifth chapter presents the predictions of some relevant policy scenarios. The last chapter summarizes the policy implications of the results, and proposes a way to improve the analytical power of the model.

Chapter 1 – Production Systems of Selected Crops

1.1 Wheat

Wheat is Syria's major staple food commodity, consumed mostly in the form of bread. Due to the national security situation, a major objective of the GOS is to ensure that Syria is self-sufficient in wheat. Wheat production has been encouraged on both rainfed and irrigated areas so that Syria became self-sufficient in wheat in the mid-1990s. This has been achieved by a combination of the accumulation of national strategic stocks and the plantation of sufficient land to wheat to ensure that national production is approximately sufficient to meet domestic needs, even in a drought year.

1.1.1 The use of Production Factors

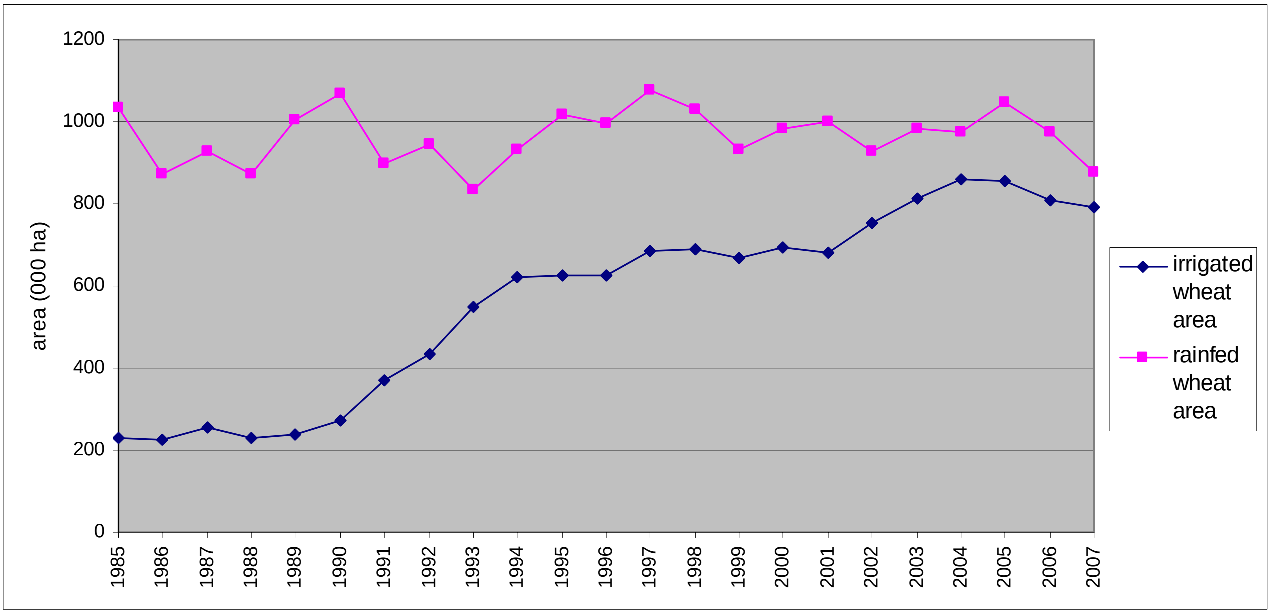
Natural Resources

Areas under wheat increased from 1,098,296 ha in 1986 to 1,700 thousand ha in ninetieths, to remain somehow stable since then. Indeed, this increase has principally been the result of expansion in the area of land supplied with water from dams. By far the largest increase in area has been in Al-Hassakeh Governorate. Moreover, the increase in irrigated wheat yield came along with the increase in the cultivated area in general. The yield has increase from 3956 kg/ha in 1993, to 4400 kg/ha in 2006.

Syria produces hard durum wheat and soft wheat on irrigated and rainfed land during the winter season. Most rainfed wheat comprises hard varieties. Hard durum wheat reportedly comprises roughly 60% of total production and soft wheat 40%. Wheat is the dominant irrigated crop in Syria, accounting currently for roughly 50% of all irrigated land, 60 of the irrigated land devoted to annual crops, and 70% of the irrigated land devoted to the strategic crops. The national area of irrigated wheat increased in every year from 1988 to 2007, rising over this period from 229,000 ha to 790,000 ha. Unlike irrigated wheat, there has been no obvious trend in the area of rainfed wheat over the past 20 years. This has in most years been marginally above or below one million ha, depending on rainfall conditions (**Figure 1.1**).

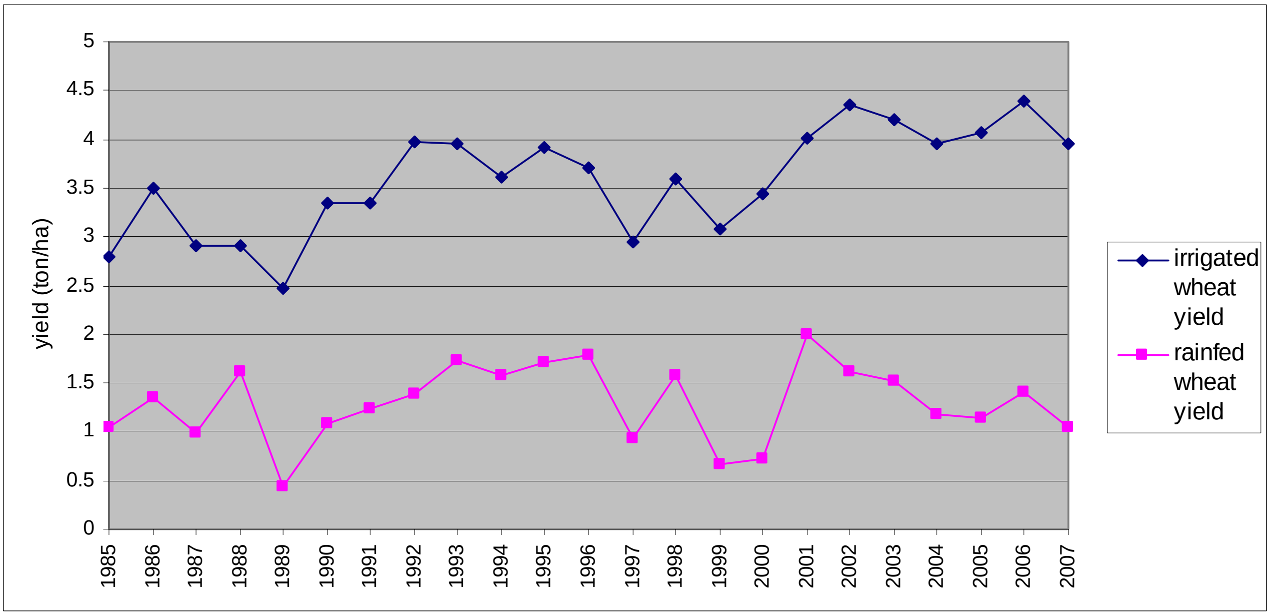
Rainfed wheat yields tend to be highly unstable, with the national average ranging from less than 0.5 tons per ha in a drought year to over 1.7 tons per ha in a year of good rainfall. By comparison, irrigated yields are relatively less unstable, with the national average ranging from some 3.0 tons to 4.0 tons per ha (**Figure 1.2**). Trends in rainfed per-hectare yields are difficult to identify due to the instability in annual production. The 1990s have seen a small general improvement in irrigated wheat yields over the levels recorded in the 1980s, probably due to the introduction of some high yielding varieties in the 90s.

Figure 1.1 – the evolution of wheat area (ha)



Source: elaborated from the NAPC database

Figure 1.2 – the evolution of wheat yield (tonne/ha)



Source: calculated from the NAPC database

Labour

Labour is rarely used in the production of wheat in Syria. Most wheat in Syria is highly mechanised Therefore, labour is not of importance for wheat production.

Capital

Wheat costs and capital requirements differ from one area to another and from farm to farm in the same area. The most important factor that causes this variation is the cultivation type whether rainfed or irrigated. Of course, production costs of wheat per hectare are much lower for rainfed wheat than the case for irrigated wheat. This is due to the water costs that are absent in the case of rainfed wheat and due to the increase in the input use (especially fertilisers) that should accompany the increase in irrigation. Furthermore, water costs of irrigated wheat differ from region to region and from year to year due to the differentiations in rainfall distribution and to rainfall fluctuations.

Machinery

It is very important element of wheat production in Syria. The gross margins calculations of the Study Workforce show that most or all agricultural operations in wheat production are mechanised over all the country. Most important are ploughing, seeding, fertilisation, and harvesting. The only operation that is usually performed by labour is irrigation although large areas of wheat are irrigated by sprinkler schemes especially in the areas where wells form the most usable source of water.

The level of mechanisation rises, as expected, as the farm size rises. In other words, small farmers depend on labour (especially family) more than medium and large farmers do. The gross margins calculations of the FSS indicate that most medium and large farmers depend on their own machinery for ploughing, seeding and fertilisation, while almost all farmers depend on hired machinery for harvesting.

1.1.2 Wheat Farming Systems

The most important criterion that affects wheat production systems is the cultivation type whether rainfed or irrigated. The increase in wheat irrigated area, observed in **Figure 1**, has been the result of the expansion in irrigation especially in Euphrates and Al-Khabour Basins as a consequence of digging many private wells in addition to the construction of some dams.

Rainfed wheat is concentrated in the relatively high rainfall areas such as Agro-Climatic Zone 1 or in the areas where irrigation is banned by the Government such as most Agro-Climatic Zone 4. However, wheat irrigation is mostly supplementary in Syria and in many areas of the country it is not used every year. In other words, the amount of irrigation water devoted to wheat, where exists, differs from year to year according to the quantity of rainfall and the distribution of it along the year.

Wheat is irrigated in Syria through two modes: flood and sprinkler. However, most irrigated production employs flood irrigation, in which sprinkler scheme occupies 15% at most.

The competing crops to wheat differ from one region to another due to the differentiation in climatic conditions, water availability, Government policy, etc. For example, cotton is the most important crop cultivated beside wheat in Al-Hassakeh governorate where the MAAR encourages farmers to rotate cotton with wheat as the following wheat-cotton-wheat since this governorate produces some 40% of the total cotton output of the country. In other governorates such as Al-Raqqa, Der-Ezzour, Aleppo, and Al-Ghab, sugarbeet is also important due to the Government policy that concentrates the production of sugarbeet in these governorates through the agricultural plan of the MAAR. In Homs and Hama, some winter crops are important beside wheat such as onion, cabbage, peanut, potato, carrot, and others. The same applies to the southern area of Syria (Dar'a and Al-Sweida) wheat and legumes, while wheat is a negligible crop in the coastal areas where the dominant crops are citrus, olive and greenhouse vegetables.

1.2 Cotton

Syria recently occupied the tenth place in the world in terms of annual average production, with a share of 1.6% of the total and the second place in terms of yield per hectare (Al-Jamal, 2003).

Some economic sources say that more than 20% of labor force depends partially or totally on cotton; cultivation, manufacturing, marketing, and other related services (MAAR, XXXII Cotton Conference, 2002). At the end of the 1990s, the value of cotton production was SP29 billions. By then, the value of produced cotton was almost equal to 2.5% of GDP and about 10.7% of the agricultural production value (NAPC, 2006).

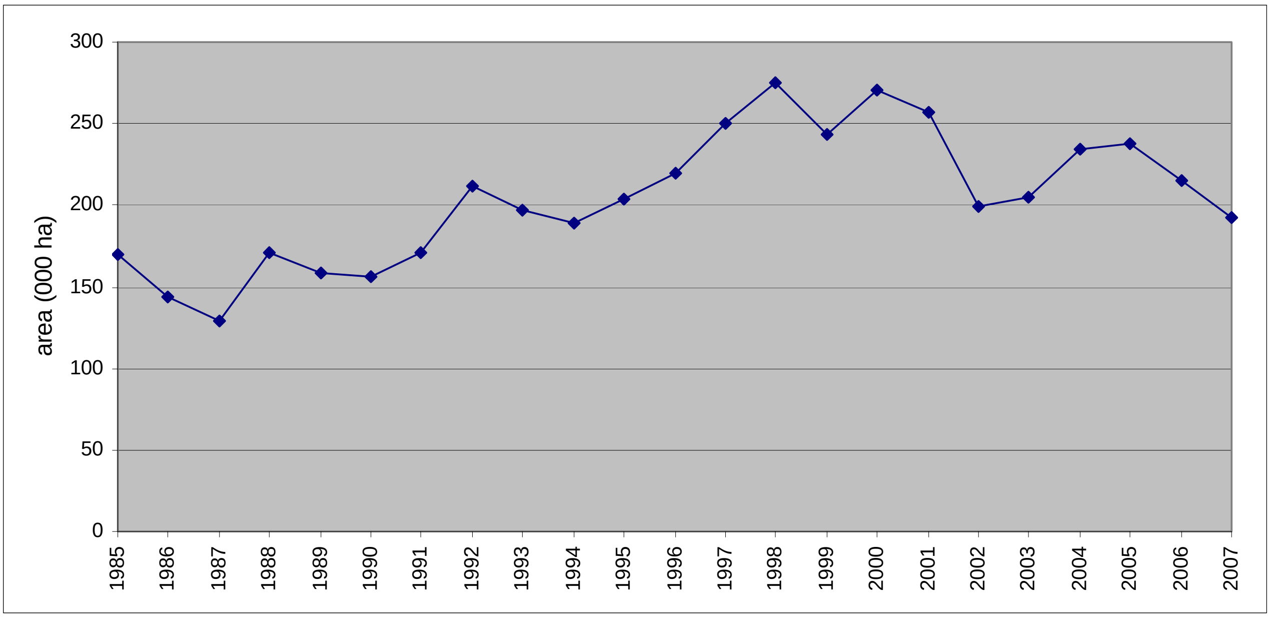
It is the first among agro-industrial crop in terms of production value, the second exported item in overall exports (following oil) and the third most important contributor to GDP, after petroleum and wheat (Muna, 2001). Therefore, cotton is probably the most important strategic crop for Syrian agriculture.

1.2.1 The use of Production Factors

Natural Resources

Cotton cultivated area has been substantially expanded in the 1990s from 156,000 hectares, in 1990, to a peak of 275,000, in 1998, then it dropped again to become about 193,000 ha in 2007 (**Figure 1.3**). This has basically been the result of increasing the total area of irrigated land in Syria resulting from increased use of water from the Euphrates Dam (commissioned in 1974) and from dams commissioned in the early 1990s in Al-Hassakeh. However, the big increase in the area cultivated under cotton was due to the increase of areas irrigated by private wells especially in Al-Hassakeh governorate. Nevertheless, the drought of 1999-2001 caused the cotton area to decrease again starting from 2000 as shown in **Figure 1.3**.

Figure 1.3 – cotton area evolution in Syria



Source: calculated from the NAPC database

Cotton is cultivated in Syria in the following governorates: Al-Hassakeh, Al-Raqqa, Der-Ezzour, Aleppo, Hama, Idleb, and Homs. It occupies about 20% of the country irrigated area[1], consuming some 3-4 billions of cubic meters of water which corresponds to about 25% of domestic annual available water (Somi, 2002).

Irrigation is considered one of the most important factors that affect quantity and quality of cotton production. Therefore, some studies suggest that delivering sufficient quantities of water at the corresponding dates can increase the yield by 50% (Somi, 2002).

The water irrigation requirements of cotton vary according to the differentiation in the ecological conditions (humidity, rainfall, soil quality, etc) of the different areas in which cotton

[1] There are roughly 1.3 million hectares of irrigated land in Syria (Westlake, 2001).

is cultivated. **Table 1.1** shows that water need of cotton varies between 7771 CM/ha in Al-Ghab and 12408 cm/he in Al-Hassakeh, taking into consideration that these quantities reflect irrigation requirements of flood irrigated cotton and they differ inside each governorate according to the differences in growing period and the soil quality.

Table 1.1 - water needs in cotton cultivation governorates

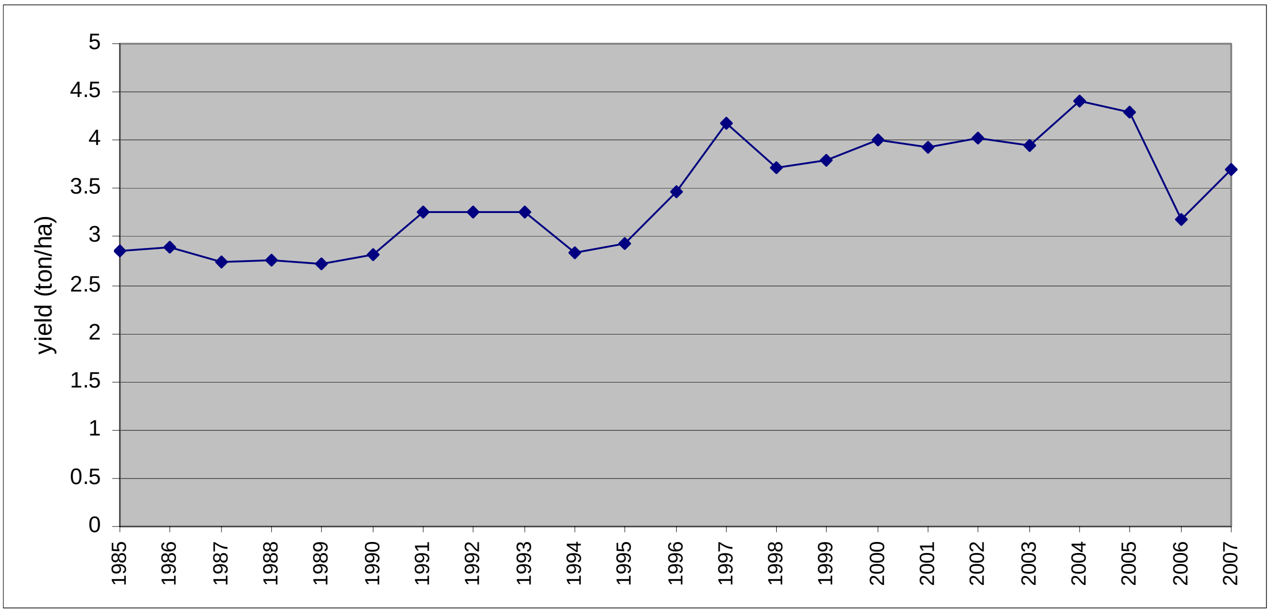
Governorate	Homs	Hama	Al-Ghab	Idleb	Aleppo	Al-Raqqa	Der-Ezzour	Al-Hassakeh
Water need cm/he	8556	9561	7771	9744	9887	10289	12408	11075

Source: Somi, 2002

The yield of cotton has substantially increased over the last 20 years (**Figure 1.4**). This increase has been the result of one or/and more of the following factors:

1. the adoption of irrigated cotton mode in 1983;
2. The development and adoption of new, environmentally adapted varieties as Al-Raqqa 5, Aleppo 90, Der-Ezzour 22, etc. which increased cotton production by 40%;
3. Adoption of furrow planting (that gives a 20% higher yield than flood planting) and improved irrigation techniques;
4. Improved agricultural extension;
5. Increasing of farmer's agricultural knowledge .

Figure 1.4 – seedcotton yield evolution



Source: calculated from the NAPC database

<u>Labour</u>

Cotton is mainly produced in farms that rely on family labour that performs a substantial part of the farm work. However, the required speed to achieve some operations push farmers to hire some casual labour. This occurs particularly in the harvesting season and to perform some other operations such as weeding. The source of the casual labour differs from region to region across the country. In Al-Hassakeh, the major part comes from relatively distant areas, such as the landless people from Idleb and Hama. In the other governorates, casual labourers come from neighbouring villages.

Labour wage in cotton harvesting is not based on work time, it is rather based the achievement. On average, each labourer takes from SP 3.5 to Sp 4.5 for harvesting 1 kilo of cotton in the first harvest when cotton density is high. The cost of harvesting 1 kilo of cotton increases in the second harvest to reach SP 7 to SP 10 depending on the field density. Farmers usually do not perform a third harvest due to its high cost compared with its revenue, which makes it uneconomical.

Traditional contractors, the *chaweshes*, perform the function of labour organisation and mobilisation as they do for other crops. They organise the labour whereby labour demand and supply meet. They pool labour and make it available in different areas according to the market demand, which increases significantly in autumn, when the harvest season of cotton is (Sadiddin, 2005).

This intermediation makes the effective wage that labourers receive less than the real wage paid by farmers, which is about SP 125 per workday, in which the *Chawesh* takes a commission from each employee about SP 25 per workday. In addition, he has a daily wage of SP 200-300 from the farmer. The commission he receives from employees should be in theory equivalent to the cost of housing and transportation he guarantees for them. In reality, it might be higher (Sadiddin, 2005).

Capital

Cotton costs of production differ from one area to the other and from farm to farm in the same area. The most important factor that causes the variation of cotton production costs is irrigation water source. Since cotton is a water-intensive crop and requires much water, the latter forms a significant share of the costs. For example, cotton irrigated from public nets generally costs less than cotton irrigated from wells. However, other factors play an important role in determining the production costs of cotton, which are mostly related to the local conditions of the producing areas such as differences in labour wages, differences in soil and other ecological conditions that require different levels of input use, and differences in management levels and technologies that result from differences in farmers' levels of education, etc.

The Agricultural Cooperative Bank (ACB) is the only formal source of credit for Syrian farmers. In addition, the Government depends on it for the performance of some of its agricultural policies especially those related to the strategic crops from which cotton is of special importance.

Based on the license issued to the farmer, the ACB issues loans in money and in kind at two different times of payments. The **first payment** (from February to April) is granted to farmers as an in-kind loan and monetary ones. The in-kind loans are usually in the form of seeds and fertilizers. The decision No. 24, on April 30, 2001, issued from the SAC, stated that the chemical fertilizers should be sold at the real cost price of each season that, annually, is reconsidered if there is any change in its cost. The monetary part of this payment is equal to about SP1000 per dunum.[2]

The **second payment** (from August to November) is also granted to farmers as in-kind loans and monetary loans. The in-kind loans are in form of jute bags provided by the ACB (usually it is about 2.5 bags per dunum). The interest rate that farmers have to pay is 6% for collectively cooperative loans and 7% cooperative loans obtained on the behalf of farmers. The interest rate for private farmers is 8%.

Since cotton is a water-exhausting crop, the Government has always encouraged cotton farmers to adopt drip irrigation schemes by offering loans through the ACB. The ACB offers loans to farmers that want to use new irrigation methods. These loans are given according to the production plan and the percentages of crops in agricultural rotation. Therefore, new irrigation

[2] One dunum is approximately one tenth of an hectare.

modes are financed according to the planned areas for cotton with drip irrigation groups. The sum of such loans varies from SP 200 thousand to SP one million according to the total irrigated area hold by the farmer, so that to obtain the loan ceiling, the farmers must hold 50 dunum of irrigated land at least. Although the ACB still offers such loans (at the current interest rates) but they became totally unimportant after the foundation of the national Fund for Conversion to Modern Irrigation which provides subsidized loans without any interest (see below).

Although cotton harvesting is performed by hands in Syria, machinery plays a significant role in cotton production. Most mechanised operations are ploughing, seeding and fertilisation although the last two are performed manually in huge areas especially at the small farms in which family labour is sufficient. Mechanised harvesting, although tried, has not been introduced in Syria due to two reasons: the first is technical meaning that the CMO does not accept the mechanically harvested cotton because it includes a lot of imperfections; second is of policy objectives meaning that cotton is a main source of employment for the casual agricultural labour and the mechanisation of its harvesting might raise unemployment.

1.2.2 Cotton Farming Systems

In Syria, cotton farming systems differ according to various criteria: technology, region, agrarian rotations and others. In some cases, some of these criteria overlap with each other to determine one production system. Different regions usually result in different irrigation water sources (private wells, rivers and public nets). Furthermore, water sources affect irrigation techniques pursued in cotton cultivation (drip or flood). For example, drip irrigation is only possible if the water source is private wells, while flood irrigation dominates land irrigated from rivers or public nets.

Region also plays an important role in determining water needs of cotton. The latter increase in Syria when moving from north to south and west to east due to the increase in average temperatures and the decrease in average rainfall. In addition, agrarian rotation pursued in each area affects the farming systems. The agrarian rotations that cotton farmers follow are different from one area to another due to several reasons, from which farmers' experience, the agricultural plan of the MAAR and differing climatic conditions are the most important.

In Al-Hassakeh Governorate, the predominant rotation in cotton farms is wheat/cotton rotation. In Al-Raqqa, Aleppo and Der-Ezzour, sugarbeet is an important crop beside cotton and wheat. In the central governorates of Syria (Homs, Hama, and Idleb), more crops are cultivated beside cotton and wheat. Examples are potato, union, and some vegetables.

The other crops cultivated beside cotton differ in their planting harvesting dates and their areas according to the different governorates and mantikas. Wheat is cultivated beside cotton in all governorates, however, since it is a winter crop while cotton is a summer crop, so wheat cannot be, in principle, considered a competing crop to cotton in the agrarian rotation. Nevertheless, the overlapping of the two crops' seasons (cotton planting is in March while wheat harvesting is in June) makes the cultivation of cotton after wheat harvest unfeasible within the same season. Therefore, cotton can only be planted once every two years on the same land plot. Thus, technically speaking, cotton can occupy 50% of the land plot every year, while wheat can occupy the remaining 50%.

Though, some summer crops are cultivated in other parts of the country and they are competing crops to cotton such as sugarbeet and potato. These two crops are cultivated in February and harvested in July, so they cannot be cultivated as intensive crops after wheat harvest in the same plot; consequently, they are competing crops to cotton. Sugarbeet plays a significant role in this context due to the large Government intervention in its cultivation through setting pricing and licensing systems similar to those of cotton. In addition, the big involvement of the parastatals in its marketing makes it desired by farmers since because this involvement reduces the risk of price fluctuations, from which the unregulated crops suffer like vegetables.

Areas cultivated with these three crops (cotton, sugarbeet and potato) are constrained by several factors, most important are: the total area of the farm, the agrarian rotation requirements, water availability, and the licensing system for each crop. The latter is considered a big constraint that limits the expansion of cotton and sugarbeet cultivation since the marketing of these two crops is confined to the parastatals. Nevertheless, the statistics of the MAAR clarifies that many farmers cultivate cotton in excess of the licensed areas. This is explained by the existence of informal market for cotton. However, water scarcity in several areas makes the expansion in the cultivation of these three crops very difficult especially that they are water-intensive crops. In addition, the agrarian rotation requirements limit the area of the three crops in total to only 50% of the farm area since these crops are soil-exhausting crops and should be followed by less exploiting crop (wheat) in the next season.

Most farms have been applying the flood irrigation system. Whereas, the Government through the Ministry of Agriculture and Agrarian Reform (MAAR) encourages farmers to apply new efficient technology like drip irrigation mode through the provision of extension advice and loans. This policy is expected to affect the structure of farming systems of cotton producers, since the adoption of modern irrigation techniques change the costs structure and increase the yield.

1.3 Barley

Barley is one of the most important crops in Syria and is by far the major crop cultivated in rainfed areas, where often it is the only viable alternative. The relevance of Barley is linked to the livestock production sector by being the major source of feed grains, and for this reason is considered a very important strategic crop for Syria. The average annual production (over the last 10 years) is of about 1 million tons, over an average area of about 1.4 million hectares (equivalent about 27% of total Syrian cropped land), which imply an average yield of about 0.68 tons per hectares.

1.3.1 The use of Production Factors

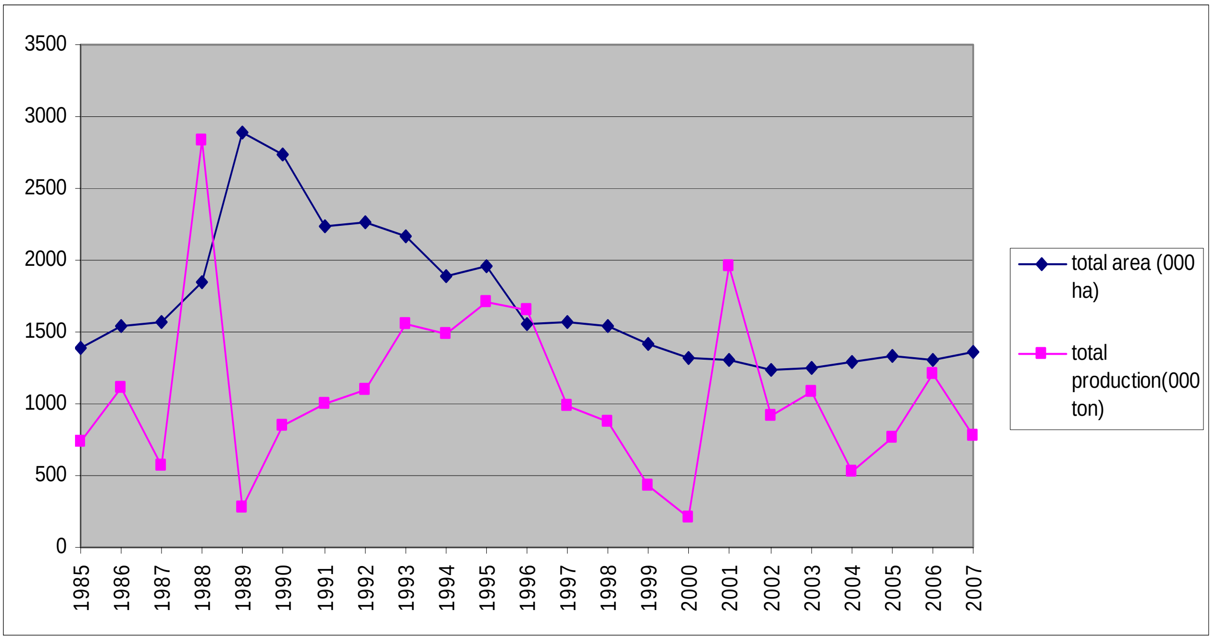
Natural Resources

Over 95% of all barley is produced on rainfed land. Barley, which requires less rainfall than wheat, is planted mainly in the Climatic Zones 3 and 4. The Government banned the planting of barley in Zone 5 in 1995. National per-hectare barley yields are roughly half those of rainfed wheat, planted in Zones 1 and 2.

Both black and white barley are produced in Syria, with the production of black (concentrated in the north of Syria) exceeding that of white (concentrated in the coastal areas and the south). Black barley is preferred by livestock farmers, other than in the south (Westlake, 2001).

Figure 1.5 indicates that the area planted to barley increased progressively from about 1.38 million ha in 1985 to around 2.89 million ha in 1989, then it gradually decreased during the nineties to about 1.3 million ha in 2000, but remained stable since then. The increase in the area planted to barley in the eighties was mainly due to encouragement of barley plantation in the Syrian steppe (Al-Badia). Therefore, the first sharp fall to 1.55 million hectares in 1996 was due to the banning of barley plantation in Climatic Zone 5 in 1996. But in 2000, the national barley areas fell to 1.3 million ha due to the drought-affected 1999/2000 crop year. Despite the reductions in barley planted area, it should be noted that the rainfed area planted to barley still exceeds the approximately 1.0 million hectares that are currently planted to wheat.

Figure 1.5 – the evolution of total barley area and production

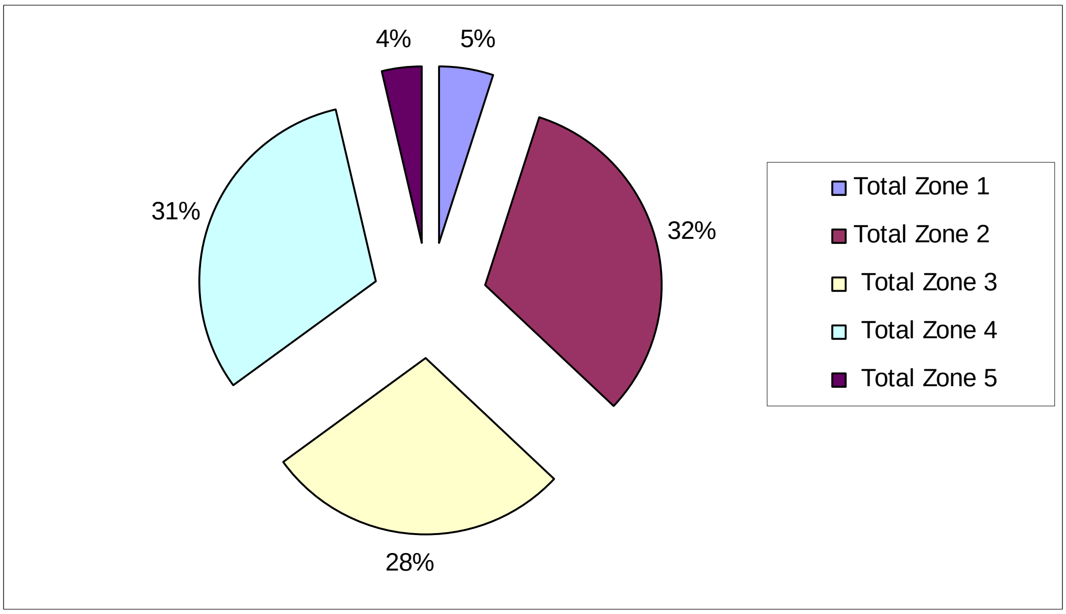


Source: calculated from the NAPC database

Figure 1.5 indicates also the extreme fluctuations in barley production, caused by the reliance of barley production on rainfalls which are characterised in Syria by high fluctuations.

Barley cultivation is concentrated in Climatic Zones 2, 3, and 4. **Figure 1.6** shows that, in 2007, about 91% of barley area was in these three zones, while Zone 2 occupies the first place with a share of 32%.

Figure 1.6 – the distribution of barley area by climatic zones in 2007



Source: calculated from the NAPC database

Barley is mainly cultivated as a rainfed crop in Syria. Although some barley is irrigated, its area did not exceed 5% of the total barley area in 2007 when irrigated barley area reached about 63,000 ha. This suggests an increase with respect to what it was in 2004 (3% of the total barley area) . irrigated barley production is concentrated in Climatic Zone 5 in Al-Badia near Palmyra Mantika Centre.

Labour

Labour is rarely used in the production of barley in Syria. Most barley in Syria is mechanised for most agricultural operations. Therefore, labour is not of importance for barley production.

Capital

Machinery is a very important element of barley production in Syria. The gross margins calculations of the Farming Systems Study (FSS) show that almost all agricultural operations in barley production are mechanised. Most important are ploughing, seeding, and harvesting. The only operation that is usually performed by labour is irrigation. However, very minor areas are planted to irrigated barley.

The level of mechanisation rises, as expected, as the farm size rises. In other words, small farmers, who usually have small farms, depend on labour (especially family) more than medium and large farmers do. The gross margins calculations of the FSS indicate that most medium and large farmers depend on their own machinery for ploughing, seeding and fertilisation, while almost all farmers depend on hired machinery for harvesting.

As for all farmers of Syria, the ACB is the only permanent formal source of credit for barley producers. The ACB offers in-kind and in-cash loans either directly to farmers or through the cooperatives of the villages for the farmers who are cooperative members (refer to the section of policy issues below for more details).

The in-kind loans are given in form of seeds, nitrogen fertiliser, and phosphor fertiliser. Rainfed barley planted in Climatic Zone 2 is granted 4.5 and 3.5 units of the two fertilisers respectively, while rainfed barley in Climatic Zone 3 is granted 3.2 and 3.1 units respectively. The in-cash loans consist of SP 75 per dunum for barley in both Climatic Zones 2 and 3, while barley producers in Zones 1, 4, and 5 cannot acquire any credit from the ACB.

In addition, there is a big and significant informal market for credit. The main source relevant to barley production is the traders. A trader gives the money to the farmer when needed according to agreed arrangements between them (usually half of the money at the beginning of the winter season and the rest as instalments) (Sadiddin, 2005).

However, the only important input for barley production is seeds. Most farmers attain seeds from their own production of the previous year, purchase them from the market, or obtain them from the ACB, which gives 15 kg/dunum of barley seeds in Zone 2 and 10 kg/dunum in Zone 3.

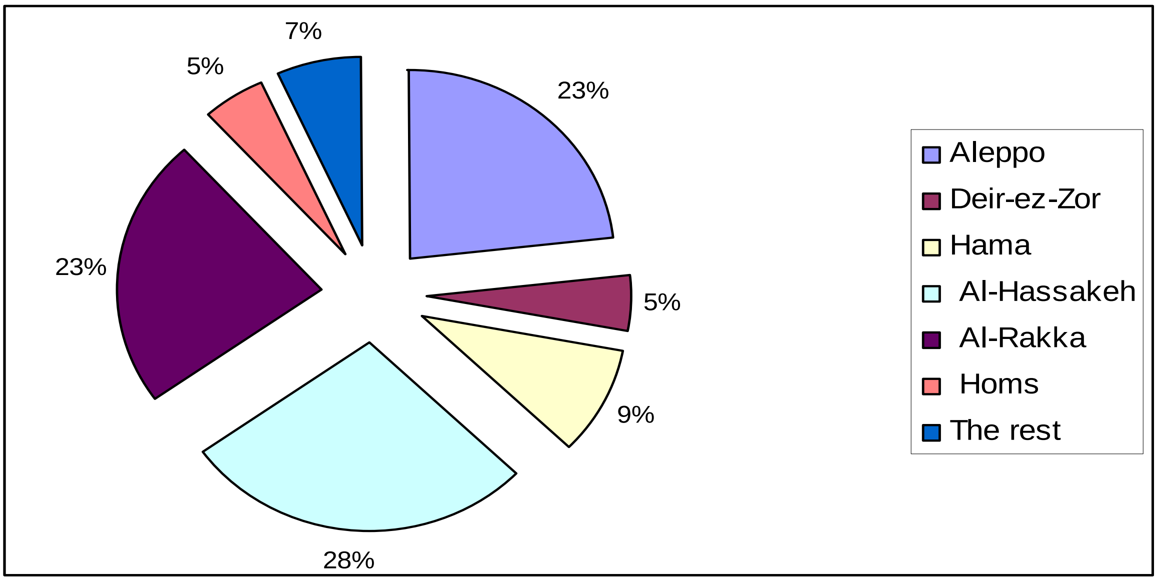
1.3.2 Barley Farming Systems

The only technological significant difference in barley production in Syria is the cultivation type whether rainfed or irrigated. Irrigated barley is negligible in Syria due to its minor share compared to that of rainfed barley, which occupies more than 95% of the total area planted to barley.

Barley is cultivated and produced everywhere in the country. However, its cultivation is concentrated in three governorates, which are Al-Raqqa, Aleppo, and Al-Hassakeh which, in turn, included about 23%, 23%, and 28% of the total barley area in 2004 respectively as shown in **Figure 1.7**.

The figure (1.7) shows that Hama, Homs, and Der-Ezzour have also some importance in terms of barley area, in which they included 9%, 5%, and 5% of the total barley area in 2004 respectively. The remaining 7% are distributed in the other governorates.

Figure 1.7 – the distribution of barley cultivated area in 2004 by governorate



Source: calculated from the NAPC database

Figure 1.6 above illustrates the distribution of area planted to barley by climatic zones. The figure shows that more than 95% of barley area is concentrated in Climatic Zones 2, 3, and 4.

Farm size, in general, tends to get larger when moving from Climatic Zone 1 to Zone 5. However, the yield tends to decrease due to irrigation water scarcity and rainfall scarcity and fluctuations. Since barley is cultivated as a rainfed crop, it tends to rotate mostly with other rainfed crops such as rainfed wheat, lentil, and cumin. In Zone 4, as a special case, barley is usually rotated with fallow.

Chapter 2 - Policy Issues

Syrian agricultural sector is considered a very important sector in terms of its contribution to the Syrian GDP (23-29% during the last 25 years), or in terms of its contribution to the employment of the labour force (26-30% of the total labour force is employed in agriculture, of which 70% female and 30% male). These figures have very important implications for any policy reform process. In addition, agricultural sector in Syria is the main source of covering the increasing food demand of the population and the food industry. It also supports the balance of payments through the exports of agricultural products.

To achieve food security objectives, policies in Syria were oriented to attain high level of self-sufficiency until the early 1980s. However, this goal led to inefficient use of domestic resources. Therefore, the market orientation has been necessary in order to adjust to global changes, to exploit the opportunities offered through international trade, and to improve the efficient use of domestic resources. While a detailed description of the overall government agricultural policy is available in other sources, this chapter is devoted only to describe and discuss the policy instruments that affect the decisions making processes of Syrian farmers, which need to be modelled. The focus will be given on policies that have been recently amended.

2.1 Price and delivery policy of outputs

From a policy viewpoint, crops in Syria can be classified into strategic crops and other crops. Strategic crops are those whose prices are affected directly by government price policy, either through administering fixed prices or through setting floor prices. Crops considered strategic in Syria are seven: wheat, barley, cotton, sugarbeet, tobacco, lentil, and chickpea.

The Government annually sets prices for all strategic crops at which public agencies and establishments will buy the crops' outputs. These prices are applicable at the same level throughout the entire country. In addition, they are all determined based on unit costs of production, with the objective of ensuring that farmers are able to cover the costs and make some profits. Such a way of price setting explicitly has the aim of isolating farmers from market forces and motivating farmers to produce specific crops in line with policy preferences.

For cotton, sugarbeet, and tobacco, the officially administered prices are the only ones at which farmers can sell, as the state-owned establishments are the sole buyers of these crops. However, this is not the case for wheat, barley, lentil and chickpea, since farmers can also sell to private buyers. Under such a case, the official price is in effect a floor price. However, farmers reportedly do on occasion sell to traders at less than the official price because the trader is able to offer a purchase package that the farmer finds more attractive than the alternative offered by the Government, due for example, to more attractive payment terms. In addition, the official prices of lentil and chickpea have been for several years much lower than those prevailing in the markets, which imply that farmers who produce these two crops do not usually sell them to governmental agencies.

The official price of wheat had been set until recently at SP 11.8 for durum wheat and SP 10.8 for soft wheat per one kilogram, but it also differed according to some quality charactristics in the sense that this price is the maximum that a farmer can get for his/her output. In reality most farmers used to get a price that slightly fluctuates around SP 11.5 per one kilogram. Cotton price also differs according to quality, but it also differs according the delivery date of output to motivate farmers for early harvesting to avoid the bad impact of early rainfall on cotton fibre. The prices until recently were 30.75, 26.25, and 19.75 SP/kg for the following delivery periods respectively:

- until November 15th
- from November 16th to November 30th
- from December 1st and on.

However, more than 95% of the total output is delivered during the first period. As for wheat, these prices refer to the maximum price a farmer can get, while the average price in reality that farmers get fluctuates around 27.5 SP/kg.

The floor prices for barley, lentil, and chickpea were respectively SP 7, 16, and 17.8 per kilogram. The principle of price differentiation based on quality applies to them too. The pricing system for tobacco is much more complicated than those of the other strategic crops since and there is not scope here to describe as it is not that relevant for this research, but the gross margin calculations performed by the workforce of the research demonstrate that the price of tobacco fluctuates around SP 120 per kilogram.

Nonetheless, the Government undertook in 2008 a series of actions among which the most important was to raise the price of diesel to 25 SP/litre (an increase of about 292%). This decision was followed by three decisions aiming at compensating the farmers for the increased costs of production (Decisions No. 27, 31, and 80 issued by the MAAR in 2008). Consequently, the prices of strategic crops became as follows:

Wheat: 20 SP/kg for durum and 19.5 SP/kg for soft

Barley: 16 SP/kg

Cotton: 41 SP/kg (the decisions do not state and price differentiation according to delivery dates as before)

Sugarbeet: 3.75 SP/kg

Lentils: 23 SP/kg

Chickpeas: 25 SP/kg

In addition, a subsidy of 30 thousand SP/ha is given to producers of cotton irrigated from private wells.

The prices of **other crops** are mainly determined through the interactions of supply and demand without heavy intervention from the Government.

2.2 Planning and licensing Policy

The annual agricultural plan of the MAAR is the core operational vehicle of the national planning system in the agricultural sector. Its aim is to direct farmers towards a particular pattern of land use perceived by policy makers as best able to achieve the national objectives. Its plan also serves as a framework at the beginning of each cropping year to guide the provision of credit, inputs and other services to farmers directly through the ACB or indirectly through the agricultural cooperatives. In addition, it is used as a guide to plan the subsidy services.

While a detailed description of the planning and licensing systems is available in other sources (Westlake, 2001), the relevant part to this policy is the one related to the licensing systems of certain crops. For sugarbeet, tobacco and cotton, farmers are not allowed cultivating these crops in excess to the areas permitted in the licensing systems, if they are to get the official supported price for their produce. These licensing systems are set according to the following mechanism.

According to the shares of strategic crops set in the plan, committees from the directorates of agriculture of each governorate discuss the previous production plan and identify the new irrigated areas in coordination with the extension units of the relevant villages. Then the directorates of agriculture propose a new production plan and send the tables of the irrigated areas with the expected production and yield to the MAAR to be discussed it in the Presidency of the Ministers Council (PMC). The final approval to the plan is made by the PMC. Then the MAAR sends the plan to the directorates of agriculture in the different governorates, which distribute it to the agricultural maslahas to be diffused to the extension units and the peasant cooperatives to be finally performed.

Each farmer has a fixed percentage to plant any of these three crops (cotton, sugarbeet, and tobacco) according to the land area and the resources of water to which he has access. Any farmer that has at least one hectare can get a license, provided the existence of a formal document stating that he has access to the land. However, if irrigation water source is a well (underground water), a farmer should also provide a document stating that the land he has access to includes a licensed well. In case of farmers who have unlicensed wells, the MAAR nominates special committees to ensure that the well is appropriate, so the farmer can obtain the license even if the well is unlicensed (NAPC, 2006).

2.3 Inputs price and distribution policy

Prices of fertilisers that are approved for local production and for imports are those at which the ACB, the sole distributor, pays for supplies from both sources. The ACB averages these costs along with costs of carry-over stocks to arrive at a uniform ex-warehouse selling price for the country. Onward costs from the warehouse are borne by the buyer (farmers or their cooperatives). Given the above, it must be expected that the costs of production vary from year to year due to increases in some items and decreases or increases in the way the fixed costs are absorbed by quantity produced. In addition, imported costs also would not remain the same. However, fertilizer prices had remained the same over a long period of time (that is SP 5400 per ton for ammonium nitrate, SP 7700 for urea, SP 8300 for TSP and SP 12100 for sulfate of potash), which implies that the purchase prices included subsidies to farmers. Although prices of fertilizers have been recently increased, the subsidy was not erased since the purchase prices of fertilizers are still lower than their cost counterparts as shown in Table 2.1.

Table 2.1 – the current prices of fertilizers and their costs at the ACB (SP/ton)

Fertilizer item	price	cost
Urea	8,900	10,380
Ammonium nitrate 30%	5,800	5,920
Ammonium nitrate 33%	6,500	10,260
Super phosphate	8,160	8,260
Sulphate of potash	12,500	21,640

Source: The ACB Regulation No. 338/11372

The same fundament is also applied to the seeds of some strategic crops. Plant protection chemicals are traded by the private sector and their prices are determined through the supply and demand.

2.4 Credit policy

The ACB is the main public provider of credit in the rural areas. Credit offered by the ACB can be classified into short-term, medium-term and long-term loans with different interest rates. The credit policy was recently exposed to considerable reform due to the Legislative Decree No.

30 issued in 2005. The reform touched all elements of the credit policy: interest rates, credit terms and the range of eligible activities. The ACB used for a long time to offer credit only for pure agricultural activities, but now it can provide credit for various development projects (agricultural, industrial and constructional), on the condition that they all serve the process of rural development through employment creation and strengthening the linkages among the various economic sectors in the rural areas. It is believed according to this viewpoint that strengthening such linkages whether they are of production or consumption types would enhance the flows of labour and capital from the agricultural sector to the other sectors (or vice versa), which in turn, is expected to assist in achieving a comprehensive development in the Syrian countryside. The following table summarizes the new types of loans offered by the ACB with the new interest rates.

Table 2.2 interest rates adopted by the ACB according to loan term and activity

Term	sector	Activity sector	Interest rate
Short	Public and colletively cooperative	All	6%
	Cooperative on behalf of memebers		7%
	Private and co-joint sector		8%
Medium	Public and colletively cooperative	Agriculture	7%
		Non-agriculture	8%
	Cooperative on behalf of memebers	Agriculture	8%
		Non-agriculture	9%
	Private and co-joint sector	Agriculture	9%
		Non-agriculture	10%
Long	Public and colletively cooperative	Agriculture	8%
		Non-agriculture	9%
	Cooperative on behalf of memebers	Agriculture	9%
		Non-agriculture	10%
	Private and co-joint sector	Agriculture	10%
		Non-agriculture	11%
Interest rate of delay in repayment			12%

Source: the ACB

Short –term loans aim to cover farm expenses such as ploughing, harvesting, irrigation and fuel, cost of inputs, for small tools and for animal feeds and veterinary medicines. In addition, they cover the costs of maintaining agricultural machinery and pumping-sets as well as the costs of agricultural products' storage. Such loans have to be repaid in a period of one year maximum, and it is offered in cash and in kind (unsually in form of fertilizers and seeds). Loans provided to fund the farms expenses are subject to the seasonality of agricultural activities in which it is not possible to abtain any credit before the dates specified in "requirements' tables" special for this purpose. These tables include also the inputs required by one dunum for each cropping activity, and the dates of loan repayments. Short-term loand provided for non-agricultural activities are confined to the variable inputs of technical professions and industries related to rural development, and they are given over the year.

Medium term loans are given for periods more than one year but not exceeding five years. They cover purchasing machinery and tools required for agricultural production and land reclamation. They also fund the purchase of livestock and the establishment of fish farms as well as digging wells and irrigation canals. Moreover, they cover machinery needed for chicken industry and sorting and packaging machines as well as fans for combating frost and maintenance stations and others. They cover, furthermore, projects of animal feed processing and the manufacturing of both plant and animal agricultural products in addition to projects of grain processing and manufacturing of cans needed for the packaging of agricultural products.

Long-term loans, on the other hand, are for periods of more than five years but not exceeding ten years and they are aimed at financing the construction of stores, land improvement, forestry projects, fruit tree planting programs and cold storage facilities, in addition to modern irrigation schemes and the processing of both plant and animal products.

The ACB provides the loans according to the following mechanisms

- Loans provided in form of physical inputs (in-kind loans),
- Cash loans provided on the basis of a contract between the by the borrower and the ACB or a bond signed by the borrower to the command of the ACB with the amount of the loan,
- Loans according to a current account opened by the borrower at the ACB, then the borrower can withdraw cash when needed.

THE ACB also offers some services such as discounting the bills of purchase presented by the borrower and extending guarantees for payment on the due date against supplier credit if the supplier is a third party. The combination of these functions makes the ACB perhaps the most important institutional instrument of the government to promote agricultural production and to protect the standard of living of the rural population.

Each farm household must have a crop license as a prerequisite to obtain credit and/or to purchase inputs from the ACB. The crop license is issued every year and contains details of farm size, agro-ecological zone, whether the crops are irrigated or rainfed, which are the crops “allowed” to be grown in the following agricultural year, and the recommended requirements of fertilizers, seeds and chemicals. However, for farmers who are members of cooperatives, it is the latter that performs all the procedures needed to access credit on behalf of their members.

For medium and long-term loans, the access procedure is more protracted. Many farmers complain about the dissatisfaction over long procedural delays in processing applications for such loans. Many others have the impression that the bank does not give long-term loans, which poses the importance of diffusing information within the farming community so farmers can make full use of available credit opportunities. Property collateral is essential for eligibility to medium and long-term loans. Authorized appraises along with the other documents connected to the short-term loans must be submitted. It is also necessary to submit documents of technical design about the project prepared by specialist technicians and approved by the relevant public institutions, in addition to submitting a report of economic feasibility studies. Some other conditions exist for some specific projects. However, the loan is taken up for consideration only after receiving the report of the inspection committee (special for this purpose) (Parthasarathy, 2001).

Farmers find it difficult to obtain loans for machinery like harvesters and tractors. They have the impression that lower priority is given by the ACB to medium and long term loans. This precludes important activities like land reclamation and fruit tree replanting (Parthasarathy, 2001).

In addition to what is mentioned above, the ACB plays an intermediating role between several public projects and commissions from one side and farmers and rural people from the other side. Such projects usually aim at supporting rural and agricultural development through the provision of loans and banking services to their beneficiaries such as the loans of Unemployment Combating Commission. Another example is the National Project for Conversion to Modern Irrigation (NPCMI) which belongs to the MAAR and was founded by the MAAR Decision No. 86/t of 2006. The project is promising and has the ambition of converting all irrigated areas in the country to modern schemes, and it will be discussed in details below.

<u>The link between credit policy and inputs distribution policy</u>

As just mentioned above, short-term loans are given in cash (for amounts up to SP 50,000) and in kind as inputs. For private farmers two sureties are needed and in the case of cooperative members any single default would render the entire group ineligible for the next loan. Loan amounts are determined strictly on the basis of input eligibilities determined in the crop license. Loan sums and inputs in kind are given to the cooperative for disbursement to individual members according to their eligibility. For this service cooperatives are given 1% besides a commission of 1.34% on fertilizers (Parthasarathy, 2001).

Several members stated that they want “to be free” and that they do not want anymore to be penalized for others’ defaults. They do not mind the extra interest and the inconvenience of having to process crop license documents and collect the inputs from the bank warehouse by themselves. But they cannot be free, since their accessibility to land is regulated by the Agrarian Reform Law, which conditions farmers continuous accessibility to the land to being members cooperatives.

In spite of what has been mentioned above, the information gathered during the fieldwork of this study confirm that short-term loans are very difficult to obtain when farmers grow crops that are not purchased by state-owned establishments. This means that when farmers grow crops rather than wheat, sugarbeet, cotton, and tobacco, obtaining short-term production credit from the ACB has been very difficult recently. The explanation given by the local officials of the agricultural departments is that many farmers have defaulted and therefore that the ACB has many times suffered budget deficits. This has caused the ACB to confine its short-term credit to these four crops, since it is very easy then to control farmers’ repayments in collaboration with the relevant institutions who buy the product from the farmers. These agencies are respectively the General Establishment for Cereals Trade and Processing (GECTP), the General Establishment for Sugar Industry (GESI), the General Establishment for Cotton Ginning and Marketing (GECGM), and the General Establishment for Tobacco Control (GETC).

Alternative Sources of Finance for Rural Households

Many farmers mentioned the fact that, for medium and long term needs, they borrow from friends or relatives living outside the country, mostly other Arab countries (Lebanon and Gulf States). Furthermore, machinery suppliers are a common source of finance for purchase of equipment. The procedures are short and simple, although interest rates are high (they vary from about 20% up to 40%). Interest on such deals is generally made a part of the price. Farmers are aware of the higher cost incurred by this route of financing but do not mind such additional cost for the sake of saving time and avoiding inconvenience.

For production expenses, the alternative sources of credit are the input suppliers, output dealers, exporters and cold storage units’ owners. Input suppliers are generally small traders and do not have the capacity to extend credit covering the whole crop duration. They usually provide fertilisers, seeds, and plant protection chemicals. Farmers are generally anxious to apply chemicals to protect the crop and the expenses they have already incurred on the land and for this reason consider agro-chemicals to be of higher priority over other inputs. Consequently, they are well motivated to keep good relations with agro-chemical dealers by repaying loans relatively more punctually.

Output dealers, exporters’ agents and cold storage units’ owners are active in fruit and vegetable growing areas. Their involvement in credit provision takes several forms. Direct payments ahead of the season are given usually with an agreement on the unit price at which the output would be purchased. Farmers are then under obligations to sell the crop to the dealer at a pre-negotiated price, given that they have to repay the loan, they are likely to be at the weaker end of the bargain. Another form of financing by the output buyer is to agree on a lump sum to be paid to the farmer for the entire output. The lump sum is paid in suitable instalments to enable the farmer to meet production expenses. The expected yield is estimated by the contractor in such a way that he recovers interest at a fairly high rate and makes also a profit, which is often quite high, taking full advantage of the farmer’s financial needs. To meet difficult conditions caused by environmental factors, farmers are often forced to liquidate their assets. When the need is large, they may be also forced to sell the house and equipment. Smaller farmers often sell their animals.

Given the above, it seems that the current credit system favours to some extent the so-called strategic crops particularly wheat, cotton, tobacco, and sugarbeet. Farmers who cultivate these crops have relatively easier access to credit provided in kind by the ACB in form of seeds and fertilisers. This encourages farmers facing a liquidity problem to cultivate these crops. In addition, the failure of some farmers to repay earlier credit to the ACB has left many poor farmers excluded from formal credit trough the ACB, leading them to depend on the informal sources of credits, which are quite expensive suggesting cases of abuse by traders and input providers.

The possibility to access these informal sources of credit depend mainly on cultivating the crops that have stable prices and are easy to trade, which are, once again, wheat and cotton. In such cases, a trader buys the production of wheat or/and cotton in advance at prices lower than the official ones. The trader gives the money to the farmer when needed according to pre-agreed arrangements between them. After the production is delivered to the trader, he manages to sell it to the relevant governmental establishment. Sometimes, the production is sold through the cooperative of the village by the trader using the name of other farmers, although is the trader that takes the revenue. Such activity is usually protected by social norms and traditions even though it is illegal. Therefore, when a farmer is caught in debt with the private traders, it is very likely that it goes on cultivating cotton and wheat to keep on the informal credit source.

2.5 Irrigation-related policies

Speaking about irrigation policy means in general policies related to the provision of irrigation water at the farm level. However, the purpose of this section extends beyond that. It also aims at describing other kinds of policies that affect all kinds of water accessibility by farmers and to determine the type of water costs that farmers need to incur (whether fixed or variable) as well as the magnitude of these costs. In this respect, one can categorize irrigation water sources available to farmers in Syria into three types: public nets, rivers and springs, and private wells (Sadiddin & Atiya, 2009).

The Government has constructed over the last three decades a large number of irrigation canals that drain water from dams and make it available at the farm level. Most maintenance costs of these projects are borne by the Government. Farmers who have access to public nets usually pay an irrigation fees per land unit on annual or seasonal basis, which are expected to contribute only slightly to these costs, since they are relatively very low. The annual fee is only SP 3500 per hectare, but it goes down to 600, if irrigation is confined to winter cropping. Such fees are paid annually regardless of the amount of water used. They are paid when the official classification of the land considered states that it is irrigated (even if the water endowment is not enough to irrigate the entire farm that might usually occur during drought years).

Farmers who use water from rivers and springs for irrigation do not pay any kind of fees to the Government. They either pump the water directly from the source using a private engine, or they organize themselves in formal or informal cooperatives and purchase one large engine that serves all members. The choice usually depends on their location (far or close to the water source) and on their financial capacity. The cooperation type is very common formally in Deir-ez-Zor. In case of cooperation, pumping costs are borne by all members each according to his total land area. Farmers who access public nets may also incur some pumping costs if the system does not allow water to be driven by gravity into the fields, which applies to most farmers in Al-Ghab (supply study survey).

Pumping costs become very significant when farmers use private wells as the main source of irrigation. Such costs increase as the depth of wells increases, but they also depend on the capacity and age of the pump-set used. Most pump-sets in syria work on diesel, while the rest used electricity. Deseil and electricity, in Syria, were highly supported by the Government policy. For example, the consumer price of diesel in the neighbouring countries (Lebanon e.g.) used to fluctuate from 25 to 35 SP/litre according to the world price fluctuations, while it was fixed in syria at 7.40 SP/litre. Electricity had a similar situation especially that many power generating stations in Syria still use diesel (Sadiddin & Atiya, 2009).

The recent price policy of diesel and electricity had two reasons. The first one aimed at supporting consumers as Syrian people use mainly diesel for warming in winter. The second aimed to stimulate economic development, agricultural and industrial, through providing cheap source of energy. However, this policy had caused a drain on the public budget after the increase in international prices that have caused the smuggling of huge quantities of diesel from Syria to the neighbouring countries espcially Lebanon (where prices are in line with the international ones). This problem has recently urged the GOS to revise the policy and amend it by increasing the price of diesel to 25 SP-litre, though the GOS still distributes quotas of diesel for home consumption (1000 litre per family per year) at a supported price (9 SP/litre) (Sadiddin & Atiya, 2009).

Moreover, the awareness in the importance of modern irrigation to ration the use of water has recently risen especially that the agricultural sector consumes about 89% of the water invested in the country. This issue has become more relevant after the subsequent waves of drought that have beaten the country. This resulted, as mentioned above, in the foundation of the Department of the NPCMI, which was a consequence of the Legislative Decree No. 91 issued on 29/09/2005 by the President of the Republic which commands the foundation of a national Fund for the conversion to modern irrigation, linked directly to the Minister of Agriculture and Agrarian Reform with a total capital of SP 52 billion paid within ten years.

The executive instructions of the Decree were issued by the MAAR decision No. 47/t dated on 26/02/2006, in which the credit terms and conditions were identified, where the Fund will contribute up to 20-35% as a subsidy, given that the credit is without interest is repaid within ten years in which the repayment date is defined according to the timing of the main crop harvests of the beneficiaries. Personal and banking collaterals are accepted if the total sum of the loan does not exceed SP one million, which would noticeably facilitate the access to the credit. But if the loan sum exceeds SP one million, a real estate collateral is necessary.

The Department of NPCMI has branches in all governorates and it targets all farmers of irrigated areas who still use traditional flood irrigation methods. The loans are coupled with extension and training programs to assist farmers on technical aspects of the use of modern irrigation techniques. Potential beneficiaries will be classified in groups so that priorities can be considered, which will be first given to small and poor farmers. Furthermore, priorities will be given to areas more technically suitable to modern irrigation, or to areas where the dominant cropping patterns are more appropriate for the adoption of modern irrigation on the technical, practical and economic aspects.

Chapter 3 – Problem and Methodology

In the Syrian Arab Republic, the agricultural sector still plays a dominant role for national income, employment generation, and in the modernisation of society. In order to ensure the positive contribution of agriculture to the national objectives, the agricultural sector has received considerable attention by policy makers in recent decades. Major policies were formulated to establish direct support through price mechanisms for strategic crops and to promote infrastructure investment in rural areas (primarily roads and irrigation as well as land reclamation). At the same time, the agricultural sector and the farming community has faced a series of developments, which include, among others, increasing exposure to international markets.

Over the last several decades, the orientation on food self-sufficiency was remarkably successful and food production kept pace with the rapidly growing population, leading to a low dependency on imports for basic food items. Food production needs in combination with the state-stimulated orientation on raw material production for the agro-industrial sector (mainly cotton, tobacco and sugarbeet) have shaped the production structure of the agricultural sector.

The agricultural policies in Syria simultaneously pursue several objectives. In the case of food crops, they included a focus on stimulating food production in support of increased national food self-sufficiency, which changed in the 1990s to focus more on achieving food security. At the same time, the policies aim to support the farming community by offering floor prices and fixed prices. In the case of industrial crops (tobacco, sugarbeet and cotton), there are also the objectives to ensure an adequate supply to the processing plants and to enhance the trade balance by increasing exports (cotton) and reducing imports (sugar).

The traditional objectives of these agricultural policies aimed at achieving the optimum utilisation of natural and human resources and securing adequate supplies for food security, processing industries and exports. They evolved over the last 15 years from strict self-sufficiency policy to broader self-reliance, based on the recognition of the critical role of competitiveness to marketing raw and processed output internationally. The declared policies reflect, at the same time, an increasing concern for environmental constraints of production, especially the necessity for efficient use of scarce natural resources including land and water. In addition, inherent trends towards decreasing farm sizes, the limits of natural resources (particularly water to expand irrigation), and the cost of support to agriculture led to increasing difficulties to pursue earlier policies over the long-term (Fiorillo & Vercueil 2003).

The difficulties that obstruct the achievement of the national goals have generated a debate on the sustainability of the set of the previously prevalent agricultural policies and have led to some changes in the recent past, while more reform is expected in the future. In this respect, the Government of Syria (GOS) has recently been carrying out gradual reforms in economic and agricultural policies, giving up the centrally planned economic system and moving towards a more liberalised one that depends on the intersections of market forces. The analysis of such a system requires reliable tools to predict the responses of supplies and production systems of agricultural crops to policy changes.

3.1 Choice of methodology

At the beginning, the workforce of the study has faced a fundamental problem regarding the methodology to be used to perform the agricultural production analysis. Basically, two general methods have been deeply discussed: an econometric model based on time-series data and a structural mathematical progamming model based on cross-sectional data. The decision has been made to use the latter for a number of reasons that are summarised below.

Econometric models can be usually used to estimate the supply and demand functions, which indicate the market equilibriums of quantities (supplied and demanded) and prices, which are then used to understand the way the sector tends to move. Supply functions of agricultural output estimated using econometric models can be quite useful in understanding the overall behaviour of the agricultural sector and sub-sectors. However, there are quite difficult problems to overcome when relying on such models, which can be generally categorised under the headings of data, economic structural changes (that may result from a policy change or external shock), or a combination of the two.

One important aspect of data problems arise from the fact that, in many cases, many crops compete for the available fixed resources employed in the production activities. This competition results in cross effects among the supplies of the different crops, which must be considered as necessary elements of the estimated supply functions of the crops in question. This poses the question of the necessity of having sufficient degrees of freedom in the time-series data used to estimate both the own and cross-price elasticities, which is usually difficult to obtain. This is very much true in the context of developing countries such as the Syrian one, where data of this type is either scarce or quite imprecise (Hazell & Norton 1986).

Economic structural changes are usually caused by changes in the production technologies, market opportunities, and/or prices of both inputs and outputs. Government policies affect all of these. When using econometric models to analyse the current and alternative policy options, policy instruments may have to deal with values that are placed outside the values observed historically. In other words, it may be impossible to base policy analysis on extrapolations from parameters drawn from historical data when the policy instruments considered are new (Hazell & Norton 1986).

Mathematical programming models can assist sufficiently to solve both problems, since they are based on cross-sectional farm budget data and other information obtained at the micro level to generate the supply functions. In addition, they can be used to analyse the direct changes in economic structure whether related to change in technology, which usually affects yield and production costs, or related to prices and market opportunities, which change the profitability of various activities. Such changes and their effects are very difficult to capture through econometric models, which means that the resulting estimates supply elasticities of such models are unreliable when such structural changes are introduced into the model. Furthermore, the supply functions of programming models provide plenty of information useful to estimate the demand functions of inputs associated with the supply functions of outputs such as water, labour, and others. This allows tracing the impact of policy changes not only on the supply, but also on the derived demands of agricultural inputs (Hazell & Norton 1986).

Moreover, the use of econometric models requires some assumptions that are difficult to be made for the main agricultural commodities in Syria. They are the assumptions of competitive markets, which do not hold for many crops in Syria especially the so-called strategic crops. This is because these crops either have fixed prices (cotton, sugarbeet and tobacco) or have floor prices (wheat, barley, chickpea, and lentil). These prices are for many crops maintained at levels higher than their international counterparts (e.g. prices of cotton, wheat and sugarbeet). In addition, the cultivation of some of these crops (cotton, sugarbeet and tobacco) is organised through a licensing system that further violates the assumptions of competitive markets.

As the justifications for the choice of methodology are demonstrated, we move to describe the theoretical model of the mathematical programming method used in this research, which is the purpose of the following section.

3.2 General description of the linear programming model

The production function of a farm can be given by:

$$h(\underline{q}, \underline{x}, \underline{z}) = 0 \qquad (1)$$

where $\underline{q}$ is the vector of output quantities, $\underline{x}$ is the vector of variable input quantities, and $\underline{z}$ is the vector of fixed factor quantities. Variable inputs are usually hired labour, fertilisers and other chemicals, seeds, hired machinery, and all other inputs that can be purchased in desired quantities. Fixed factors are private factors that cannot be acquired in the time span analysed such as land and equipment, and public factors such as roads and extension services and other exogenous features such as weather and distances from markets.

Assuming that p and w are the prices of outputs and inputs respectively, the producer's gross margin is given by $p'q - w'x$. Assuming a profit-maximisation behaviour of the producer subject to technology constraint:

$$Max \; pq - wx \qquad s.t \; h(\underline{q}, \underline{x}, \underline{z}) = 0 \qquad (2)$$

The solution to this problem provides a set of output's supply and input's demand functions at the individual farm level, which heavily depend on the technology described in the production function (1).

Representing the farm profit-maximising problem (2) through *mathematical programming* requires some simplifying assumptions:

1. the use of variable inputs can be described by their per-unit cost, so that the objective function described in equation (2) simplifies to

$$Max \sum_{i=1} \tilde{p}_i q_i \qquad (3)$$

   where:

   $\tilde{p}_i = (p_i - c_i)$

   where:

   c_i is the per-unit cost of variable inputs for i-th crop.

   p_i is the per-unit price of the output for i-th crop,

2. the technology is described by

$$Aq \leq z \qquad (4)$$

   where:

   A is a matrix of technical coefficients expressing the unit requirements of fixed resources.

The elements of this matrix, a_{ji}, indicate the amount of the j-th fixed factor required to produce one unit of i-th output. Typical relevant fixed resources include land, family labour, liquidity (cash availability), and water.

Additional rows to the matrix *A* can be included to describe the relevant technological constraints, such as cropping rotation requirements, as well as relevant policy constraints such as crops' licensing systems.

To put this model into application, it is required to make an assumption on the technology at the individual farming system level. The simplest assumption is to assume fixed coefficients, which implies constant marginal costs. This assumption requires that the production costs and total outputs of various crops be given per area unit (per hectare e.g.).

Given this assumption, the model formulae given by equations (3) and (4) are manipulated as follows:

$$Max\ GM = \sum_i (p_i y_i - c_i) h_i \quad \text{for } i = 1,2,......,m \qquad (5)$$

Subject to:

$$\sum_i h_i \leq H \qquad \text{total area less or equal to the farm size} \qquad (6)$$

$$\sum_i a_{ij} h_i \leq b_j \qquad \text{total availability of other fixed resources} \qquad (7)$$

$$f(h_1, h_2, ..., h_n) \leq 0 \qquad \text{rotation requirements and policy constraints} \qquad (8)$$

where:

GM is the total gross margin of the farmer (GM = total revenue – variable costs);

H is the total farm size;

p_i is the price of the product of the *i*-th crop;

y_i is the yield of the *i*-th crop;

c_i is the per area unit variable costs of the *i*-th crop;

h_i is the area cultivated with the *i*-th crop;

b_j is the availability of the *j*-th resource (such as water);

$a_{i,j}$ is the requirement of the *j*-th resource for one unit of land cultivated with the *i*-th crop;

$f(.)$ is the function that defines a set of constraints on the relative dimension of the various crop areas to obey agronomic rotations among crops or to obey policy constraints such as cotton licensing system.

3.3 Limitations of the linear programming model

While the assumption of fixed coefficients is made for simplicity, the model described above ignores all problems associated with risk and uncertainty, in the sense that it implies the assumption that farmers are risk-neutral which is the exception rather than the rule. Although risk is embedded in every economic activity, agriculture and its related industries are characterised by an unusually high degree of risk. This is due especially to the reliance of agriculture on biological processes and its susceptibility to the vagaries of climate and weather. Added to this is the inelasticity in the supply and demand for agricultural commodities, which can lead to large price fluctuations in agricultural markets when harvests are exceptionally bad or good (Hardaker, Huirne, Anderson & Lien 2004).

This leads us to the conclusion that farmers in reality do not really maximise profits, they rather attempt to do so, given the available information, technology and states of nature, while facing various sources of risk that can be classified under two types: risks associated with markets and those associated with weather and climate. While the latter causes fluctuations in output, the former causes fluctuations in prices, and in both cases, the total net revenue experiences high degree of uncertainty.

However, the assumption of profit maximisation in the context of this study is not without empirical justifications. Given that the most serious effect of exposure to weather is due to rainfall fluctuations, such effects are minimal as most agricultural output takes place in farms that are wholly irrigated. The availability of irrigation can help farmers coping with risk associated with rainfall fluctuation directly by enabling them to avail water into the fields in appropriate quantity at the right time, and indirectly by reducing or eliminating the risk of underutilisation from the side of plants of some other inputs such as chemical fertilisers. Furthermore, risks associated with markets and reflected in form of price fluctuations are minimised by the agricultural pricing policy of the products in question. All crops in question either have fixed price (cotton) or have floor price (wheat and barley).

Last but not least, profit maximisation model described above, though it has the advantage of simplicity, will not however enable us to perform any simulation that incorporates risk, meaning that we can only perform simulations by changing some policy parameters (mainly prices), but we will not be able to predict what would happen if the entire policy were dropped.

Chapter 4 – Setting-up the Model for Syrian Agriculture

The analytical tool to be used in this research is the modelling of representative farms through mathematical linear programming. In order to apply this method, the farms of Syria should be classified in a relatively small number of representative farm types. This classification should take the following criteria into consideration:

1. the cultivation mode of a farm whether irrigated or rainfed, which is very important since it significantly affects farm costs, structure, cropping patterns, etc.
2. the boudaries that separate different administative districts (mantikas). This is useful because data collection by governemtal agencies is mainly based on these boundaries.
3. the boundaries that separate agro-ecological zones. This is necessary as many data collected by governmental agencies are also based on these boundaries. In addition, different agro-ecological zones have important effects on irrigation requirements (i.e. water use) of the cultivated crops in different areas since these zones are determined according to the average level of rainfalls. In general, the higher the rainfall the lower the irrigation requirements, holdiong all other things constant.
4. the sources of irrigation water, which are can be classified in three main types in Syria: private wells, public nets, and rivers. Water source usually affects water cost, which, in turn, affects water use.
5. the farm size (e.g. small, medium, or large), which has an impact on the economy of scale, affecting, in turn, the overall profitability of the farm as well as its capability to innovate and adopte new technologies.
6. the cropping patterns, as different farms might grow different crops reflecitng specialisation. This affects irrigation water use because different crops have different irrigation requirements.
7. the irrigation techniques, which can be generally categorised into flood, drip, or sprinkler schemes. They clearly have an impact on water use, since modern techniques tend to save water in comparison with the flood traditional technique. In addition, modern irrigation schemes affect the composition of production costs which influence the decision making of farmers.

Therefore, in order to estimate the supply of agricultural output and the derived demands for inputs, we need a model that represents the aggregate behaviour of the agricultural producing sector in Syria. The model used in this study is based on a bottom-top approach. We start modelling the behaviour of individual farming systems. By aggregating the supply and demands of individual farming systems, we reach the aggregate supply of agricultural output and the derived aggregate demands for inputs such as water and labour at the governorate as well as the national levels. This can then be used in assessing the incidence of possible alternative policies at both levels.

To derive these functions, we need first to make an assumption about the overall objective at the farm level. In our research, we assumed that Syrian farmers have the objective of profits maximisation, in which profits are expressed in terms of gross margins obtained from the overall activities carried out at the farm level. The choice of such an assumption is not without evidence.

A previous study has shown that food production for the sake of home consumption is rare and confined to some vegetables mainly grown in home gardens. The same study has also confirmed clearly the market-oriented behaviour of the major part of Syrian farming systems, which justify very much the assumption of profit-maximisation. Although many Syrian farming systems produce many crops that are sold to governmental agencies and whose productions are organised through the annual agricultural plan, the incentive systems that are offered to farmers motivate them to follow a profit-maximisation behaviour (Wattenbach, 2006).

By the incentive systems, we mean the set of policy instruments that the Government uses to motivate farmers to produce crops in line with the annual production plan. These are mainly prices that are set higher than what would prevail if markets were left to interact freely, and licensing systems to prevent farmers from producing more than needed under the threat of not receiving the supported price.

Now we move to define the constraints imposed on the profit-maximisation problem.

4.1 Definition of constraints

4.1.1 Constraining resources

Fixed resources are land, water, family labour, and all other private factors that cannot be acquired in the time span analysed in addition to the public factors such as roads and extension services and other exogenous features such as weather and distance from markets. The possibility of these resources to be constraining in the agricultural sector depends very much on their total availability in the economy and the functioning of their markets.

In the context of Syrian economy, the market of casual agricultural labour is said to be well functioning according to the findings of a previous study. It is stated that labour organization and mobilisation functions according to local and non-local demands. This function is performed by traditional contractors, the C*haweshes*, who pool agricultural labour (mainly female) in areas where there is excess supply of labour and make it available in different governorates according to market demand (Forni, 2001). This suggests that labour is not a constraining resource in the context of Syrian agriculture. In case family labour is not sufficient to perform a specific operation, the possibility to hire labour is quite high.

However, the possibility that water is a constraining resource in the Syrian agriculture seems to be quite high. This has been approved by previous studies and working papers, stating that most water basins in Syria suffer from water deficit mainly due to intensive water use in agriculture that uses up to 80% of the total water use of the country (Ortega & Sagardoy, 2001) (NAPC water, 2005).

Furthermore, and given the poor conditions of Syrian farmers that impose on them a constraint of liquidity lack, another constraining resource can be considered in the model, which is the availability of cash capital. This can be expressed in an equation exhibiting that the amount of cash required to cover the variable costs should not exceed the available cash in a certain farm type.

This constraint is concluded from some findings of previous studies (Wattenbach, 2006), and supported by the fieldwork findings of this study. The reasons behind this constraint are mainly two. The first one is related to the credit policy which favours the so-called strategic crops particularly wheat, cotton and sugarbeet. Farmers who cultivate these crops have relatively easy access to credit provided in kind by the Agricultural Cooperative Bank (ACB) in form of seeds and fertilisers. This encourages farmers facing a cash constraint to cultivate these crops.

The other reason behind the cash constraint results from failure to repay earlier credit to the ACB. This leaves many poor farmers excluded from formal credit trough the ACB, leading them to depend on informal sources of credits, which are quite expensive suggesting cases of abuse by traders and input providers. These informal sources of credit depend mainly on the crops that have stable prices and are easy to trade, which are wheat and cotton. In such cases, a trader buys the production of wheat or/and cotton in advance at prices lower than the official ones. The trader gives the money to the farmer when needed according to pre-agreed arrangements between them. After the production is delivered to the trader, he manages to sell it to the relevant governmental establishment. Sometimes, the production is sold through the cooperative of the village for the trader using the name of other farmers, although is the trader that takes the revenue. Such activity is usually protected by the social norms and traditions even though it is illegal. Therefore, when a farmer is caught in debt with the private traders, it is very likely that it goes on cultivating cotton and wheat to keep on the informal credit source.

The above discussion leads us to conclude that one reason why many poor farmers continue to grow the so-called strategic crops not only because they are profitable or imposed by the government policy (see below), but also because of what we call the cash capital constraint. Then farmers who can grow other crops (such as fruits or vegetables) in relatively large quantities should be those who do not face any cash constraints, or those who face prohibitive constraints to the production of some or all strategic crops. It is then the aim of this research to test for this assumption (the presence of cash constraint) and its consequences on farmers' behaviour and their decision-making process.

4.1.2 Policy-imposed constraints

One might think of the cash constraint discussed above to be a policy-imposed as it is very much affected by the government credit system. However, under this subheading, we only consider the constraints that are directly caused by government policy, which does not apply to the cash capital case. In this context, 'directly caused' means government actions that directly affects the decision making of farmers on 'what to produce' and so the types of crops that can be grown and on 'how much' and so the quantity of each specific produce. This is caused by the licensing system of the annual agricultural plan set and approved by the MAAR (**Chapter 3**).

This licensing system is imposed on cotton, sugarbeet and tobacco. It imposes a limit to the maximum area a farmer can cultivate under a particular crop in order to receive the official price for all of his/her output, which is said to be much higher than the prevailing world price. The way this licensing policy is implemented in reality is different according to the crop and the institutions involved in the implementation practicalities as explained in Chapter 3.

4.1.3 Technical constraints

These are the constraints imposed by the technical rotations required for the cultivated crops, and they are different from one area to the other due to differences in prevailing cropping patterns in the country, which is due to differences in the availability of resources; in government policies, and in climatic conditions.

In rainfed farming systems located in agro-climatic zones 1, where farmers produce mainly wheat and barley in addition to chickpea, lentil, cumin in smaller areas, plus some other rainfed crops in minor areas. The agrarian rotation followed is simply "wheat-others", in which others include all crops mentioned above a part from wheat. However, in agro-climatic zones 2 and 3, where the average rainfall is similar but quite lower than in zone 1, the rotation followed is "wheat-others-fallow". In zone 4, however, the cropping pattern is confined to wheat and barley in the following rotation "wheat-fallow-barley-fallow-barley-fallow-barley-fallow", which means that wheat is on average grown only once every eight years on the same land plot.

In the irrigated farming system, rotations are more complex. According to the survey findings, farmers follow rotations advised by the technical experts of the local agricultural departments. They divide the crops into cereals (wheat and barley) and non-cereals. The scientific basis of the rotation states that it is not advisable to grow any of the non-cereal crop two sequent times in the same land plot. Otherwise, some pests and diseases may develop causing damage to the relevant crop, or reducing its yield significantly. Therefore, the rotation constraint is that the combined area of the non-cereal crops is equal to or less than the combined area of the cereal crops.

Barley and wheat are very similar in terms of technical requirements, cost structure, and some aspects of policy intervention. The only difference is in their pricing policy. Whereas wheat has a fixed price equal to SP 11.8, barley has a floor price equal to SP 7.5. The secondary data sources suggest that only some farms produce barley in limited quantities. The survey findings prove that these farms do not grow barley for sale; they rather use it to feed their livestock (mainly sheep).

The best way of considering this fact in our linear programming model is to include the sheep flocks in the analysis. However, this is beyond the scope of this research due to time and resource constraint. Including sheep flocks in the analysis will is not expected to add significant value to our model concerning the measurement of the agricultural policy impact on water use. This is because sheep herds consume negligible amounts of water in comparison to those of crops such as wheat, cotton, and barley especially that sheep herds spend at least half of the year away from the farm grazing the pastures in the Syrian steppe (*Al-Badia*).

To solve this problem, we assume that farms producing barley do so for the market, and the incentive price of barley would be the one that these farmers would pay in case they do not grow barley. This is equivalent to the wholesale price of barley dominant in the market, which was SP 9.5 in the reference year (2006) of the research. This means that there should be a minimum area planted with barley, which is translated in our model by setting a constraint stating the area planted with barley to be equal to or greater than the observed area of barley.

4.2 Data description

The data used in the farms' classification are available in the database of the National Agricultural Policy Centre (NAPC) and the Statistical Abstract of the Ministry of Agricultural and Agrarian Reform (MAAR) (2005). The classification is performed through a process of disaggreagtion as follows:

- The entire area of each governorate is divided according the mantikas' boundaries.
- The entire area in each mantika is divided according to the agro-ecological zones.
- The entire area reached in the last division is divided according to the cultivation mode whether rainfed or irrigated. At this stage we reach the last level of disaggregation for the rainfed farming systems.
- Then, the irrgated area in each agro-ecological zones is divided according to water sources
- The irrgated area from different water sources is divided according to irrigation techniques.

Therefore, farm types are distinct according to their location (mantika), agro-ecological zone (1-5), cultivation mode (irrigated or rainfed) irrigation source (wells, nets, or rivers), and irrigation technique (flood, sprinkler, and drip).

4.2.1 Farm fixed resources

Farm size and cropping patterns

The definition of the average farm size for each typology is determined by dividing the total cultivated area at the last level of disaggregation (the irrigation technique level for irrigated systems and agroclimatic zone level for rainfed systems) by the number of farms. Due to the absence of official data about the number of farms at this level, the estimates of the local experts (the heads of agricultural departments at the district level) are used. Then the total areas of the cultivated crops is divided by the number of farms to obtain the average cropping pattern of each farm type. The crops' areas are taken from NAPC database.

Water avaialbility

Water availability at the farm type level is fully determined through the findings of the survey. Its determination depends on irrigation water sources. When the source of water is private wells, water availability is estimated based on the maximum capacity of the pump-sets that the farmers have. So water availability in each month is the same across the year assuming that farmers have deep wells that are reliable in all times of the year. Of course, there are many farmers who have shallow wells that are unreliable in bad rainfall years. These farms are not considered to be using wells as the amin source of irrigation. They are catgorised under other types because they are assumed to use wells as supplementary water source.

When water source is public nets, farmers' access to irrigation water is manipulated by governmental agencies. In this case, water availability in each farm is estimated according to a pre-determined schedule set by the Ministry of Irrigation (MOI) in which every farmer has access to water for some time per week at certain times of the year. However, in the case where a river is the main source of water, water availability is estimated usually in a similar way to that of wells.

Family labour availability

Based on the findings of the survey, family labour availability is assumed to be the same for all farms' types and equal to 225 hours per month. The survey results suggests that in most families, only one person works full time on the farm, with the participation of another family member who devotes only about 50% of her/his time for on-farm activities. Considering that the agricultural workday in Syria is 5 hours, we can conclude that a full time worker can devote 150 hours a month, with a total family labour availability of 225 hours.

Irrigation methods

The observed irrigation schemes are flood, sprinkler, and drip. These techniques are presented in the model using dummy variables taking values of zero or one. These dummies represent an 'investment switch' so they allow making simulations of switching farms from the flood scheme to drip or sprinkler techniques by the changing the value of the variable from zero to one. In this regard, the model recognises that some irrigation techniques are not suitable for some crops, for example, drip scheme is not suited for irrigating wheat and barley. In addition, the model recognises the possibility of switching wheat and barley (but not cotton) to the rainfed mode. This is because wheat and barley can be grown without irrigation, but resulting lower yields, but it is impossible to grow cotton in Syria without irrigation.

4.2.2 Technical requirements and coefficients

Irrigation water requirements

The irrigation requirements of the various crops are determined at the agro-ecological zone level in each governorate by month (GCASR, 2006). However, these data are adjusted in light of the survey findings because farmers use more water for irrigation than indictated in the seconadary source. The numbers indicated in the official source are calculated using some equations reflecting the 'optimal' irrigation requirements rather than the real ones[3]. Therefore, they are

[3]- this information is obtained from Mr Mamoun Kanafani, the officer who is officially responsible about delivering the abstract of water requirements in GCASR.

only used as a reference point to estimate the irrigation requirements used in the analysis.

Irrigation requirements are different by governorate, agro-ecological zone, crop, irrigation techniques and month. The differences in terms of different irrigation techniques are based on assumptions drawn from the discussions with the local experts of agricultural departments in Al-Hassakeh. It is assumed that sprinkler and drip schemes save 10% and 20% with respect to flood traditional scheme, although the water saved using these two modern techniques are much higher in the 'optimal' situations. The lower saving percentages result from the technical difficulties that farmers face in using the modern schemes. This has implications for policy actions and is discussed later in the report in more detail. Of course, irrigation requirements of rainfed crops are zero.

Labour requirements

Labour requirements for each crop are mainly obtained from a secondary source at a monthly level (MAAR). However, the labour requirements for labour demanding operations (such as cotton and sugarbeet harvesting) are modified in light of the survey findings to reflect the differences in yield among different farm types, since the numbers of the secondary source are averages at the national level. This is important because cotton harvesting forms the main labour requirements for cotton and is heavily affected by yield. The adjustment is based on a simplifying assumption that the labour required for harvesting is a linear function of yield.

Physical inputs

These data include the crops' requirements of chemical fertlisers and seeds. They are three kinds of chemical fertilisers used for all crops: nitrogen, phosphate, and potash. Their required quantities differ depending on the crop only for irrigated cultivation. If the crops are rainfed, they are then different accoring to the agro-ecological zones too due to the differences in average rainfall and crops' responses to fertlisation.

Crops' yields

Crops' yields differ according to mantikas, agro-ecological zones, and irrigation methods for irrigated crops. The numbers are obtained as averages from the database of the NAPC. Due to the absence of data on the yields of crops irrigated by drip and sprinkler schemes, their yields are estimated based on the discussion with the local experts. It is assumed that sprinkler and drip techniques increase the yields by 10% and 15% repectively with regard to flood technique. This takes into consideration that some techniques are not suited for some crops; for example, drip technique does not suite the irrigation of wheat and barley. In this case, yield is assumed equal to zero.

For rainfed crops, yields are calculated from the NAPC database as the average yields for the last seven years only at the agro-ecological zones. This averaging is just an attempt to minimise the effects of fluctuations from year to year as a result of rainfall fluctuations or/and pests' and diseases' effects.

4.2.3 Prices of inputs and outputs

Prices of outputs

It is mentioned above that some crops have fixed prices. These are cotton, sugarbeet, and tobacco. These prices are used in the mode taking into account that the prices received by farmers are slightly different from the official ones reflecting differences in quality. Therefore, we used the average price calculated at the national level and reported in the annual agricultural abstract of the MAAR. They are SP 2.10 for sugarbeet, SP 27.5 for cotton, and SP 120 for tobacco. For crops that have floor prices, which are wheat, barley, lentil, and chickpea, we started assuming that their floor prices are the effective ones in the decision making process of farmers, then we used some calibration procedures to reach the effective ones which were expected to be higher than the floor ones for these four crops.

Generally speaking, the choice of prices is not an easy task to perform for crops whose prices are determined by the interactions of supply and demand without any intervenstion from the Government. We first used as a reference the wholesale prices prevailed in the reference year of the study (2006), but then we use some calibration procedures to reach the pressumed effective price.

Prices of inputs

The prices of most physical inputs, namely all kinds of chemical fertilisers and seeds of cotton, wheat, and barley, are set administratively by the GOS through the ACB as follows:

Chemical fertilisers

- Nitrogen: 9 SP/kg
- Phosphate: 9 SP/kg
- Potash: 13 SP/kg

Crops' seeds

- Cotton seeds: 11 SP/kg
- Wheat seeds: 15 SP/kg
- Barley seeds: 15 SP/kg

For the seeds' prices of other crops, we used data collected at the farm level after cross-checking them with local experts for validity.

4.2.4 Labour wage

Labour wage in Syria is paid in non-standardised way. It might be paid on a daily basis as in the case of weeding where the wage is 150 SP/day (for a work day of six hours), or it might be paid according to the amount of work done as in the case of cotton harvesting (4.5 SP/kg). In addition, the labour wage might be different according to the task whether it easy or hard. This issue was discussed with the local experts as well as with the interviewed farmers. The conclusion is to assume that labour wage is 25 SP/hour (the same as the wage of weeding).

4.2.5 Water costs

Water costs are different according to water sources. Farms that depend on the public nets for irrigation pay an annual irrgation fee per hectare regardless of the amount of water used. These farms do not incur any operational costs for getting the water into the fields since it is driven by gravity. Farms who depend on private wells and rivers do not pay any fee, but they incur pumping costs.

These costs are calculated by the model at the farm level, multiplying the water use (per CM) by the average cost of pumping one CM in each farm. The cost of pumping one CM is calculated using the survey findings, simply by dividing the total water use of interviewed farms (of each farm type) over the total pumping costs. The latter includes the costs of fuel (mainly diesel), oil, and repairs. However, since most interviewed farms use only flood irrigation method, the costs of pumping using drip and sprinkler methods are calculated in light of some research performed by the GCASR (Somi, 2002). This results in a table that have three costs of pumping one CM for each farm type to allow simulations of switching from one irrigation method to another.

4.2.6 Other costs

Rental machinery costs

All crops are highly mechanised. Wheat and barley are almost totally mechanised, where irrigation is the only manually performed operation. The situation is similar for cumin, chickpea, and lentil with the only exception that harvesting is performed both mannully and mechanically. For cotton, machinery is used only for ploughing and tillage.

Most all farmers rent machinery to perform these operations due to the active market for these services caused by the presence of specialised agents providing them. During wheat harvesting season, harvostors from Turkey are allowed to enter Syria to assist meeting the demand for this service.

The costs of all services are standarised for irrigated cultivation and paid on a per-hectare basis. However, harvesting cost in the north-eastern governorates (Al-Hassakeh, Al-Rakka, and Der-ez-Zor) is paid on an output-percentage basis which is 5-6% of the production value. For rainfed crops, the costs of all machinery services are linked to yields, which are functions of agro-ecological zones. However, only the harvesting costs is directly linked to yields (10% of the output value for wheat and barley and about 5-6% for lentil, 2-3% for cumin and 9-10% for chickpea), while the costs of other machinery services are indirectly linked to yields and are paid on a per-hectare basis.

Transportation and other costs

These include the costs of trasnsportation of the output (to the market or governmental delivery centers), costs of liquid chemicals, packing materials, etc. These costs form a small proportion of the total variable costs, and they differ only depending on the crop for irrigated farming, but also according to yields for rainfed farming. Since yields of rainfed crops are only different at the agro-ecoilogical zone level, they are differentiated only by agro-ecological zone.

4.3 Solving and validating the model

The software used in setting up, solving, calibrating and simulating the linear programming model is the Generalised Algebraic Modelling System (GAMS). All data are entered into GAMS and organised in three separate sheets. One includes the model structure and some data that are unique for all farm types such as the prices of outputs and physical inputs. The other two sheets include the rest of the data organised according to the level of aggregation at which the data are collected. The second includes all data that are different at the farm level. This includes all farm fixed factors in addition to costs of pumping one CM of water. The third contains the technical coefficients and the rental machinery costs[4].

Up to now, the validation is only done for Al-Hassakeh through examining whether the first solution of the model reports crops' areas that are similar to their observed counterparts. This is achieved by slight modification of some technical coefficients (yields and water availability), given that the model is simple with straightforward assumptions. At the end, the model reports results that are very similar to the observed numbers in terms of crops' areas, outputs, and water use.

The model reports similar results to the observed ones in Al-Hassakeh due to the fact that the assumption of profit maximisation is relatively suitable in the context of Al-Hassakeh's farming systems. This is because most agricultural output takes place in irrigated farms where irrigation reduces significantly the exposure to drought hazard. Furthermore, risks associated with markets and reflected in form of price fluctuations are minimised by the agricultural pricing policy of the three products in question, which are the main crops in the region. All crops in question either have fixed price (cotton) or have floor price (wheat and barley) as mentioned before.

However, when attempting to validate the model for other governorates, the model results have been always significantly different from the observed ones. This is because farmers in other governorates cannot really maximise profits, they rather attempt to do so, given the available information, technology and states of nature, while facing considerably the risk of markets

[4] - the detailed data entered into the GAMS are available from authors upon request.

reflected in price fluctuations for some crops for which the government has no pricing policy. Therefore, the analytical model is of no use at the moment to analyse the agricultural production in these governorates since its main assumption (profit-maximization) does not hold properly. Then an alternative assumption must be proposed to improve the analytical power of the model and will be discussed in more details later in the report.

Last but not least, profit maximisation model described above, though it is relatively suitable for Al-Hassakeh conditions, will only enable us to perform simulations by changing some policy parameters (mainly prices), but we will not be able to predict what would happen if the entire policy were dropped, since it ignores risk and uncertainty. Such policy simulations are the subject of the following chapter.

Chapter 5 – Preliminary Results/Al-Hassakeh Governorate

This chapter is devoted to summarise some preliminary results of the analysis. The results shown in this chapter are partial in terms of geographical coverage since they are confined to Al-Hassakeh governorate. They are also not final as they may be modified based on further analysis and calibration, and we present them now to boost discussions that might well feedback into further analysis producing a better quality of the final results.

The simulations performed on the basis of the government agricultural policy, especially the most recent policy reforms that affects the agricultural sector, namely the change in the price of diesel and prices of strategic crops as well as the subsidy devoted to cotton produced on land irrigated from wells. Thus as the government has increased the price of fuels (in which the price of diesel was raised from about 7 SP/litre to about 25 SP/litre), the costs of production have also increased, which in turn, pushed the Government to raise the prices of strategic crops (in order to remunerate farmers) as follows:

cotton from 30.75 SP/kg to 41 SP/kg

wheat from 12 SP/kg to 16.5 SP/kg

barley from 9 SP/kg to 15 SP/kg

sugarbeet from 2.25 SP/kg to 3.75 SP/kg.

Then after calibrating the mathematical programming model according the prices prevailing in the reference year of the study (2005), it has been modified to take into consideration the recent changes in the prices of inputs and outputs. Then we have performed the following scenarios, while all other things are kept unchanged:

1. the effect of wheat price change on wheat output and total water use.
2. the effect of cotton price change on cotton output and total water use
3. the impact of introducing cumin into the cropping patterns on water use.
4. the impact of modernising the irrigation schemes on water use
5. the impact of changing water costs on the outputs of cotton and wheat as well as on water use.

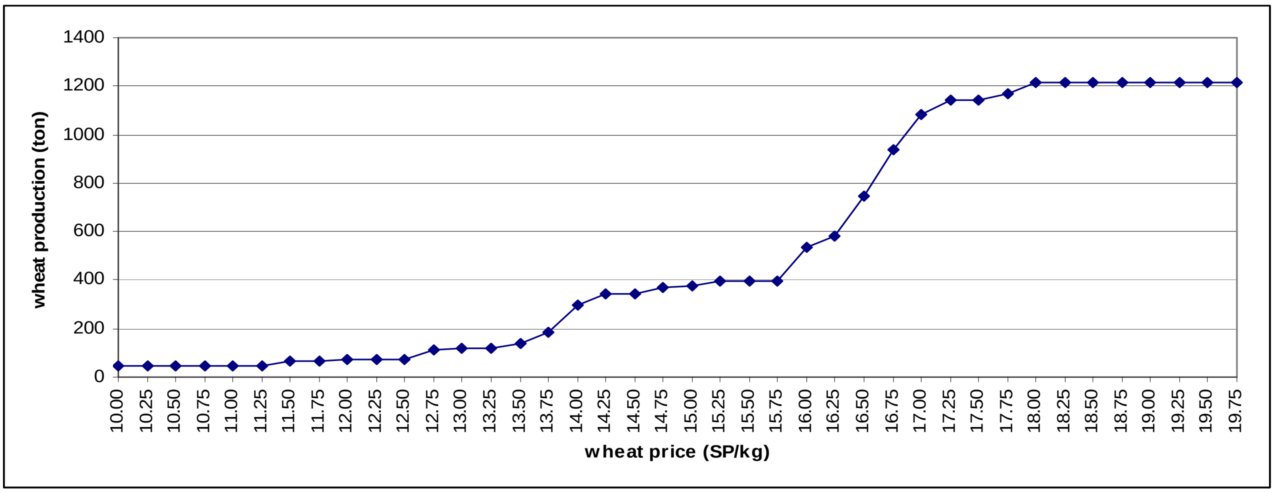
Barley is not considered at the level of Al-Hassakeh governorate due to its negligible share in its cropping patterns that are dominated by cotton and wheat in the irrigated farms, and wheat and lentil in the rainfed farms. Sugarbeet, on the other hand, is not grown at all in Al-Hassakeh.

5.1 The impact of wheat price change on wheat output and total water use

This scenario aims at assessing the impact of wheat price change on wheat output and water use. It is performed by a gradual rediction of wheat price with tracing its impact on wheat output and water use. The results are summarised in the following figures. **Figure 5.1** shows that wheat production in Al-Hasakeh remains relatively very low when the price of wheat is increased up to about 13 SP/kg. However, the increase in output becomes dramatic as price is raised to 16 SP/kg, which is more/less the floor price of wheat set by the GOS in the recent reform.

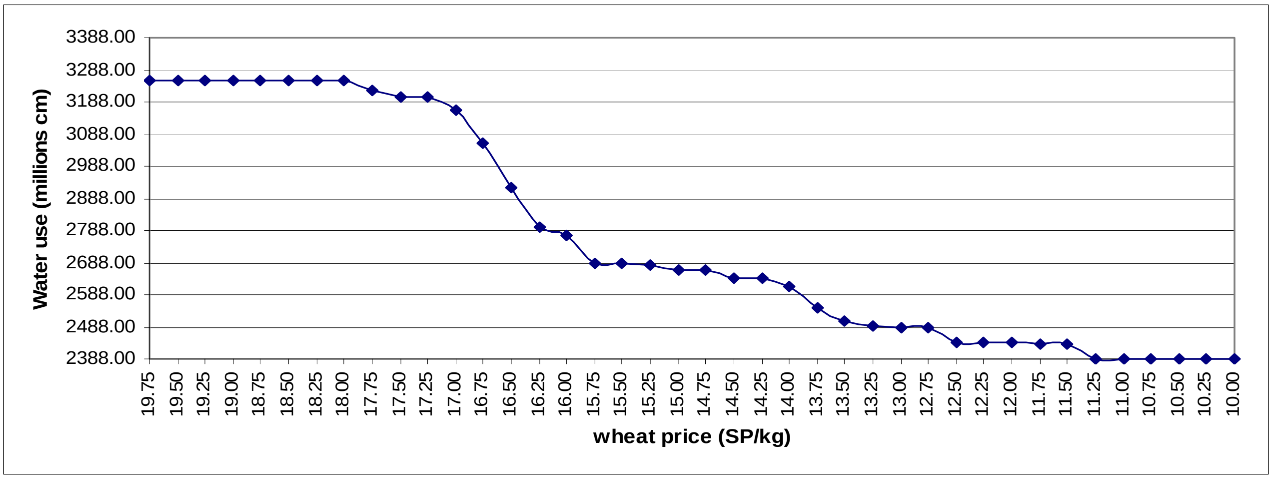
Figure 5.2, on the other hand, summarises the impact of wheat price change on water consumtion. It shows that decreasing wheat price up to 11 SP/kg would result in a reduction in water use from about 3300 millions CMs to less than 2388 millions CMs. Consequently, water deficit is eliminated only when wheat price reaches 11 SP/kg as shown **Figure 5.3**.

Figure 5.1 – the impact of wheat price change on wheat output



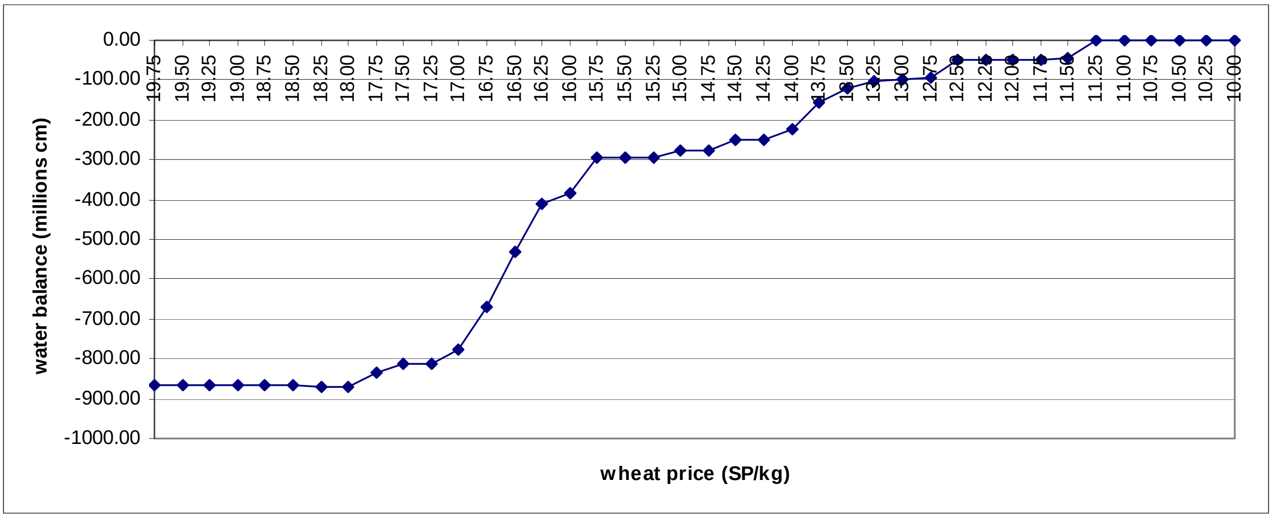
source: research results

Figure 5.2 - impact of wheat price change on water use



Source: the results of the research

Figure 5.3 - impact of wheat price change on water balance

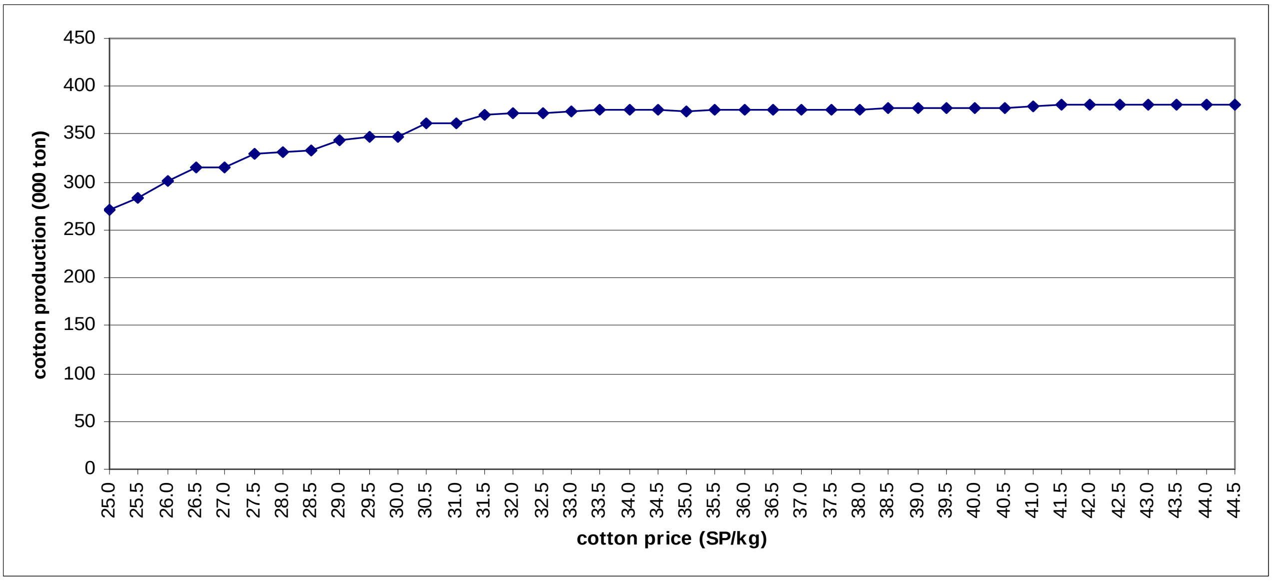


source: the research results

5.2 The impact of cotton price change on cotton output and total water use

The second scenario, instead, aims to assess the impact of cotton price policy on cotton output and water use. It was carried out by decreasing gradually the price of cotton with tracing the consequent changes whether for output or for water use. **Figure** 5.**4** suggests a considerable increase in cotton output when price is increased from 25 to about 30 SP/kg. This suggests that the new official price of cotton that have a national average of about about 37 SP/kg is very advantageous for cotton producers in Al-Hassakeh(before the recent increase of fuel price). However, **Figure 5.5** suggests that to reduce water consumption by significant amount (as a result of reducing cotton production, given that cotton is the most demanding crop in terms of water), cotton price should be decreased significantly as shown below.

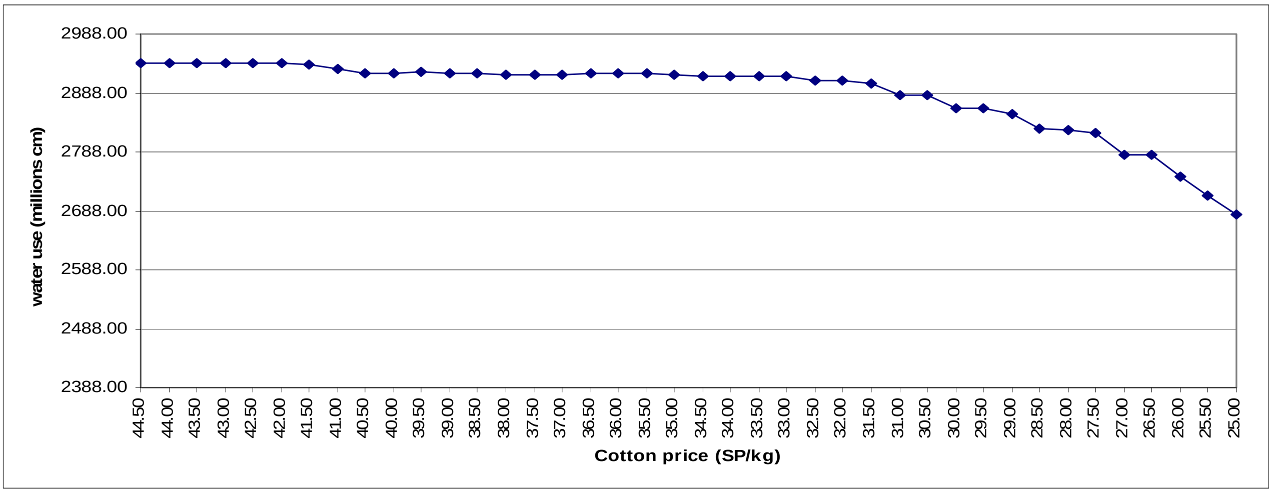
Figure 5.4 – the impact of cotton price on cotton output



Source: research results

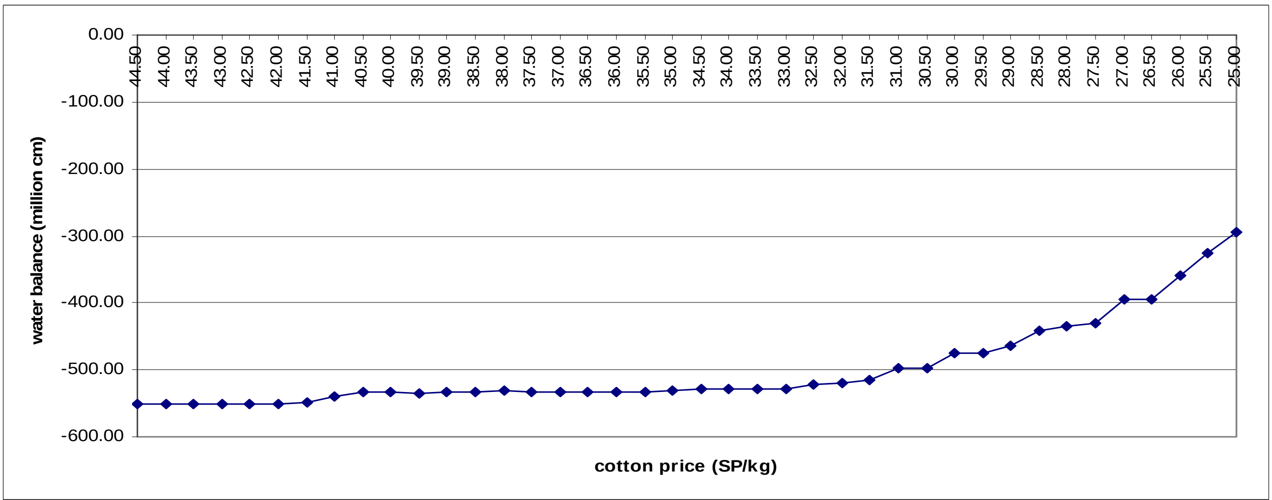
Figure 5.5 suggests that decreasing the current cotton price does not reduce the water deficit even when cotton price reaches 25 SP/kg(before the recent increase of fuel price) which is a very low price with respect to its production costs, in which there would be still a considerable deficit (of about 300 million CMs) (**Figure 5.6**).

Figure 5.5 - impact of cotton price change on water use



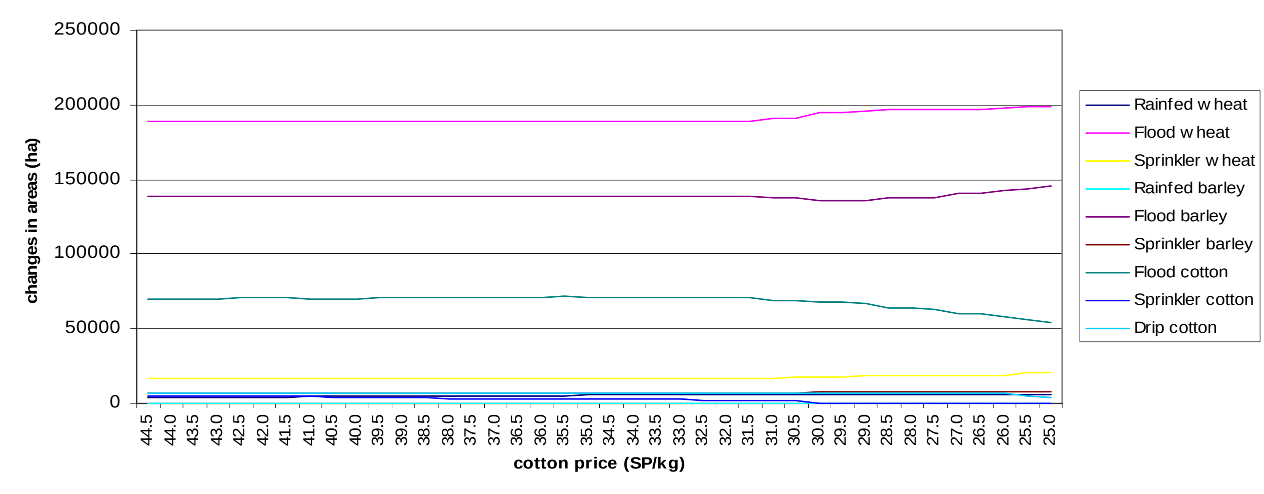
source: the research results

Figure 5.6 - impact of cotton price change on water balance



source: the research results

Figure 5.7 - impact of cotton price change on cropping pattern



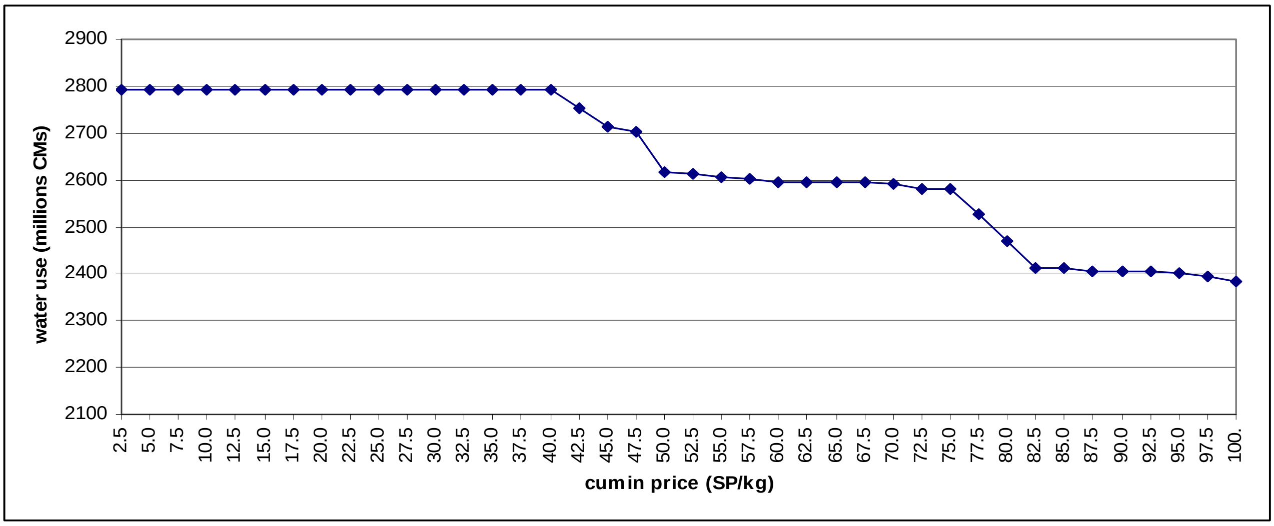
source: the research results

With reference to **Figure 5.7,** no change in the cropping pattern occurs when the price goes down to 32.5 SP/kg, suggesting that the current price generates high gross margins for Al-Hassakeh farmers (previous price of diesel). The relatively slow decrease in water use would only occur if some land cultivated with cotton is switched to wheat (as a consequence of decreasing the price of cotton). If cotton price reached 30 SP/kg, barley may start to replace cotton, in addition to increasing the areas of wheat replacing cotton too.

5.3 The impact of introducing cumin on water use

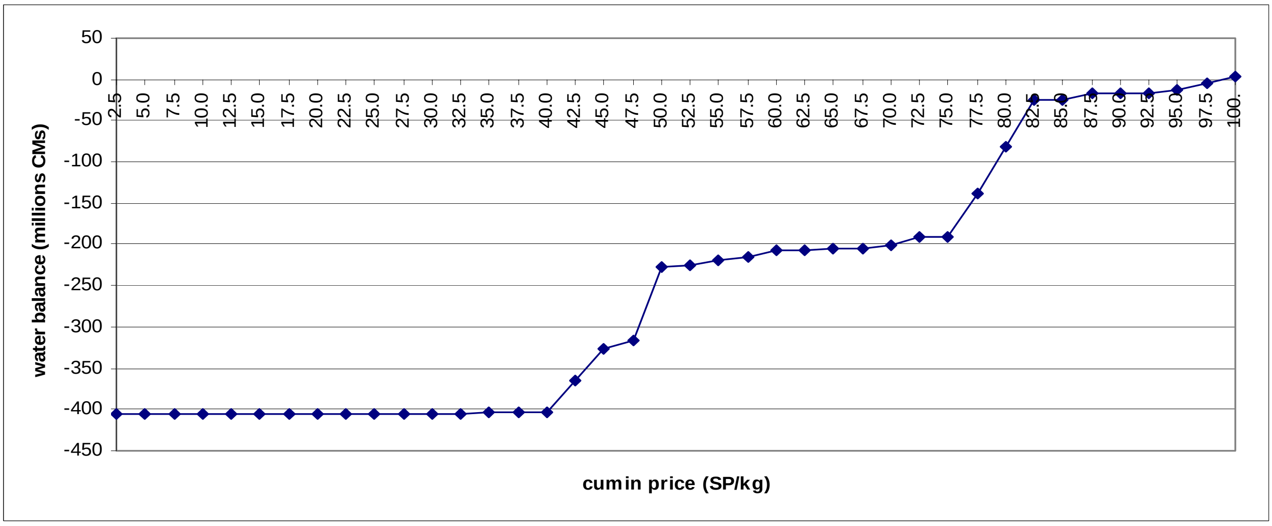
This scenario aims to evaluate the impact of introducing cumin into the cropping pattern. In the initial situation, cumin price is set equal to zero to simplify all the constraints that prevent cumin cultivation although its price has recently been very high. Therefore, the introduction of cumin into the cropping patterns is performed by raising its price, to simplify that all constraints (discussed in Chapter 3) are erased by a policy action. **Figure 5.8** describes the impact of changing cumin price on water use, suggesting that water use starts to decrease when cumin price reaches about 30 SP/kg. After that, it continues to go down almost steadily.

Figure 5.8 - impact of cumin price change on water use



source: the research results

Figure 5.9 - impact of cumin price change on water balance



source: the research results

Figure 5.9, on the other hand, shows that water deficit disappears only when cumin price becomes more than 100 SP/kg.

5.4 The impact of modernising the irrigation schemes on water use

This scenario intends to assess the impact of switching all irrigated farms of Al-Hassakeh to the modern irrigation techniques, whether sprinkler, drip, or both. It is mentioned above that the initial solution of the model results in a total water use of 3303 millions CMs before the recent reforms (namely the increase in diesel price and prices of strategic crops) and 2793 millions CM after these reforms. Given that the current annual water availability in Al-Hassakeh is about 2388 millions CMs, we have a deficit of about 915 and 405 millions CMs respectively.

This simulation is composed of three scenarios. The first is to allow all farms to adopt sprinkler schemes only. The second is to allow all farms to switch to drip technique only, and the third is to allow all farms to have both techniques. The rationale behind the last scenario is that modern irrigation schemes are crop-specific, whereas sprinkler is suited for wheat and barly and drip is suited for cotton only, although the latter might be irrigated by sprinkers too. Therefore, farms who already have a sprinkler scheme use it to irrigate all crops, but farms with only drip technique use it for cotton only. But there are some farms who have both techniques, so they use the sprinkler for wheat and barley and drip for cotton.

Table 5.1 summurises the results of the three scenarios. It shows that the switch to sprinkler method only saves water more than the switch to drip method does, although, in principal, drip technique saves more than sprinkler. This is due to the crop-specific characteristic of drip method that makes unsuitable for irrigating wheat and barley. Therefore, the switch to drip method means that only cotton would be irrigated by drip, while wheat and barley would continue to be irrigated according to the initial situation which is mostly flood. That is why the larget amount of water saving occurs when all farms switch to both modern methods.

However, even when all farms have the two modern schemes, there would still be a considerable deficit (of about 35 million CM) duplicating the results of a previous study done by Ortega-Varela et al (2001) despite the sharp increase in the cost of pumping water.

Table 5.1 - impact of adopting modern irrigation on water use and balance

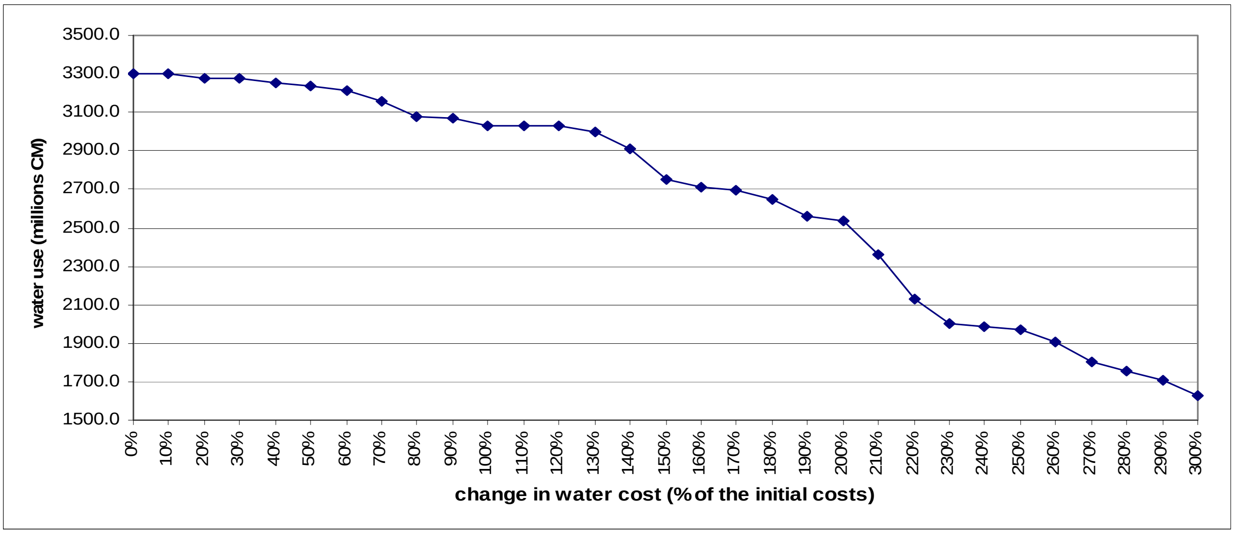
The scenario name	Water use	Water availability	Water balance
The initial situation before reform	3303.24	2388	-915.24
The initial situation after reform	2793.3	2388	-405.3
All to sprinkler only	2587.2	2388	-199.2
All to drip only	2562.38	2388	-174.38
All to both	2422.86	2388	-34.86

Source: the results of the research

5.5 The impact of changing water costs on water use

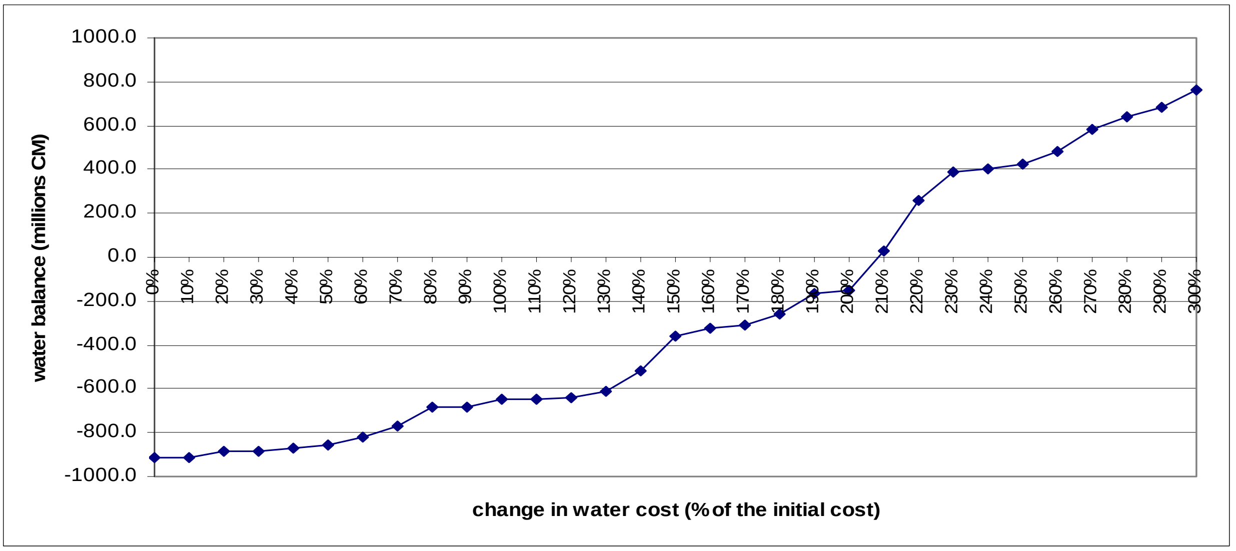
This scenario aims at assessing the impact of increasing water costs on water use and balance. Diesel cost accounts for more than 95% of the total costs for flood irrigation schemes, while the rest is the cost of oil and repairs. For drip and sprinkler, a significant part of the costs is due to the costs of irrigation schemes. Due to the significant differences in water costs among farm types and different irrigation techniques in the same farm type, the increase in water cost is expressed in percentages with respect to the initial values. The increase in water costs proposed here would mainly result from an incease in diesel price. **Figure 5.10** shows the change in water use as water costs increase, suggesting a gradual but steady decrease in water use. However, water costs have to increase by more than 200% in order to restore the deficit (**Figure 5.11**).

Figure 5.10 - impact of water costs change on water use



source: the research results

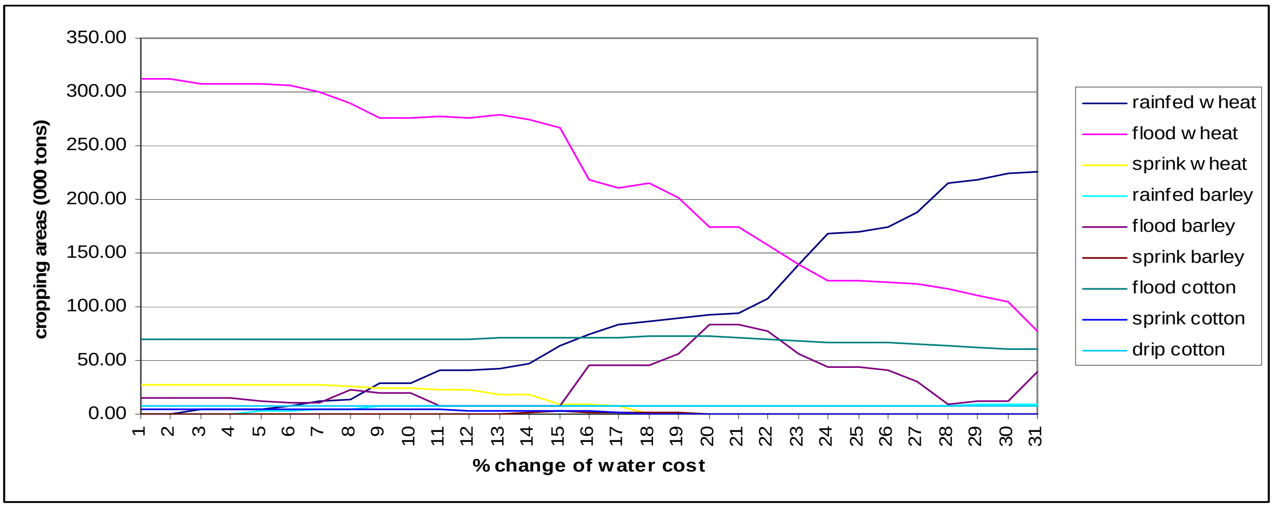
Figure 5.11 - impact of water costs change on water balance



source: the research results

This decrease in water use is due, at the beginning, to the switch of land cultivated with irrigated wheat to rainfed wheat. When water costs increase by 70%, land cultivated with cotton in the farms of sprinkler irrigation starts to go down, switching to mainly to rainfed wheat, but after increasing water costs by 150% it also switches to flood-irrigated barley. The latter fluctuates very much after the increase of 200% (**Figure 5.12**).

Figure 5.12 - impact of water costs change on cropping pattern



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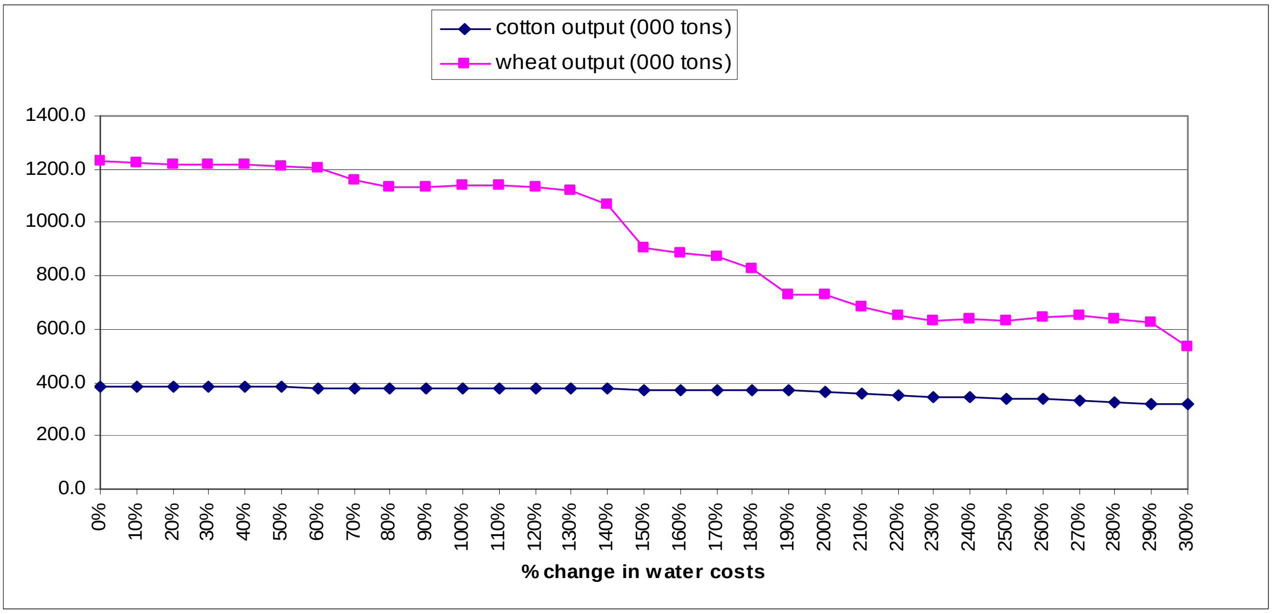
5.6 The impact of changing water costs on the outputs of cotton and wheat

It is suggested in the previous section that water balance in Al-Khabour basin cannot be restored until water costs increase by about 200% (all other things being equal). However, it must be noted now that this would be due to a dramatic decrease in the areas planted with wheat causing a significant reduction in wheat output. **Figure 5.13** shows that while cotton output seems to maintain some stability (due to its advantageous price indicated above), wheat output tends to go down dramatically after an increase in water costs of 60%. This has important implication for policy makers, especially that the Government is now considering a reform to the subsidy policy of petroleum products. It must be noted that wheat producers may be very much worse-off, and some may stop producing, if diesel price was raised without any other compensational measures.

Figure 5.13 – the impact of water costs change on wheat and cotton outputs



Source: the research results

Chapter 6 – Conclusions and Further Work

As stated above, the results of the analysis shown in the preceding chapter are partial in terms of geographical coverage as they are confined to Al-Hassakeh governorate. They are also not final as they may be modified based on further analysis and calibration, and we present them now to boost discussions that might well feedback into further analysis leading to more reliable.

For now, the following notes can be made about agricultural output and water use in Al-Hassakeh:

- Converting to modern irrigation schemes, without changing the present cropping pattern, cannot solve the water deficit problem. Even when all farms convert to the modern techniques, there would be a considerable water deficit of about 495 millions CMs, having water deficit decreased by about 12.7% only,
- The study suggests that reducing cotton to 25 SP/kg (compared to the current 40 SP/kg), cotton would still be a profitable crop in some area taking into account the old price of diesel (7.30sp/litter) and subsidized fertilizer. Furthermore, such a price reduction causes cotton output to decrease leading the GOS to lose the second important source of foreign currency; the water deficit is estimated of 300 millions CMs.
- One of the possible alternative policies for restores water deficit is raising water costs by more than 200%, however, the study should consider deeply the social impacts and livelihood and suggest the alternative crops.
- Reducing wheat price restores the deficit only when it reaches 11.25 SP/kg. However, this would have a considerable effect on wheat output, which goes down by about 95%, making such measure unattractive by policy makers,
- Introducing cumin price restores the water deficit when it reaches 97 SP/kg. In this case, wheat output is reduced by about 32%, which is still high enough to be unattractive from the current viewpoint of the policy makers regarding food security policy in Syria.
- These conclusions imply trade-offs between the objectives of the current agricultural policy. Saving water objective competes with food security and foreign currency requirements.

However, we strongly state that these results are preliminary and partial. It is mentioned in section 3.3 of this report that the applied analytical model relies on a simplifying assumption on the technology at the individual farming system level, which is the assumption of fixed coefficients. While the assumption is made for simplicity, the model described above ignores all problems associated with risk and uncertainty, implying that farmers are risk-neutral which is the exception rather than the rule especially in agro-food business.

This leads us to the conclusion that farmers in reality do not really maximise profits, they rather attempt to do so, given the available information, technology and states of nature, while facing various sources of risk that can be classified under two types: risks associated with markets and those associated with weather and climate. While the latter causes fluctuations in output, the former causes fluctuations in prices, and in both cases, the total net revenue experiences high degree of uncertainty. Economic theory provides several alternative behavioural models to take into account the consequences of risk exposure on economic behaviour, such as the expected utility theory and the so-called state –contingent approach. In a further research, the possibility of using either one or the other approach should be explorted depending on the types of risk faced by farmers and the available data to build the models.

However, and given that the most serious effect of exposure to weather is due to rainfall fluctuations, such effects are likely to be minimal in our case in the irrigated farming systems in which the availability of irrigation can help farmers coping with risk associated with rainfall fluctuation directly by enabling them to avail water into the fields in appropriate quantity at the right time, and indirectly by reducing or eliminating the risk of underutilisation from the side of plants of some other inputs such as chemical fertilisers. However, such risk is likely to be the main determinant of farmers' investment decisions in the rainfed farming systems which should be carefully explored in any further research.

On the other hand, although risks associated with markets and reflected in form of price fluctuations are currently minimised by the policy of support to strategic crops, price risk should be explicitly taken into account in a model intending to measure the impacts of policy changes, considering that these policies may change and will likely increase considerably the extent of market risk exposure.

This leads us to the need of formulating models in which the cropping decisions are taken by farmers in presence of price uncertainty. We might be able to do so by considering as the objective function to be maximized, the Expected Wealth of the farm household (instead of farm profit), in which the expectation is formed after considering the predicted variability of prices and the mechanisms for income smoothing (most notably credit) that are available, to a different extent, to Syrian farmers.

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