IV. LESSONS FROM SURVEYS-Agro-economic diagnosis-

Part 2: An experimental classification of farming systems and farmer's strategies

IV.1 FOREWORD

The description of the farming systems we will realize here and the conclusions which will be drawn directly result from a field work realized by *Venot* between March and September 2003. This field work, based on semi directive interviews with farmers -Cf. the field guide survey in appendix VI- has led to an inventory of the different farming systems within the Lower Jordan River Basin in Jordan.

This section aims to give a synthetic vision of the heterogeneity of the irrigated agriculture within the *Basin* studied. We therefore described the main representative farming systems, focusing on three dimensions: the agronomical, the economic and the sociological one.

IV.2 THE FARMING SYSTEM CONCEPT & AIMS OF THE STUDY

IV.2.1 Foreword

This chapter generally aims at doing an assessment of the water sector in Jordan and at depicting the dynamics of the irrigated agriculture within the *Lower Jordan River Basin in Jordan* by raising the diverse issues in relation with the different water uses and in particular with the agricultural uses.

In a second time, it aims at identifying and quantifying diverse scenarios to depict the future of the water sector in Jordan. One of the objectives is also to assess the impacts of such scenarios on the Jordanian society and notably on the *"Jordanian agricultural society"* at the River Basin level.

Moreover, in reality, positive as well as negative impacts of scenarios (measures or policies) are usually spread unevenly across the population. Therefore, to have a field-related idea of what could be the global future evolutions of both the water and the agricultural sectors in the Lower Jordan River Basin, it is thus needed to go beyond the calculation of an 'average' benefit -or loss- according to an 'average farm'. It seems to us actually necessary to investigate in details the diversity of the situations observed in the Basin in order to know how the different socio-economic strata and the different kinds of farmers will be affected by the evolutions to come, how these latter could alter their status and how the present relations and dynamics we observe could be modified.

In order to reach this objective, we used a conceptual tool: **the farming system**. The description of the set of the farming systems spread throughout the entire Lower Jordan River Basin and the fine knowledge of the micro-socio-economic processes occurring at this peculiar scale would allow us depicting the multiple facets and the multiple realities of the irrigated agriculture in Jordan.

This qualitative *field-knowledge* would allow us identifying and understanding the strategies and the dynamics now observed within the basin and we would thus be able to depict the "reality" of the diverse processes occurring in the Jordanian water sector as well as their social, political and economic determining factors. This more global understanding would finally allow us presenting some field-related scenario of evolution at the River Basin level as far as the water and the agricultural sectors are concerned

IV.2.2 The Farming System Notion

The French concepts of *'système de production & système d'exploitation'* are not new; however the Anglo-Saxon adaptation of these two notions appears very recently at a time when the agricultural development in developing countries had to face some failures.

The qualitative field-knowledge of the diversity of the agricultural realities in a particular region reached thanks to the description of the different farming systems has then been seen as a mean to identify and implement some close-targeted rural development projects. Furthermore, this qualitative approach and the description of the processes occurring at a micro-scale found also its justification because it made possible to quickly and precisely assess the impacts on the farmers (and other rural actors) of the projects implemented.

We have chosen in this study to use the terms *'farming system'* and *'production system'* to designate the French *'système d'exploitation'* and *'système de production'* notions.

Consisting in a set of elements dynamically related and organized, the farming system seems actually to us the adapted level to study and understand the strategies developed by the farmer according to a given, moving and modifiable context in order to achieve one -or several- predefined goal(s).

The **Farming System** we consider is divided into two sub-systems (cf. the Picture besides):

- **The Management System** which consists in a *'decisional sphere'* where strategies -translated into method and decisions- are developed through a panel of actions in order to reach predefined objectives. This system is directly dependant of the social and cultural context in which the farmer develops its activities.
- **The Production System** which can be defined as the combination between the productions (cultural, herding and transformations systems) and the production factors (natural resources, labour, structural resources and costs of the farm as well as the access way to resources) of the farm. This system consists in a *'structural & technical sphere'*.

Two levels of analyse can be realized: the study of the production system which consists in a description of the nature and function of the production factors and the study of the entire farming system which is a focus on the functioning and the socio-economic organisation of the production units. In the following section we will base us essentially on an economic point of view to elaborate a farming system typology according to different classes of farmer's revenue.

It is now important to underline that the farming system notion is not only juxtaposition between the two spheres mentioned above but put into a prominent place the existing relations between these two centres which are studied objects as such. In the global and comprehensive approach we try to develop, the Farming System notion becomes a tool to analyse the economic and agronomic functioning of the farms in a particular social and cultural context. Farming Systems constitute here a basis to study the way the agriculture could evolve in the future on a qualitative point of view and which could be interestingly complemented by a more global statistical analysis.

In our representation, we choose to represent the farming system as an equilateral triangle allowing us not to prioritize one of the dimensions we have considered (production, production factors, social status and context of the farmer. Cf. scheme besides) even if we consider that the decisions of the farmer are predominant in the construction/implementation of the farming system itself. We consider actually that the social belonging of the farmer and thus the management system condition the strategies the farmer develops in order to implement a particular production system. For one given social status/context or management system, the number of production systems which could be observed in the reality is limited to a certain range depending precisely on the management system. Complementarily, the structural conditions which lead to the development of a particular production system have consequences on the strategies which could be developed by the farmer who only can implement a given set of strategies precisely dependant on the production system.

To conclude on this point one management system can be translated in the field in several production systems included in a given range while one production system can be the translation of several management systems inside given limits it requires.

Lastly, thanks to the representation given besides, we can see that by the practices he develops, the farmer has some influence on the social, political, economic and ecological context which had previously conditioned the farming system itself. The farming system and its environment are thus closely related in one dynamic *"meta-system"*.

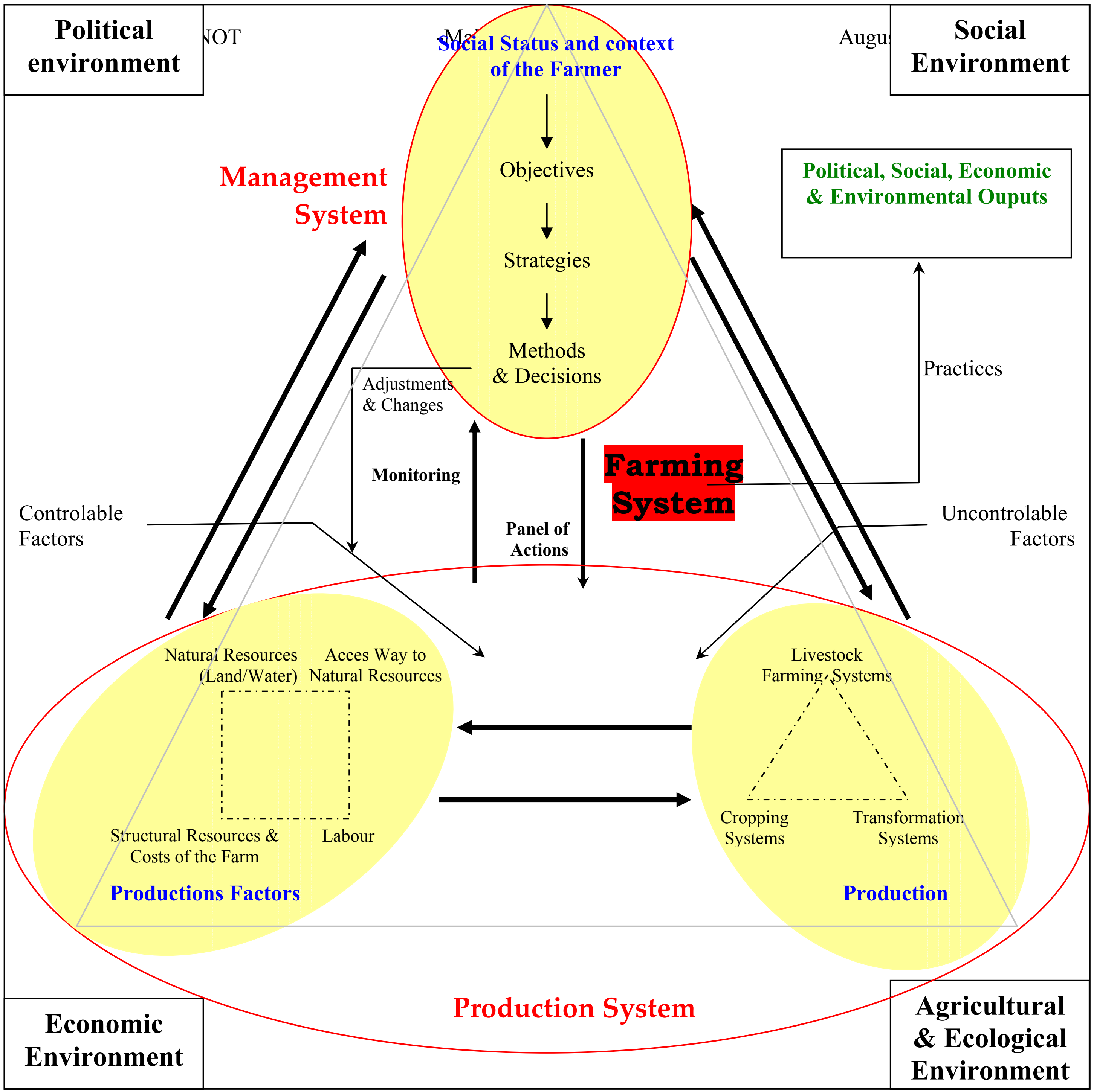

Figure 14-Bis Graphic Representation of the Farming System Notion

IV.2.3 Aims of the Study

The following section firstly aims at giving a synthetic vision of the diversity of the irrigated agriculture within the *Lower Jordan River Basin in Jordan*. We will therefore describe the main representative farming systems, focusing on three dimensions: the agronomical, the economic and the socio-anthropological one. Based on this diagnostic we will try to identify several kinds groups of farmers to understand the strategies they developed and that according to different parameters:

- **The social relations of the farmer** with other agricultural or non-agricultural actors of the water-agriculture sector in Jordan;
- **Their relations to water**. We intend here for example: the *water tenure*[83], the volume of water pumped, the importance of water in the exploitations costs…;
- **The location of the farm** within the Basin and the different agricultural zones we have identified.
- **The production system** (cf. the previous paragraph) and particularly the **profitability of the farm;**
- **The agricultural strategy of the farmer.** By strategy we intend here a *'set of means, methods and decisions developed in order to achieve one –or several- predefined goal(s) or objective(s)*[84].

It is of course settled that these parameters are not independent and are linked together. The identification of the relations between these different characteristics will lead to a farming system and farmers typology which will constitute, as we said it before, the basis used for the impact assessment of the different scenarios we consider to affect the water and agricultural sectors in Jordan

IV.3 METHODOLOGY OF THE AGRO-ECONOMIC DIAGNOSIS

IV.3.1 Introduction

The method used here to identify and characterize the farming systems within the *Lower Jordan River Basin in Jordan* is based on field surveys and interviews with farmers allowing at developing an agronomical, technical and economic description of the farms[85]. The first stage is to build several 'typical production systems' (cropping pattern, sequence and method of cropping, land tenure, labour, and costs… cf. above) then an economic modelling is realized. Net margin and net profit brought out per unit of surface are calculated by considering all the revenues and all the costs of the farmer. Thanks to this mainly-economic-description of the farming systems (based on some social and technical realities) it is possible to realize a classification of the farmers and to understand the farming strategies they develop.

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[83] The term *'Water tenure'* has to be considered here as an equivalent to the term *'land tenure'*. We can for example differentiate different 'water tenures': the farmer can have his own well or he can rent in a private well to irrigate his farm. He can also buy water from a private well-owner or from a public service (Jordan Valley Authority in the Jordan Valley). Issues related to the access to water will be developed all along the description of the farming systems which follow.

[84] *'Strategy'* has to be considered on a global point of view while *'objective'* is here more punctual.

[85] For further information on the way to elaborate this economic typology see the methodology developed by the department of 'Agriculture Comparée' at the French National Institute of Agronomy in Paris-Grignon (INA P-G) and notably presented in *Devienne (lessons documents).*

IV.3.2 Graphical representation

(i) Interest of the representation

In the following section and for the farming systems in which both the familial strategies and the familial field work are important we present a peculiar graphical representation according to the INA P-G method. Therefore, the description of the farming system is not only based on the profit brought out per unit of surface which is an useful but only partial information since it ignores some structural information of the farming systems (like the number of familial worker and the effective revenue of the family)[86].

For familial farming systems it seems actually more pertinent to work on and to present the Net Profit per familial worker and per year[87] expected to be brought out in the farm and to compare it to the poverty level (and the sustainable level[88]). That could actually allow doing a more accurate description of the farming system and better understanding the strategies developed by the farmers.

These charts thus represent the *'Net Profit per familial worker and per year'* in function of the *'surface cropped per familial worker'*. This last item is actually one of the main characteristics of the familial farming systems[89] and is simply obtained by dividing the total surface of the farm by the number of persons belonging to the family and working on the farm[90].

It is worth noticing that each farming system only exists in a particular domain of validity which can be delimitated (in other things and pertinently for familial systems) thanks to the parameter "surface cropped per familial worker". A range of situation is thus delimitate and Net Profit per familial worker is calculated and represented within this range by some coloured line segments (cf. charts in the following section) on the charts. This representation has also the advantage to present the intensification of the system in terms of labour. Actually, it is obvious to say that higher is the surface per familial worker, the more intensive is the system in terms of labour-force.

To conclude on these charts:

- The slope of the lines corresponds to the Net Profit brought out per dunum and per year: it is the **profitability** of the farm,

- The intercept corresponds to the depreciation costs which are not proportional to the surface cropped. The intercept translates the **initial investment** which has been done by the farmer and the necessary costs of maintenance of the equipment.

The aim of these representations is to "replace" the farming systems in a more global economic context and in particular to compare the revenue brought out per familial worker to the poverty line and to the sustainable line, the latter giving an idea of the long term viability of the farm.

To simplify, if the line segment representing the familial farming system is above the poverty and the sustainable lines, the farming system is profitable and economically viable on the long term. If the segment is between the poverty and the sustainable lines, the system allow bringing out a low Net profit per familial worker but not sufficient to develop and insure the long-term viability of the farm. Finally, if the segment is below the poverty line, farmers are living into poverty and the farming system seems to be non-economically viable even on the short term. In the two last cases, the only economic-determinism find its limits since to explain the persistence of such non-economically

[86] Two parameters of previous importance in familial farming systems

[87] In parallel, for the entrepreneur farms and the land investors farms, we preferred work on *'the return on investment'* which seems to be the most pertinent items to economically characterize such farming systems and farmers.

[88] The sustainability line is the threshold above which the farming system is not threatened by economic collapse.

[89] It is actually linked to two main structural characteristics of the farming system: the total surface of the farm and the number of familial members involved in the farm functioning.

[90] In addition, we can consider that an agricultural worker is generally in charge of two dependant children and one dependant elderly person.

profitable systems, it is needed to call for other processes affecting the farming system (we can for example think to indebtedness (cf. box besides)[91], multiple-resources economy, part time farming, familial solidarity…)

(ii) The threshold considered

In our charts, we have considered that the salary of a permanent worker in agriculture generally reaching 1.200 JD/year (1.700 $) is closely related to the *Poverty Line*. On another hand, we have considered the *Sustainable Line* is related to the salary of an employed farm manager earning 1.800JD/year (2.550 $). Moreover, according to the surveys realized, we can consider that each agricultural worker is in charge of three dependant persons. The poverty line thus only reaches 300 JD/ca/year (430 $) and the sustainable line 450JD/ca/year (635 $)[92].

[91] It is worth noticing that we do not have tackled the process of farmers getting in debt at the farming system scale. We only present general data on debt in a box besides

[92] For information, the World Bank consider that the Absolute Poverty Line reaches 313,5JD/ca/year (448 $) and the Abject Poverty Line only 124 JD/ca/year (177 $) while the Jordanian government, the DFIP and the UNDP consider that these two indicators can respectively be evaluated at 468 JD/ca/year (660 $) and 223 JD/ca/year (315 $).

Box 4. Indebtness in the Jordan Valley

The most important *institutions* lending money to farmers are the Jordan Valley Farmer Union (JVFU) [93] and the Agricultural Credit Corporation (ACC). We present here some global data, drawn from the ACC 1999 Annual Report.

ACC is dealing with 59.000 borrowers with an outstanding balance of JD 100,8 millions. For the sole year 1999; JD 27,4 millions have been newly granted to a total of 10504 *'farmers'*. 6500 sheep raisers have thus been granted by the way of feed loans for a total of JD 15 millions i.e. an average loan of 2307 JD/ca -3254 \$/ca. 4004 fruits and vegetables farmers have been granted of JD 12,4 millions i.e. an average loan of 3096 JD/ca (4366\$/ca)[94].

The average loan amount per borrower reaches 2606 JD (3675\$) and the average amount of one loan is about 2726 JD (3843 \$). There are thus more borrowers than loans, it means than some borrowers share the loan they owe to ACC.

Added to that, 65% of the number loans are seasonal loans (60% in terms of loans value) while 30% are short term loans (both in number and value) and 5% are long term loans (10% in value).

The table below allow us adding some of the main line of agricultural credit in Jordan.

	Amount of the loan (JD)	<5000	5000-10000	10000-20000	20000-30000	>30000	Total	% of total on Jordan
Northern Ghor	Nb of contracts	1975	173	56	9	2	2215	4,6
	Amount (in JD)	2516541	921418	537116	147277	82000	4204352	4,2
Middle Ghor	Nb of contracts	1603	176	54	14	5	1852	3,9
	Amount (in JD)	2031773	895024	544606	282600	306074	4060077	4,0
South Ghor	Nb of contracts	1697	150	56	14	20	1937	4,1
	Amount (in JD)	2391292	772962	524096	236878	691885	4617113	4,6
Total Jordan Valley	Nb of contracts	5275	499	166	37	27	6004	12,6
	Amount (in JD)	6939606	2589404	1605818	666755	1079959	12881542	12,8
Total Basin	Nb of contracts	22794	2747	926	278	193	26938	56,4
	Amount (in JD)	30922988	14101142	9087600	4512851	6229495	64854076	64,3
Total Jordan	Nb of contracts	41755	4157	1295	348	218	47773	100
	Amount (in JD)	54455144	20908158	12767138	5800193	6944177	100874810	100
Total Jordan (%)	Nb of contracts	87,4	8,7	2,7	0,7	0,5	100	
	Amount (in JD)	54	20,7	12,7	5,7	6,9	100	

Table 10. Structural aspects of agricultural credit in Jordan -loans contracted in 1999-
(Source: ACC, 1999 Annual report)

We can see that 87,4 % of the loans are lower than 5.000 JD (7.050\$) and 96,1% lower than 10.000 JD (14.100\$). Moreover, 90% of the loans are granted to farmers cropping less than 30 dunums.

In the Jordan valley, DoS & FAO (1997) have estimated at 7.891, the total number of agricultural holding in the Jordan Valley. The table thus shows that the number of loans newly contracted in 1999 towards the ACC reaches 76% of the number of holdings[95] for a total amount of JD 12,8 millions (i.e US\$ 18 millions). For the entire Jordan, the number of loans contracted in 1999 towards ACC reaches 66% of the total number of agricultural holdings).

[93] Names before Jordan Valley Farmer Association. The Jordan Times (07/08/2000) evaluates the farmers debts to JVFU at around US\$ 1,41 millions.
[94] The recovery rate of ACC reached 75% from 1997 to 1999.
[95] This rate is important but does not mean that a loan is contracted in 76% of the holdings since several loans can have been contracted for one sole holding.

IV.4 AGRO-ECONOMIC DESCRIPTION OF THE FARMING SYSTEMS[96]

IV.4.1 General Cropping pattern

In the Lower Jordan River Basin in Jordan we can evaluate that appreciatively a little bit more than 21.000 hectares are irrigated both in the Jordan Valley and in the *Highlands.* But if the surfaces irrigated are comparable, the structure of the farming systems differs a lot between the *Highlands* and the Valley. In the valley, the irrigated agriculture is mainly a very intensive vegetables-farming organized around small farms of 3,5 ha in average[97] mainly irrigated thanks to a water-supply public network. On the contrary, most of the farms in the *Highlands* are larger (15 to 30 ha in average) and irrigated thanks to deep private wells.

Both in the Jordan Valley and in the *Highlands,* we will classify the farming systems in several 'families' according to their main characteristics. This classification will be done according to the kind of crop and the plantation method[98]. We will precisely describe these 'families of farming systems' in order to put in prominent place the differences which can be noted from one 'agricultural area' -as described above- to another.

IV.4.2 Farming systems of the Jordan Valley

(i) Open field vegetables farms[99]

- Introduction

Vegetable farming is one of the major agricultural activities in the Jordan Valley. Twenty different species, at least, are grown (tomatoes, potatoes, eggplants, zucchini, cabbage, cauliflower, onions, lettuce, *melokhia*, green beans are the most common, the diversity is higher in the north of Deir Alla than in the south of this village where the climate is more severe). The harvest period can last from a few days to 8 months, depending on the species. The vegetables are packaged in polystyrene boxes and, in most of the cases, sold in Amman or in Irbid, on the central markets[100]. Prices are very unstable: they can change from 1 to 5 or 10 from one season to another, or even from one day to the following. In order to soften the effects of these fluctuations, farmers usually grow separately various species at the same time. The safest species are either those that are harvested on a long period or those on which it is possible to advance the harvest or to delay it. Because of the fluctuations in price, it was rather difficult for us to evaluate for each kind of farmer the average prices he benefited. Small changes in the prices we used can severely change the calculated incomes.

[96] In this section, the net return (in JD/du or in $/du) refers to the net profit for familial farms and to the return on investment for entrepreneur's farms. This latest is obtained by deducting the entrepreneur salary to the net profit (we considered a remuneration of 1000 JD/month/ca for the entrepreneur -1.400 $-). We indicate by a star (*) that return on investment is considered, it is for farming systems for which the initial investment is high. It is worth noticing that we will only deal, in this section, with **irrigated farming system.** We do consider neither the rainfed farming system (excepted for the peculiar case of olive tree orchards) nor the herding activity despite its cultural and economic importance in the *Basin*.

[97] Range from 15 to 100 dunums for most of the farms

[98] This classification seems to us to be pertinent. Actually, there isn't any association of crop within the Basin. In the valley for example, it is possible to find farmers having a citrus plantation and a vegetable plot but the management of the two plots are so dissociated (there isn't any transfer of fertility, of labour force…) that it is possible to consider that they are two different farming systems. In most of the case 'farmers' who have such farms with different kinds of crops are absentee owners who delegate the crop management to employees or sharecroppers. Another association exists: breeders could be also cereals farmers to feed their herd and could go in the field after the harvest to feed their animals with the crops residues.

[99] See appendixes for a detailed description of the operational sequence for vegetables cropping.

[100] This is the most common rule, but other ways to market the production can be described. For example, in the case of tomatoes exported to Turkey, the farmer packages the production and a turkey importer comes with his truck to take the production in the farm.

To model these vegetables farms, the difficulty comes from the diversity of planted crops and of chemicals used. We first tried to understand the most frequent successions of crops and cropping patterns. For each model, we isolated one representative crop succession. Then, for each crop, we modeled the average added value and the needed daily labor, with a high-yields level and a low one. Using these crop models and the chosen crop successions, and adding to this the needed equipment and permanent labor, we recomposed the modeled farms with a modeled crop succession.

On a technical point of view, we will present here only the vegetables farms using drip irrigation, mulch[101] (with, eventually mini-tunnel). It is worth noticing that, in the middle of the valley (near the village of Deir Alla); some farms still using surface irrigation exist. Excepted this peculiar production system (cf the following box), all the other farms are equipped with a pool and a pump as well as some filters. This equipment is needed to use efficiently the on-farm drip irrigation system[102], and allows also irrigating the crops according to their day-by-day water requirements and settling the water to avoid the emitters to be clogged. With such an irrigation system, a permanent worker can take care of about 30 dunums all the year long except for the seedling, the harvesting and the packaging for which daily workers are needed. It is important to understand that, the higher the equipment costs are, the more the farmer wants to insure high levels of production, by using chemicals of better quality, treated manure, hybrid seeds, *etc…*

In order to localize the farming systems please refer to the map presented in the section dealing with the agricultural zoning. As far as are concerned open field farming systems, we can identified from the north to the south four main ‘agricultural areas’: the north (around the villages of Wadi Ryan and Kreymeh) the middle-north (between Kreimeh and Al-Arda), the middle-south (from Al-Arda to Karamah) and the south (from Karamah to the shores of the Dead Sea). The term ‘middle’ will be used to gather the two areas middle-north and middle-south if there is no need to differentiate it.

Picture 15. Open field farm in the northern (left) and in the southern part of the valley (right)
(Source: MREA, 2003)

- Land tenure

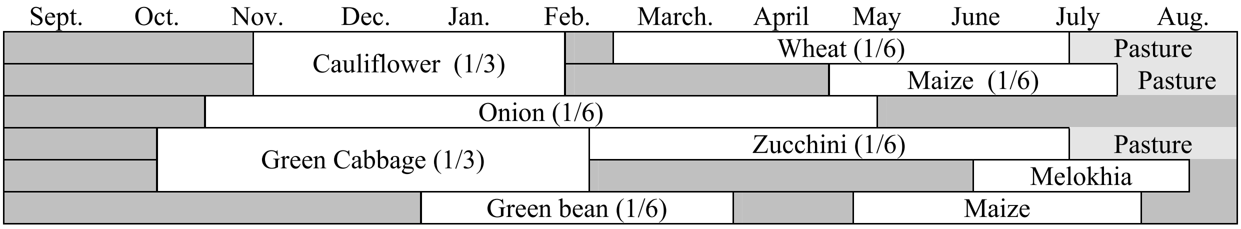
In general, vegetables farmers in the Jordan Valley are tenants of the land or sharecroppers (*“partner”* of a large landowner). Some few farmers own their land. As there is a large diversity of farmers implementing different kinds of cropping methods, we will do here a classification of the farming systems depending firstly on a farmer’s characterization. We can thus identified two main kinds of farming systems for which there are several available production systems:

[101] It is a black plastic strip covering the in-line drippers and the seedbed, one or two holes within the plastic allowing the plant’s growing.
[102] The drip irrigation system needs a high and constant pressure to be efficient (around 1 bar at the emitter level and around 3 bars at the FTA-level before the filtration and on the farm irrigation system because of some pressure-losses within the filters and the pipes)

Box 5. Poor farmers with surface irrigation in the middle of the valley[103]

Farmers developing this production system are mainly ancient slaves of large Jordanian tribes (*'abid* in arabic) or Palestinian refugees of 1948. They are familial farmers living in the valley and most of the time tenant or sharecropper on the land they crop (in general 30 dunums) even if some owners having beneficiating from the land reform of 1962 can also be found. In general, one familial worker takes care of 4 to 15 dunums and it is worth noticing the family has a small herding activity (often one or two dairy cows).

The production system can be characterized by a very low level of both initial investment (spade, hoe for the weeding and the maintenance of irrigation earth canals)[104] and annual investment (no labour costs, fertilizer costs very limited since the cow manure is used). The following table represents a classical cropping pattern[105] developed in this kind of farms.



It is worth noticing the large diversity of crops planted in order to be less dependent on the marketing conditions of the production. These farmers also favoured non labour consuming crops in order to manage to face the labour picks with their sole familial labour force. Cereals residues are reclaimed by the dairy cows.

Vegetables or cereals	Yield (T/ha)	Market price[106] ($US/T)
IV.4.2.1.1.1.1 Green Bean	14,0	560
Zucchini	13,5	280
Onion	18,0	170
Maize	12,5	170
Cauliflower	20	110
Green Cabbage	30	50
Melokhia	7,5	140
Wheat	2,2	200

Table 11. Yield and market prices observed

In this farming system, the Gross Ouput reaches about 240 $/dunum and the revenue 140 $/dunum. Added to this agricultural activity, herding allows bringing out a Net profit of 620 $/year/dairy cow.

The lactation period length around 300 days, and the reproduction is done by artificial insemination (with a success rate of ½). A cow can produce 4.000 to 4.500 kg/year, the milk being sold on the local market (0,3 US $/kg) while calves are sold at 11 months (350 kg and 1,8 Us $/Kg)[107]. The manure is used to fertilize the vegetables cropped. The needed capital (about 1000 $/cow) to develop this breeding activity is generally obtain thanks to familial mutual aid

The agricultural activity and the breeding activity allow together to bring out a Net profit of about 180$/dunum/year i.e a revenue per familial worker included between 720 and 2.700 $/familial worker according to the surface cropped per each familial worker. This revenue is higher than the poverty line only if each familial worker takes care of more than 10 dunums.

It is worth noticing this average revenue is lower than the average loan per borrower we have mentioned in the box on indebtness (this one actually reaching 3675 $, mainly as seasonal loans). It means the farmer is not able to reimburse its entire loan and thus get more deeply in debt to Credit Corporations or agricultural merchants…

[103] After Millet & Moreau, 2004
[104] Farmers own neither land preparation material nor trucks to transport the production to the central markets
[105] It is worth noticing the choice of the crops is more linked to economic criteria (market price, inputs and labour needs…) than on agronomical criteria
[106] Average of prices in the central market of Amman (1999-2003)
[107] Cull cow are sold at 6 years at 1,6 US$/Kg (around 525 kg/cow)

- The small entrepreneur's farms which can be found in the north and the middle-north of the valley. The farmer manages its farm (30 to 60 dunums) and the field work is done by some permanent employees and daily workers when it is needed. Farms can be equipped or not with mini-tunnel and are generally rented.

- Familial farms are present in the entire valley. Even if crops planted are similar, we can find a large diversity of land tenure and production systems. It is in this class of farming system that ownership is relatively common. In most of the cases, these familial farms are actually *the remains* of what has constituted the objective of the land reform of 1962[108] and are often owned by some "historical owners"[109] who have beneficiated of the land reform in the 1960s and who nor have sell their land neither have invested in more costly and intensive production techniques. Two sub-classes can be identified according to the area considered:

  - In the North of the valley, only tenants of around 30 dunums can be found with or without mini-tunnel.

  - In the middle and the south of the Valley, all the familial farmers use mini-tunnel to protect tomato after the seedling[110]. We can find Jordanians as well as Pakistani[111] and Palestinian[112]. We can find small tenants or owners working on 30 dunums, large tenants working on 90 to 120 dunums and sharecroppers on 60 to 90 dunums. In these farms all the family works on the farm helped by daily workers when it is necessary. It is possible to find some rare permanent employees within the larger farms when the family does not manage to realize all the day-by-day work[113].

Two peculiar cases can also be described:

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108 This land reform actually aimed at creating, in the Jordan Valley, a "social-class" of small familial peasants owner of their land (cf. above the historical description of the *Basin* development).
109 Sharecropper can also be found.
110 Mini-tunnel allow to seed early and thus to harvest early and to beneficiate from better prices. It is a cropping technique which demands more labour: the plastic must be taken off in order to apply the chemical treatments. All the farmers in the valley used tarpaulin –sheich in Arabic- to protect zucchini from insects.
111 Pakistanis are mostly located in the middle-south area and can be roughly divided into two main groups. Some came during the 1970s and manage now to rent 90 to 120 dunums, the other came during the 1990s and now rent only around 30 dunums. They all began to work as agricultural employees during the winter in the valley and as workers in some tobacco factory in the *Highlands* during the summer. Then they manage to rent their farm thanks to a Jordanian front name. Indeed, foreigner people do not have the right to rent land in their name; they need one Jordanian person to play the role of a front man for the government. It is worth noticing than in 2001, a land-market has been created since purchase and selling have been allowed for Jordanians. Only Jordanians can buy or sell plots of land to people who want to increase the surface of their farm. The absence of any land market before 2001 is the main explanation to the persistence of small extensive familial farming systems within the valley we are describing here. This creation of a new land-market should thus have big consequences on the agriculture in the Jordan Valley.
112 Palestinian mostly fled in 1948 and settled down in the Eastern Side of the Jordan Valley, restricting their livestock farming –they still have some animals (sheep's, goats). Despite the low price of the land at this time (around 200 JD-of-2000/dunum) they did not buy any plots because they were planning to return to Palestine according to a declaration of the United Nations.
113 The existence of a large numbers of renters and sharecroppers underline the fact that there are a lot of owners with little relations to their farms. It is possible to find very large landowners belonging to a family which has beneficiated from the land reform. These owners can have until 1.000 dunums and they mostly rent the parcels or have sharecropping contracts on which vegetables are grown -like described below. They also often keep one or two units to plant citrus. These citrus-farms have a more important social and prestige value than an economic one as we will see it after.

	Yield (T/ha/crop)					
	North and middle-north valley	Middle valley				South valley
	Drip Mulch or Drip Mulch+ Minitunnel	Small rented farm (drip/mulch & Minitunnel)	Sharecropping (drip/mulch & Minitunnel)	Large rented farm	peculiar farms	Sharecropping arrangment Mulch/Drip
Tomato	40 to 60	30 to 50		40 to 60		
Zucchini	20 to 25 (15 in association in the north)					
Eggplant	25 to 30 (associated) 120 to 130 under mini tunnel	40 to 50				
Green Bean	4,5 to 5 (associated)	6 to 12				
Potato	20 to 30		50 to 60			
Pepper			20 to 30			
Melokhia		2.5 to 5				
Corn		15 to 20				6 to 8
Cauliflower				15 to 20		
Cabbage				100 to 120		
Parsley					25 to 30	
Mint					15 to 20	

	Market Price (JD/T)						
	North and middle-north Valley		Middle valley				South valley
	Drip Mulch & Minitunnel	Drip Mulch	Small rented farm (drip/mulch & Minitunnel)	Sharecropping (drip/mulch & Minitunnel)	Large rented farm	peculiar farms	Sharecropping arrangment Mulch/Drip
Tomato	70 JD (100 $)						
Zucchini	180 JD (250 $)	150 JD (210 $)	115 JD (160 $)		130 JD (180 $)	115 JD (160 $)	
Eggplant	150 JD (215 $)	140 JD (200 $)					
Green Bean		500 JD (700 $)	300 JD (420 $)				
Potato	200 JD (280 $)			120 JD (170 $)			
Pepper				140 JD (200 $)			
Melokhia			125 JD (175 $)				
Corn			200 JD (280 $)				200 JD (280 $)
Cauliflower					100 JD (140 $)		
Cabbage					70 JD (100 $)		
Parsley							
Mint							

Table 12. Yield and market prices of the main vegetables cropped in the valley

- In the village Karamah, some small landowners or sharecroppers work on their own on around 30 dunums and plant Mint and Parsley on half the farm's surface and classical crops on the remaining area. It is a familial farming system.

- In the *Hisban-Kafrein area*, vegetable farming is closely linked to the bananas production. Bananas landowners have always vegetables plots. Two systems exist: the vegetables plots are managed by a sharecropper who earns a share of the farm profit or by permanent salaried employees.

On a general point of view, it is worth noticing the proportion of sharecropper increases when going southwards[114]. In a typical sharecropping contract, costs and benefits are shared at a 1:1 rate between the owner and the sharecropper. In addition to that, it is common that the owner[115] brings the land and advances all the costs. At the end of the cropping season, and through the production marketing, the owner gets a refund on half of its annual investment. The remaining product is then shared between the owner and the sharecropper. The sharecropper (which can be either Palestinian or Pakistani or even Egyptian) manages the farm with his family[116].

- Yield and prices observed

The two tables on the page besides show certain homogeneity of the yields observed in the entire valley. For almost all the crops, the yields advanced by the farmers where quite equivalent. Eggplant and potatoes do exception. For potatoes yields are higher in the middle-south and the south valley than in the northern part of the valley, for eggplants it the contrary. For potatoes the difference observed may be linked to the variety cropped. The one cropped in the south allows higher production but is not-well-marketed; it is the contrary for the 'northern variety'.

For the prices, the general tendency is that:

- Prices are higher when crops are planted under mini tunnels than on simple mulch (see the case of the north of the valley)

- Prices are higher in the north than in the south, what is directly linked to the production quality better in the northern parts of the valley.

- Crop sequences

Farmers do in general two cropping seasons each year. We can differentiate autumn/winter crops (potato, zucchini, cabbage, cauliflower, lettuce, spinach, Sweet and hot pepper, green bean, onion) and spring crops (tomato, eggplant, green bean, hot pepper, zucchini, melon and melokhia)[117].

Concerning the cropping sequences and the cropping pattern -see the following page-, we observe important differences between the north/middle-north and the middle-south/south areas. That is mainly due to the climatic conditions -cf. the description of the climatic conditions before. Moreover, familial farmers develop more diverse cropping pattern since they plant more kind of vegetables than the entrepreneur farmers. This pattern allows softening the impact of the market-price fluctuation on the farmer Net Revenue.

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[114] Sharecropping is typical of areas where profit is not sure and depends on a lot of labour and/or inputs.

[115] What we call an owner here is the person who brings the land in the contract. This owner can be a true owner or can be an agricultural merchant who rent in the land (to another person). In this last case, another clause is often included in the contract: the farmer who crops the plot must sell his production to the merchant and this one receives the commission on the sale.

[116] He very rarely employs some daily employees during the rush period of labour.

[117] Crops planted depend on soil and microclimates. In stony soil, farmers prefer to plant potatoes in winter and zucchini after. In soil where potatoes are impossible, zucchini have more importance and is cropped with cabbages and cauliflower (or lettuce and spinach). During spring, the tomato is the most important crop in the northern cropping pattern.

The following tables present the cropping pattern used in our models[118]

- Vegetables under drip and mulch in the north and middle-north areas

Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.
Squash (1/3)					Tomato (2/3)					(Melokhia)	
	Potato (1/3)										
Eggplant (from prev. year)		Potato (1/3)			Eggplant associated with green bean (1/3)						

- Drip-mulch & Minitunnel system in the north and middle-north areas

Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March.	April	May	June	July	Aug.
	Potato (1/3)				Tomato (1/3)					Short fallow	
		........*Mini-tunnels*...... Squash and eggplant (1/3)									
Eggplant (from prev. year)				Potato (1/3)			Short fallow				

- Drip-mulch & mini tunnel small rented farm in the middle and south of the valley

Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March.	April	May	June	July	Aug.
		Mini tunnels Tomato (1/6)						Corn or Melokhia			
		Beans (1/6)									
	Zucchini (1/6)				Zucchini (1/6)						
	Eggplant (1/2) -harvest from February to May-										

- Drip-mulch & mini tunnel farm with a sharecropper arrangement -middle and south of the valley

Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March.	April	May	June	July	Aug.
…Mini tunnels… Tomato (1/6)					Zucchini or pepper (1/6)			Corn or Melokhia			
	Zucchini/pepper (1/6)			Zucchini or tomato (1/6)							
Potatoes (1/6)											
	Eggplant (1/2) -harvest from February to May-										

- Drip-mulch & mini tunnel large rented farm -middle of the valley

Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March.	April	May	June	July	Aug.
…Mini tunnels… Tomato (1/6)					Zucchini or pepper (1/6)			Corn or Melokhia			
	Zucchini/pepper (1/6)			Tomato or tomato (1/6)							
	Beans (1/6)				Beans (1/6)						
Potatoes (1/6)											
Cabbage or cauliflower (1/6)											
	Eggplant (1/2) -harvest from February to May-										

- Drip-mulch farms in the middle-south of the valley (in farms where parsley and mint are cropped on half the surface)
- Drip-mulch farm in the south of the valley –farm with a sharecropping arrangement or owned farm.

Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March.	April	May	June	July	Aug.
Tomato (1/4)								Corn or Melokhia			
Zucchini (1/4)					Zucchini (1/4)						
	Eggplant (1/2) -harvest from February to May-										

In the south, around the village of Karamah, mint and parsley are cropped. The parsley's seedling is done in October and November, 4 or 5 cuts are done between December and April. Mint is planted in March/April and harvested in November/December.Pepper appears in the "southern cropping pattern" considered in our model while it is not a 'reference' crop in the northern Jordan Valley.

[118] The figures in parenthesis represent the proportion of the farm cropped according to the crop sequence considered. If a crop sequence represents 1/X of the farm surface, it means that it is done every X years on the same plot: the rotation lasts X years.

- In the south and the middle-south areas, eggplant considered by the farmers as the *'dairy cow of the region'* has more importance than in the north in the cropping patterns considered. On the contrary, potatoes have less importance.

- In the southern part of the valley, the first crop lasts from September/October to January (like in the north) but the second crop is shorter than in the north and ends in May. After May, only corn, melokhia (and eggplant in a less extend) can support temperature higher than 40°C and thus can stay in the fields while in the northern part of the valley all the crops can be harvested until June

- In the southern part of the valley, there is a clear difference between short-cycle crops (tomato, zucchini) and long-cycle crops (eggplant, potatoes) while it is less clear in the northern part of the valley.

Concerning their equipment, these vegetables farmers rent the land preparation equipment. In the north and the middle-north they also rent the trucks to do the transport while in the middle-south and the south, farmers own their own trucks.

- Net economic return

The summary table on the following page shows the Net Return brought out in all the farming systems producing vegetables in open field. Two main dynamics can be underlined:

- The revenue per dunum is higher in the farm where mini tunnels are used,

- The revenue per dunum is higher in familial farm than in entrepreneur's farm. Actually the family only employs few workers and manages closely its farm: it has positive impacts on the farmer's revenue. We can see that, excepted in the very south of the valley, there isn't any difference between a sharecropper and renter: profits registered are similar.

- It is worth noticing the peculiar crops (Mint and parsley) allow a higher return than classical crops.

- There is a global homogeneity in the profit brought out in the middle and the south of the valley but it is worth noticing that in the north, the Gross Output (value of production) is higher than in the middle, but as costs are also higher (fertilizer, pesticides and above all wages), Net profits are similar.

The chart shows the sustainability of the familial farms by bringing the average net profit brought out to the number of familial workers in the farm[119], we can observe that:

- The entrepreneur farms in the north of the valley are the systems which allow bringing out the highest profit per familial worker (at least 6.000 $/worker with drip and mulch and 14.000$/worker with mini tunnels).

[119] The 'surface' in dunum per familial worker is not always the effective surface cropped by each member of the family. There are some farming systems in which the family is working and also employs some permanent employees. To determinate the surface per familial worker we just have divided the farm surface by the number of familial workers working (management or field work) in the farm. On a technical point of view, in open field farming systems, a permanent worker (familial or employee) can take care of 30 dunums maximum. When there are greenhouses, a permanent worker can take care of 5 to 10 greenhouses (3 to 6,5 dunums) maximum.

For all the farming system, the net return indicates the Net Profit excepted for sharecropper's owner for which we have calculated the return on investment			Surface (dunum)	Net return (JD/du) Bad year	Net return (JD/du) good year
North and middle-north Valley	Familial rented farm	Drip, Mulch & Mini tunnel	30	320 JD (445 $)	445 JD (620 $)
		Drip, Mulch	30	135 JD (190 $)	345 JD (480 $)
	Entrepreneur's farm	Drip, Mulch & Mini tunnel	30 to 60	270 JD (380 $)	395 JD (555 $)
		Drip, Mulch	30 to 60	85 JD (120 $)	295 JD (415 $)
Middle Valley	Small familial rented farm (drip, mulch & Mini tunnel)		30	200 JD (280 $)	310 JD (440 $)
	Sharecropping (drip/mulch & Mini tunnel)	Sharecropper	60 to 90	125 JD (175 $)	165 JD (235 $)
		Owner		25 JD (40 $)	130 JD (180 $)
	Large familial rented farm		90 to 120	115 JD (165 $)	255 JD (360 $)
	peculiar farms	owned familial farm	15 to 30	235 JD (330 $)	335 JD (470 $)
		Sharecropper	15 to 30	145 JD (205 $)	190 JD (265 $)
		sharecropper's Owner	60 to 120	50 JD (75 $)	120 JD (165 $)
South Valley (vegetables systems closely linked to bananas farms)	Sharecropping arrangement Mulch/Drip	Sharecropper	30 to 90	70 JD (95 $)	105 JD (145 $)
		sharecropper's Owner	150 to 300	70 JD (95 $)*	120 JD (165 $)*
	Familial Owned farm		25 to 50	40 JD (60 $)	120 JD (165 $)

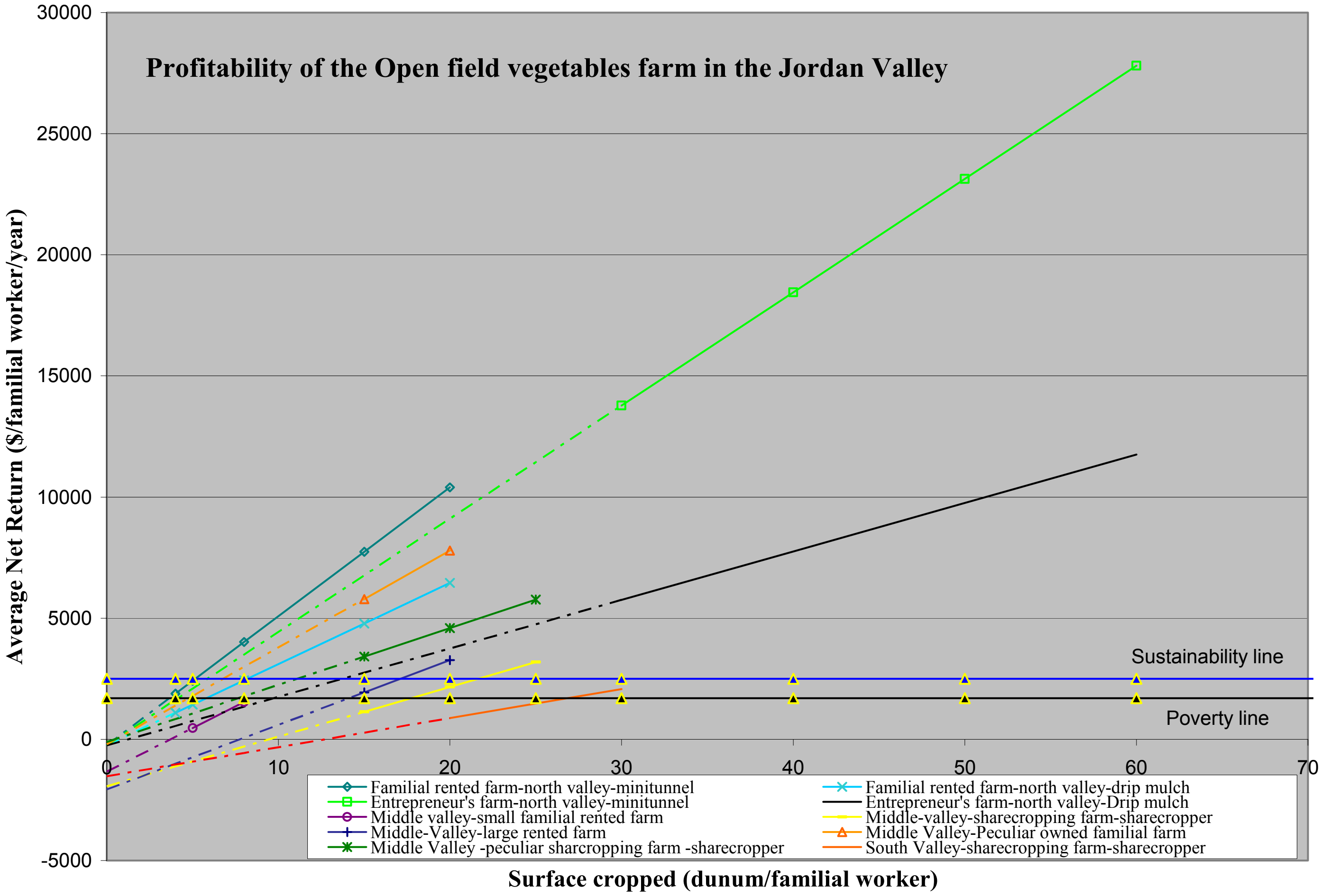


Figure 15 Net Return and Economic profitability of the open field vegetables farms in the Jordan Valley

- Familial farms in the north of the valley are above the sustainable line if each familial worker takes care of more than 8 dunums and above the average value of agricultural loan per borrower if each worker takes care of 11 dunum

- In the middle and the south of the valley, the situation is badly. Actually, if peculiar crops allow developing some sustainable farming systems, it is not the case for the classic crops. Large rented farms bring out a profit per familial worker just higher than the poverty level. Sharecropper in the middle of the valley earns the equivalent of a salary of a permanent worker[120] if each familial worker takes care of more than 20 dunums. Sharecroppers in the south of the valley and above all small tenants in the middle of the valley are in the worst situation. The revenue they can bring out from their farming systems is below the poverty level, the system seems to be unsustainable and its future is thus questioned[121].

- In conclusion, farms in the middle-south of the valley are less profitable than the one located in the middle-north of the valley.

(ii) Greenhouses vegetables farms

- Introduction

As we said it before, most of the greenhouses are concentrated in the middle of the valley, around the village of Deir Alla, while few greenhouses farms are spread southwards of Al-Arda.

Greenhouses allow controlling the temperature and the humidity all along the year, and allow producing vegetables in winter (when the prices are higher). Tomato, cucumber, melokhia, melon, hot and sweet pepper, eggplant, bean and more rarely some export production (strawberries, cut flowers…) can be found under greenhouses. Moreover, in comparison to mini tunnel, greenhouses have several advantages. It allows a better control of humidity and temperature, there is no need to remove the covering-plastic for the treatments and the wire-stakes allow a vertical development of the plants implying a higher and longer production.

Compared to the equipment needed in open field (cf. above), investments for greenhouses are very expensive. One greenhouse to be installed on 650 m² (500 m² of cropped area and an empty space on each side), costs about 1,500 JD (2.100 $) and in order to make it profitable, the soil has to be sterilized each year (which is also a costly technique). This sterilization was done before thanks to the methylbromide which is now forbidden by international laws. Solarization is the method now in use[122]. Indeed sterilization prevents self-propagating weeds, nematodes and fungus development and allow to preserve the crops and thus to keep a certain level of production. After sterilization, no weeding is required but pesticides still have to be applied every week.

One disadvantage of the greenhouses is that, after 5 years, farmers observe a decrease in yields. The reasons of this decrease are not clear. It might actually be linked to a loss of efficiency in

[120] We have considered that the salary of a permanent worker in agriculture corresponds to the poverty level.

[121] Here, we have tackled neither the debt nor the family solidarity, two social and political issues which are difficult to look into. The debt is structural information of the farming system and could modify the entire modelling. Farmers could actually do the needed investments on their farms by getting in debt. By ignoring this debt we thus have over evaluated the depreciation non proportional to the surface (corresponding to the investments in the equipment of the farm) which dictates the intercept of the lines. The familial solidarity seems to be very effective as a local cooperation and a mutual aid (social and economic) and by ignoring it; we could have under (or over) estimated the non farm income of these poor farmers. Thus, their true revenue could be higher (or lower) than the one presented on our charts. This point will be further studied and studied as a crucial issue in one of the following chapter of this book. We can however already say that these familial vegetables farmers in the middle of the valley have difficulties to reimburse their debt (in most of the cases a seasonal one - cf. box on poverty) since the revenue per familial worker is lower than the average loan per borrower. Farmers thus get further in debt and become more and more dependant on Credit Corporations or agricultural merchants.

[122] See appendix for a description and an explanation of the solarization method and of the greenhouses-operational sequence.

the soil sterilization mechanism but it also might be linked to a soil salinization, linked to an over-fertilization… Only the consequence is clear: farmers have to move their greenhouses every five to eight years. It is worth noticing here, the decrease in yields observed is only one of the reasons explaining the farmers' mobility within the Jordan Valley. This process (mobility of the farmer) and the linked dynamic agricultural landscape within the Jordan Valley is actually mainly related and due to the particular land tenure in the Valley and mainly to the importance of lessees throughout the farmers' communities. This peculiar relation to water and the periodical displacement we observed have for sure economic impact on the farming systems developed within the valley[123] but have also more global impacts on farming (generally speaking) in the Jordan valley and can explain some of the processes observed [124].

- Land tenure

We can mainly identify three main farming systems spread as follow

- Two different farming systems in the region of Deir Allah:
    - Some rich entrepreneurs having farms of 15 to 200 dunums. All the work is realized by permanent workers managed by one wage-earning manager. The entrepreneur can be involved or not in the management of the farm. In these farms the proportion of greenhouses reaches 80% of the farm surface.
    - Familial farmers managing a farm of 15 to 100 dunums. Half of the work is done by the family, the remaining by permanent and daily employees. The proportion of greenhouses reaches 50% of the farm surface[125].

- Southwards of Al-Arda[126], we can find some examples of farmers who have greenhouses. It is entrepreneur farms. This system is an intermediate one between the two previous. The farmer manages the farm on his own (surface included between 100 and 200 dunums) and all the field work is done by permanent employees. These farmers do important investments, use modern techniques and are mainly oriented towards an export market. Because of the climatic conditions, the proportion of greenhouses does not exceed one third of the surface.

Picture 16. Greenhouses in the northern Valley (left) and in the southern valley (right)
(Source: MREA, 2003)

[123] Even if limited (according to some surveys: 50 to 75 JD/greenhouses)
[124] We can for example quote the deterioration of the soil quality, the thieves of water, the difficulties to implement water and producers associations which are linked to this peculiar relation to land leading the farmer not to get involved in perennial farming practices (on the long term). This point will be studied in further details in a following section.
[125] This kind of farms is mostly found in the north of Deir Alla.
[126] It is worth noticing that farmers having greenhouses in this area always have a supplementary source of water added to the water delivered by the JVA. They either pump directly in the canal or have their own well in order to put between 6 and 8 mm/day/du.

In each of these systems, there is no global dynamic concerning the land tenure: Some farmers are tenant, other owners. We have thus considered, in our models, that half of the land is rented, the remaining being owned. Moreover, it is worth noticing that the management of the plots planted with vegetables in open field in these farms is done according to the different description realized above for the north of the valley.

- Structural characteristics of the farm and crop sequence (Tables on the following page)

Crops planted under greenhouses are the same within the three farming systems (Cucumber, tomato and pepper). Differences are linked to the proportion of greenhouses within the farm, to the quality of the production, to crops planted in open field and to the level of equipment. Two categories can be done:

- The rich entrepreneurs both in the area of Deir Alla or more south invest a lot in their farm. They own the land preparation material (tractor, truck…); they crop high value crops in open fields (melon, lettuce, potatoes for export) by importing expensive seeds from Europe and are mainly oriented towards a high-quality-export market and can have their own export-channel

- On another hand, the familial farmers (area of Deir Alla) only own the irrigation system and crop classical crops mainly sold on the local market.

- Yield and market prices observed

The table on the following page summarizes the yields of crops grown under greenhouses. We observe that, for the same crops, yields are four times higher than in open fields (Tomato, pepper). For cucumber yields are similar all along the valley, while for pepper, yields are lower in the south.

- Economic return

We can summarize the Net return of the greenhouses farms in the following table:

	Entrepreneur farms in the region of Deir Alla	Familial farms in the region of Deir Alla	Greenhouses farms in the southern part of the Valley
Net return in bad year (JD/du)	300 JD (420 $) *	180 JD (255 $)	160 JD (230 $)*
Net return in good year (JD/du)	740 JD (1035 $) *	445 JD (625 $)	240 JD (335 $)*
Average net profit per familial worker and per year (Range according to the surface cropped per familial worker)	8.550 to 21.765 $	11.520 to 157.590 $	32.875 to 92.575 $

Table 13. Net Return ($/dunum) in Greenhouses farms in the Jordan Valley

This table shows that, if we consider one agricultural area, the net return brought out in farming systems using greenhouses with modern techniques and high investments for a production oriented towards a high-quality export market (entrepreneur farm) is very higher than for systems where vegetables are cropped in open field. Moreover, it is worth noticing that because of the climatic conditions, the advantage obtained from the greenhouses is comparatively very higher in the north than in the south of the valley.

In addition to this first observation, the revenue brought out per familial worker is always higher than the sustainable line, it means that these farming systems are very profitable and will be developed in the future. This point has been confirmed by our surveys since the process of intensification by multiplication of the greenhouses (and decrease of the average surface of the farm) is still running in the Jordan Valley.

Cropping patterns used in the models

- Rich entrepreneur in the region of Deir Alla

Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mach	April	May	June	July.	August
Soil Sterilization				**Tomato + pepper Under greenhouses** (40% of the surface)					Short fallow		
Soil Sterilization			**Cucumber under greenhouses** (40% of the surface)					**Melon Under greenhouses**		Short fallow	
	Lettuce 1			**Lettuce 2**			Short fallow (20% of the surface)				

- Familial farms in the north of Deir Alla

Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mach	April	May	June	July.	August
Soil Sterilization				**Tomato + pepper Under greenhouses** (25% of the surface)					Short fallow		
Soil Sterilization			**Cucumber under Greenhouses** (25 % of the surface)					***Melokhia***	Short fallow		
Open field with mulch (50% of the surface) (Zucchini, potato, eggplant, tomato) Same cropping pattern than the system Drip-mulch open field system presented in the middle-north of the valley											

- Entrepreneur farms in the southern part of the valley

Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mach	April	May	June	July.	August
Soil Sterilization				**Cucumber under greenhouses** (1/6 of the surface)				Short fallow			
Soil Sterilization				**Pepper under greenhouses** (1/6 of the surface)				Short fallow			
			Potatoes (1/3)								
			Eggplants (1/6)								
		Tomato (1/6)				Zucchini (pepper)			Melokhia or Corn		

Yield and Market Prices of crops grown under greenhouses

	Yield (T/ha)			Price (JD/T)		
G is used for greenhouse	Entrepreneur farms in the region of Deir Alla	Familial farms in the region of Deir Alla	farms in the southern part of the Valley	Entrepreneur farms in the region of Deir Alla	Familial farms in the region of Deir Alla	farms in the southern part of the Valley
Tomato	185 to 245 (12 to 16 T/G)	185 to 245 (12 to 16 T/G)		125 JD (175 $)	100 JD (140 $)	
Cucumber	100 to 125 (6,3 to 8 T/G)	100 to 125 (6,3 to 8 T/G)	100 to 130 (7 to 8,5 T/G)	200 JD (280 $)	140 JD (195 $)	185 JD (260 $)
Pepper	80 to 100 (5,2 to 6,5 T/G)	80 to 100 (5,2 to 6,5 T/G)	60 to 90 (4 to 6 T/G)	85 JD (120 $)		
Melokhia		15 to 25 (1 to 1,5 T/G)			250 JD (350 $) per G before harvest	
Melon	80 to 90 (5 to 6 T/G)			150 (210 $)		

Concerning the familial farms, the Net return brought out per dunum is within the same range than the one brought out in the most intensive open field farming systems of the northern valley. However the structural characteristics of the farm allow the family to earn a higher amount of money per familial worker.

- Other systems under greenhouses

  - Nurseries which produce small plants of vegetables (and more rarely fruit trees: citrus, bananas and olive trees use a black scheich to protect their crops and are spread all along the Jordan Valley.

  - Some farmers use raised up greenhouses which could cover a surface of 3 to 5 dunums. This new technique is still very rare in the valley and very expensive. It allows to crop trees under the greenhouses and to have a better control on the temperature and the humidity.

  - On the contrary there are also very small tunnels, their presence is anecdotal and only three lines of mulch can be cropped under.

(iii)Citrus farms

Citrus farms can be found both in the north and in the middle of the valley. The colder conditions of the north are more beneficial to this crop than the hotter conditions in the middle.

- Land tenure

Picture 17. Citrus plots in the north of the valley

(Source: MREA, 2002)

Most of the farmers are owner of their plots and manage their farm in a more or less extensive way of cropping. We can distinguish two sub classes of citrus farm both in the north and the middle of the valley[127].

- Familial farms on 30 to 60 dunums, extensively cropped (surface irrigation, little fertilizer) if farming is not the main activity of the owner (part time farmer, retired person…) or more intensively cropped (drip or open tube irrigation) if farming is the main activity of the owner. The family works in the farm but there is often one permanent employee.

- Absentee owner farms extensively cropped on 10 to 50 dunums on average (up to 200 dunums). All the work is done by permanent employees who can take care of around 30 dunums. The social and the prestige value of these farms seems to be more important that their low economic value. The farm is often organized around a villa, the orchard being instrumental for some urban residents.

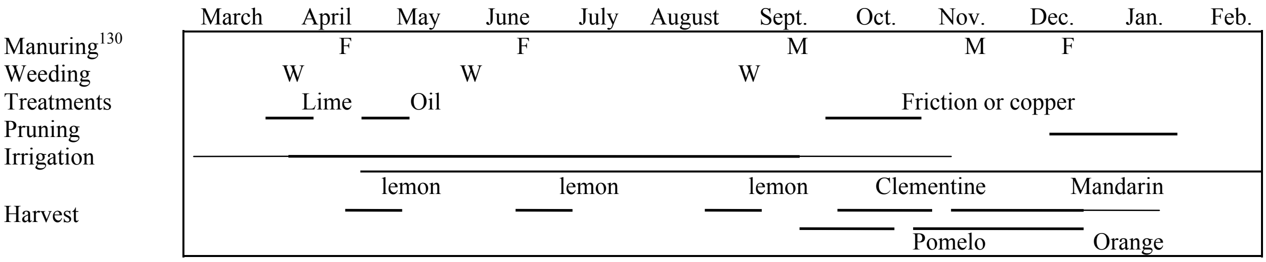
[127] The proportion of familial farms is higher in the north than in the south for the historical reasons we have described before.

- Cropping pattern

The orchards are constituted with many different species (Clementine, mandarin, lemon, various oranges…) in order to minimize the risks linked to the price variations[128]. Pomelos and Orange trees allow a better net return than Clementine and mandarin trees[129]. On average, 28 trees are planted per dunum (6*6 meters) and palm or olive trees are often planted on parcel's borders to protect the plantation from the wind. Farmers rent the land preparation material and trucks to send the production to the central market in Amman or Irbid. In orchard, the question of the trees' maturation is central. The orchard has to be renewed every 30 years, the yield being decreasing after 25 years of cropping when the evolution to reach the maximum yield is as follow:

	Year 1 & 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8 and after
Orange, Pomelos	0 %	0 %	0 %	50	70 %	90 %	100 %
Lemon, Clementine, Mandarin	0 %	50 %	75 %	100 %	100 %	100 %	100 %

- Crop Sequence



Citrus harvest period goes from September to March. The fruits are packaged in polystyrene boxes and sold on Amman's or Irbid's central market. After the harvest, the trees are pruned (February-March). From April to October, the plantation must be regularly irrigated, and should be weeded 2 or 3 times. Chemical treatments usually occur in the beginning of summer but they are more and more neglected by the farmers. Manure is applied below each tree after the first rains.

- Yield and Prices observed

Kind of trees	Production (T/ha)				Prix de vente (JD/T)	Prix de vente ($/T)
	Good year		Bad year			
	Intensive	Extensive	Intensive	Extensive		
Lemon	31	22	21	15	160	225
Clementine	33	23	22	16	95	135
Mandarin	33	23	22	16	110	155
Orange « navel » trees	24	16	16	11	300	420
Orange « *shamouti* » trees	24	16	16	11	160	225
Pomelo	35	25	23	17	125	175

[128] Since a few years, some familial citrus farmers began to plant other trees as mango, papaya, guava, dates, pecan nuts and others which constitute a higher investment, need more time to produce but bring a higher profit when the time of production is reached. It could be one of the answers to the problem of overproduction of citrus fruits.

[129] There is actually now a chronicle overproduction of clementine and mandarin in Jordan which can be explained by the fact that farmers have chosen to plant such trees because they reach maturity very quickly and sooner than the other citrus fruit trees (orange, pomelos…).

[130] F : chemical fertilizer, M : Manure, W: Weeding

- Economics

System	Intensive familial farm	Extensive familial farm	Absentee owner extensive farm
Net return (JD/du) Bad year	76 JD (107 $)	46 JD (65 $)	3 JD (4 $)
Net return (JD/du) Good year	126 JD (178 $)	110 JD (155 $)	53 JD (75$)

Table16: Net Return ($/dunum) in Citrus Farms in the Jordan Valley

This table show the low profitability of citrus farms in the Jordan Valley and the strong relations existing between the way of cropping and the revenue brought out. The more extensive is the farm, the lower the revenue is.

(iv) Bananas Farms

Bananas farms are located at the extreme north and at the extreme south of the valley as well as along small *Side Wadis* out of the JVA irrigation network schemes. Even if it is question of the same production, the farming systems are quite different. That is due to several parameters. On a general point of view, bananas farms in the south of the valley are more intensive in matter of work, fertilizer and water than the one located in the north of the valley. Actually, owners of farms are more involved in the management of their farms in the south than in the north.

- Land tenure

In the north, bananas farms are under drip or surface irrigation. They are owned by large entrepreneurs who choose to do an important investment in order to have a high economic-return[131]. The owner comes regularly in his farm to supervise the work of the employees and to supervise the harvest when merchants are coming to take the production. All the work is done by permanent employees helped by daily workers for harvest, pruning…

In the south, farms are all under drip irrigation[132] mostly owned by members of the Al-Adwan tribe (ashira). We can find small familial farms of 30 to 60 dunums of bananas and large intensive farms which can be divided into two sub-classes.

Picture 18. Bananas farm in the south of the valley

(Source: MREA, 2003)

- The familial intensive bananas farms (100 to 200 dunums with ¾ of bananas and ¼ of vegetables), managed by 5 to 10 familial workers who realized half of the work on bananas.

- The entrepreneur intensive bananas farms (200 to 400 dunums of bananas with ¼ of bananas and ¾ of vegetables under a sharecropping contract)[133], 4 or 5 familial persons are involved in the management, all the work being done by permanent employees as well as daily workers if necessary.

[131] It is also possible to find few absentee owners who developed mixed farming systems with three quarters of the farm's surface planted with citrus, the other quarter with bananas.
[132] Allowing a fertilization by fertigation
[133] The surface cropped with bananas depends on the water availability of the farm.

Moreover, still in the south we can find some small familial farmers who own between 30 and 60 dunums. They have a mixed farm: they plant bananas on ¼ to 1/8 of their farm according to the water availability, the remaining surface being planted with vegetables. All the work is done by the family. Whatever the farming system is, the land preparation equipment is rented.

- Water context

In the north, most of the farms only receive the JVA allocation of 8 mm/day/du[134]. On the contrary in the south, farmers receive water from the *Wadi Hisban* and from the Kafrein Reservoir but they also own one or two wells on their farm. By desalinating the well's water or by mixing it, in their pools, with the water coming from Hisban or Kafrein, they manage to put between 10 to 20mm/day/du. This is one of the main reasons explaining the difference observed in yields between the north and the south (cf.below).

- Yield & Prices of the production

	North of the valley		South of the valley		Small mixed farms (North & South Valley)
System	Surface irrigation	Drip irrigation	Small Familial farms	Large intensive farms	
Surface	10 to 50 on average (until 200 dunums)		30 to 60 dunums	*200 to 400 dunums for entrepreneur farm *100 to 200 dunums for familial farm	30 to 60 dunums
Yield	20 to 30 T/ha	30 to 40 T/ha	35 to 50 T/ha	50 to 65 T/ha	15 to 25 T/ha
Price	430 JD/T (605 $)	430 JD/T (605 $)	430 JD/T (605 $)	450 JD/T (635 $)	375 JD/T (530 $)
Average Product Value (JD/ha)	10 750 JD (15 050$)	15 050 JD (21 070 $)	18275 JD (25 585 $)	25 875 JD (36 225$)	7500 JD (10500 $)

The price of production depends on the bananas quality. 'Class A' or big clusters (more than 20kg) are paid 0,5 JD/kg on average while small clusters (less than 20 kg) are paid 0,25 JD/kg on average. Prices vary all the year long, and the best period seems to be in winter between the months of December and March when there is no other fruits in the market[135]. From one farming system to another the proportion of first quality clusters varies and so on for the average price of the production we have considered. Large intensive bananas farms in the south of the valley produce 80% of 'class A'-clusters while the others farms only produce 60 % of 'class A' clusters (50% for mixed farms). The production is sold to wholesale dealers, who are in charge of the maturation and transportation.

[134] This allocation is delivered for bananas orchards which existed before 1990. After 1990, there were no more bananas licensing. It means that, if farmers plant bananas after 1990, they received a basic allocation of 2mm/day/du or 4 mm/day/du according to their previous cropping pattern (vegetables or citrus). Often, owner, of mixed farm are in this case, they have a vegetable's water allocation but, because of the high profitability of bananas and of the low-intensive character of this crop (in comparison to vegetables crops) they prefer to develop an orchard on only one part of their farm and to irrigate it with their 'share of water' (they also plant vegetables on the remaining surface) than to plant vegetables on their entire farm.

[135] Stone fruits begin to be produced in March/April while the citrus' peak of production is reach from October to December.

- <u>Crop sequence</u>

Jan.	Feb.	March	April	May	June	July.	August	Sept.	Oct.	Nov.	Dec.
		Seedling/ Digging out									
				Pruning (main period)							
					Treatments/weeding						
										weeding	
										Manuring	
						Récolte					

There are two periods of seedling: March and September. To avoid the young plants suffer from the cold weather which could postpone the production, farmers favor the March period. The first year, 110 plants per dunum are sowed; this density quickly increases year after year since one to three shoots by mother-plant are kept in the orchard. Harvesting can be expected from 9 months after seedling (for the more intensive farms) to 12-to-14 months (for the more extensive farms). It is done all the year long, the main period being in winter, between the months of December and March when the prices are the highest. Chemicals are regularly applied all the year long at a higher frequency in the south than in the north. In November, farmers apply sheep manure below each plant (once a year or once every two year). In the south the farm is divided into 4 to 6 plot, one being renewed each year, it means that, in the south, the orchard stays in place during 4 to 6 years while it stays 8 to 10 years in the north. When a plot is digging up the soil can either stays fallow (in the north and small familial farms in the south) or be planted with vegetables (large intensive farms in the south of the valley). This transition year aims at 'renewing' the soil fertility in order to continue the cultural cycle.

The variety the most frequently planted is the local one named *Baladi*, but some intensive farmers in the south use some tissues culture of bananas plants, more expensive but allowing a better yield.

- <u>Economic profitability</u>

	North of the valley		South of the valley				Small mixed farms (North & South valley)
System	Surface irrigation	Drip irrigation	Small Familial farms: Well owner	Small Familial farms: Purchase of water	Large entrepreneur intensive farm	Large intensive familial farm	
'Net return' (JD/du) bad year	172 JD* (242 $)	578 JD* (816 $)	902 JD (1270 $)	352 JD (493$)	450 JD* (635 $)	1000JD* (1410 $)	25 JD (40 $)
'Net return' (JD/du) good year	568 JD* (801 $)	930 JD* (1312 $)	1472 JD (2075 $)	972 JD (1361 $)	1045 JD* (1475 $)	1595 JD* (2250 $)	120 JD (170 $)

<u>*Table 17:*</u> Net Return ($/dunum) in bananas farms in the Jordan Valley

Added to the bananas activity described above, in large intensive farms located in the south of the valley, the vegetables activity can bring 95 to 170 $/du/year for entrepreneur farmers and between 60 and 170 $/du/year in large familial farms.

This summary table shows the high profitability of banana farming, even for the more extensive way of cropping (surface irrigation in the north of the valley). For the more intensive farming systems of the south of the valley, the net return can reach very high amount around 2.000$/du/year (the net profit being around 3.000 $/du/year). In the peculiar case of the mixed farms, the net revenue is very low -lower than most of the vegetable farming systems. Why planting bananas? Farmers in this situation are the less modern/intensive farmers in the valley; they prefer mixing their farms with bananas than planting only vegetables because it needs less work. Two explanations are possible:

- The family would not be able to take care of all the surface planted with vegetables and does not have the resources to employ workers. The family crops bananas because it need less time.

- Farming is not the only revenue of the landlord who thus prefers to insure a low revenue with an activity easier to manage.

- In the two cases, on average, the revenue brought out per familial worker is below the poverty level (1.300 $/person/year if the worker works on 35 dunums what is the maximum surface he can take care, to be compared to 1.700 $/year[136])

[136] Poverty level we have consider here (cf. explanation above)

Box 6. **Note on date Palm trees**

Within the last few years, the middle of the Jordan Valley has known an important development of large irrigated farms planted with dates palm trees in particular in the area where blended water is supplied.

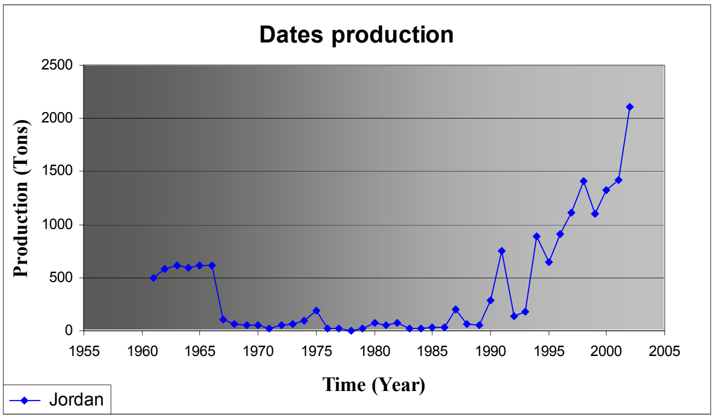


Figure 16. Evolution of Dates production in Jordan[137]
Picture 19. young palm trees farm in the middle of the valley (Source: MREA, 2003)

The chart above shows the strong increase recorded in the production of dates in Jordan during the last ten years. From 1993 to 2003, the production has been more than multiplied by 10 from 176 to 2110 tons.

This culture is actually well adapted to the sandy soils of the middle and the south of the Jordan Valley. Moreover, dates palm trees easily bear water with a high salinity and no decrease in yield due to the water quality (ECw=1,9 dS/m)[138] is yet recorded. It is a crop which consume a small amount of water (the farms are now supplied by the JVA with the 'citrus allocation' which reaches 840 m^3/du/year during the controlled period –cf. the section dealing with water management in the Jordan Valley). The implementation of these farms require a high investment (around 840 $/dunum) which is done on large surfaces (around 150 to 200 dunums). The total initial investment is thus included between 125.000 and 170.000 $/farm, an equivalent amount of the large bananas farms located in the south of the valley (cf.appendixes). Moreover, trees begin to produce only after 5 to 6 years and the maximum of production is reached when the orchard is 10 years old (on average an orchard can be kept at least during 30 years). The orchard needs an important involvement and a close management in order to be maintain in good conditions for the productivity. The owners of these farms are therefore large rich land investors developing an intensive farming system. The farm is a true 'agricultural firm'. The owner is involved in its management and mainly on the commercial aspects. All the work is done by permanent qualified employees managed by a foreman who often belongs to the owner's family. The varieties cropped are diverse and the production can be sold on the local market or on the export market to the Gulf Countries. With an important post harvest work, the production can be very well promoted and the revenue is expected to reach **1.500 to 2.000 JD/du/year** (2.100 to 2.800$/dunum) that is a similar amount than the highest revenue brought out in the large intensive Bananas Farms in the south of the Jordan Valley.

We will see that date palm trees farms, because of their low water consumption, their non sensibility to salinity and the high return it allows could be strongly developed in the following years in the Jordan Valley if the market conditions remain. Further study on the dates chain in Jordan and in the Middle East have to be developed in order to have a better knowledge of the potential which exists for dates palm trees development.

[137] *Source* **MEDAGRI.** Yearbook of Agricultural and Food Economies in the Mediterranean and Arab Countries. CIHEAM-IAMM. 1995,1998,2003.

[138] *FAO 29* indicates that yield of 100% of the potential yield can be obtained with a water with an ECw of 2,7dS/m.

IV.4.3 'Groundwater Farming Systems' of the Highlands

We will describe here, the farms irrigated thanks to groundwater abstraction. These farms are mainly located in the *Eastern Desert Area, the Upper Yarmouk the Transition and the Suburban Areas*. Farms are large: 15 to 30 hectares in average (against 1,5 to 10 ha in the valley)[139]. That is due to the high renting costs or to the high installation costs[140] notably linked to the well's drilling, the pumping system, the fences, the wind protection and irrigation system which always is an efficient pressurized "on farm" system. We will organize our description around three "large groups" of farming systems: the open field vegetables farms, the greenhouses vegetables farms and finally the fruit trees farms. Then we will present the heterogeneity of the situations within each of these groups

(i) Open field vegetables farm

A large diversity of farming system can be described here. They differs one from each other essentially in function of the 'land & water tenure'. Concerning the price of vegetables, it mainly depends on the quality of the production. Around 15 to 30% of the production has a high quality, is exported and paid 50% higher than the 'common production'.

- Land tenure

Contrary to what was the case in the valley, the land tenure is one of the main parameters affecting the farming systems. Owners of land and tenants do not developed the same way of farming. It is mainly due to the renting costs quite higher than in the valley (cf. the box on water considerations on the following page). We can identify three main categories of farms and farming systems:

✓ Rented farms

Agriculture is the main activity of the tenant. In the *eastern desert*, rented farms are familial farms of 200 to 250 dunums[141]. Half of the work is done by the family, the remaining by permanent and daily employees. In most of the cases, farmers are ancient Bedouins (from Jordan or Palestine) who settled down in the area, in the early 1980s, after giving up their livestock farming when agriculture was a very profitable sector. The family owns trucks to transport the production and rent the land preparation equipment.

In the *Upper Yarmouk Area,* tenants rent a well and irrigate a smaller surface than in the eastern desert (50 to 100 dunums), he only does the management of the farm, some permanent employees doing the field work. The tenant only owns the truck and rent the land preparation material

✓ Owned farms

In most of the cases, the farmer is a Jordanian Bedouin who settled down in the area during the 1980s or the 1990s. The farm is organized around two plots: a vegetables plot on 200 to 250 dunums and an olive tree orchard of 100 to 200 dunums[142]. The family has kept one part of this important herd (sheep and goats). Generally, on the farm, one third of the work is done by the family[143], the remaining by permanent employees. The farmer owns the land preparation material and some trucks to transport the production to the central market in Amman.

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[139] This figure is an average range. We will see in the following pages that this figure is well adapted to evaluate the surface irrigated thanks to one well but it lacks precision to predict surface of farms if we consider that one farm is an area cropped by one man (and his family)
[140] See in appendix IV the evaluation of the initial investment for the different farming systems presented here.
[141] Small farms of about 100 dunums also exist.
[142] Olive orchards will be presented in further details in a following section
[143] It is also possible to find very few absentee owners who developed this kind of system without being involved in the farm management which is thus done by a wage-earning manager.

Picture 20.Rented or owned farm in the Eastern Desert (Source: MREA, 2003)

Picture 21. Typical sharecropping farm in the Eastern desert (Source: MREA, 2003)

Picture 22. Typical open field farm in the suburban area (Source: MREA, 2003)

Picture 23. Typical open field farm in the Upper Yarmouk Area (Source: MREA, 2003)

Box 7. **Well's renting and water consideration in open field vegetables farms in the Highlands**

The well's renting fee depends upon the flow rate of the well. Due to the peculiar vision of water the farmers have in this region, this fee is de facto directly linked to the surface cropped. Actually, all the farmers we have met had the same remark: *"we irrigate the maximum surface we can with the water we can pump from the well"*. In these conditions, most of the pumps are used at their maximum capacity. In the farmer's mind the well is rented with the land it 'can' irrigate according to its capacity. We can however evaluate the renting price of a land which can be irrigated at 10 JD/du/year (14 $/du/year).

The well is equipped with a pump moved by an electric or a diesel motor. The costs of exploitation (energetic costs, maintenance costs) are lower with an electric pump than with a diesel one but all the wells ca not be equipped with an electric pump (in some area there are problems with electricity supply). Concerning the irrigation system, farmers change pipes every 3 to 5 years regarding to the economic situation of his farm.

Calculation of the well rent cost

Until 2003, a well (200 to 300 meters deep) allowing to irrigated 200 to 250 dunums was rented at 22 500 $/year (with 3150 $ for the land)[144]. It means a total fee of 100 $/du/year (85 $ for the water only). According to our surveys, the water allocation for vegetables reaches 960 m^3/dunum (it means 4 mm/day on each dunum during 8 months of cropping: it is two times more than the average allocation for vegetables in the valley). Other evaluations[145] present a consumption of 600 to 650 m^3/dunum.

As farmers rent a well at a fixed fee (depending on the well and pump capacities), and use this one at its maximum of capacity on the corresponding surface, with a constant water allocation per dunum, we have considered in our models that tenants rent in a quantity of water which is proportional to the surface. If the consumption of water reaches 1000 m^3/dunum, the 'water-rent' fee corresponds to an average costs of 0,085 $ per m^3 and if energy costs (electricity/diesel) are added, the total cost for water reaches: 0,225 $ per m^3 (0,16 JD/m^3).

In comparison, land rent in the Jordan Valley reaches, on average, 35 JD/du/year while water costs are around 0, 020 $/ m^3 (0,015 JD/m^3).

For owner of wells, we have considered a depreciation of the well at 30 000 JD (42 000 $) on 25 years corresponding to the necessary investments to be done to maintain and operate the well.

In a variant of this system, the owner does not crop his own land but rents another plot he irrigates thanks to his well to plant vegetables in open field. It allows him developing a more intensive way of cropping like the farmers who rent their wells[146].

- ✓ Farms with a sharecropping contract

Two situations can be described according to the area considered.

- o In the eastern desert, the sharecropper manages a small surface including between 10 and 45 dunums often located near a village, this kind of farming not wide spread

[144] This price has already decreased of around 20 % to reach 18 000 $/year. The reasons of such fall in well's renting fees will be analyzed in further details in the following part of this report.
[145] Calculation of water consumption by the USAID-ARD 2001-study and calculation of water requirement by the National Water Master Plan (GTZ, 1975)
[146] It is actually worth noticing, the owned farm are more extensive than the rented farms because of the social position of the farmer who could have other revenues (members of the family working in other sectors, breeding activity…) and because the owner can not change the plot he crops every year.

and stays really limited. The contract is as follow: costs are shared[147] at a 1:1 rate between the owner[148] and the sharecropper (daily wages being paid if necessary by the sharecropper). The owner brings the land, the water and does the well maintenance; in exchange he takes 15% of the production. The sharecropper manages the farm. The remaining of the production (85 % minus the refund for the costs advances) are thens shared at a 1:1 rate.

- In the suburban areas, the owner brings the land, the water and the irrigation system in exchange of 50 % of the production. The sharecropper pays all the costs, manages the farm and receives 50 % of the production. This kind of contract shows the importance of the water in the area[149].

In these two systems all the work is done by the sharecropper's family with daily workers when it is needed. Moreover, the family often beneficiate of another source of revenue (the head of the family may earn for example a civil servant or an army pension, while a brother can have a job in another economic sector)[150]

- Yield and market prices

The table on the following page shows that there is no variability in yields between the farming systems observed within an agriculture area[151]. It is worth noticing that the tomato yield is higher in the *Highlands* than in the valley, it constitutes an exception since for all the other products it is the contrary. Because of easiness in marketing, prices are higher in the suburban areas than in more distant areas.

- Cropping pattern

Due to the low quality of the soil (low fertility, saline conditions and possible contamination by fungus) and to the quantity of fertilizer they put, farmers who rent their land change the plot they crop every year[152]. Some farmers can come back on the same plots after 4 to 5 years; others always find 'new' land by going further and further from the well.

We can see on the tables besides that there are two main cropping seasons. The first is done during the spring between March and July, the other one in summer from August to October/November. In the *Upper Yarmouk Area*, the summer crop is replaced by a winter carrot-crop from November to February. As in the valley, the crops grown are very diverse (tomato, watermelon,

[147] In fact, all the costs are paid in advance by the owner. Then, at the end of the cropping season, and through the production marketing, the owner gets a refund on half of its annual investment.
[148] The owner of the well often has several sharecropping contracts on 50 to 100 dunums. He also has a plot of olive trees (100 to 300 dunums). Farming is not the main activity of this absentee owner who has other sources of revenue often non agricultural.
[149] Refer to the section dealing with agricultural zoning and dynamics linked to water effective costs.
[150] It is worth noticing part-time farming and multiple-economy is relevant for almost all the farming systems and farmers within the *Basin* since half of the Jordanian population has been or is employed in a way or another by the state and the governmental institutions. Public-pensions and other non-agricultural revenues are thus one of the structural characteristics of the irrigated farming systems in the Lower Jordan River Basin and hold a particular importance in the more extensive and less productive/profitable systems.
[151] The sole exception is the sharecropping management in the eastern desert in which the tomato yield is lower than elsewhere. We will see by respect that this system is the les productive system of the area.
[152] It is worth noticing, each well is accompanied by a licensed area where it is allowed to crop thanks to the water pumped from the well. Normally, the farmer stays within this area but transfers his plots.

	Production (T/ha/crop)				Price (JD/T)		
	Eastern desert		Yarmouk Basin	Suburban Area	Eastern Desert	Yarmouk Basin	Suburban Area
	Other systems	sharecropper					
Watermelon	50 to 70	30 to 40			60 JD (85 $)		
Tomato	70 to 90	70 to 90		50 to 60	65 JD (90 $)		80 JD (115 $)
Cauliflower	12 to 15				65 JD (90 $)		
Cabbage	25 to 35			30 to 35	50 JD (70 $)		85 JD (120 $)
Sweet pepper	14 to 16				130 JD (180 $)		
Alfa Alfa	40				80 JD (115 $)		
Carrots			20 to 30			130 JD (185 $)	
Zucchini			17 to 25	35 to 45		115 JD (160 $)	
Potatoes			13 to 17			200 JD (280 $)	
Bean				12 to 15			300 JD (520 $)

Table 14. Yield and market prices of the main vegetables cropped in open field in the Highlands

The following tables present the cropping pattern used in our models

- Rented farm in the eastern desert

Jan.	Feb.	March.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
		Tomato (1/3)					Cabbage (1/9)				Alfa Alfa
							Cauliflower (1/9)				
							Sweet Pepper (1/9)				
		Water melon (2/3)					Tomato (2/3)				
Alfa Alfa on the surface cropped the year before											

- Owned farm in the eastern desert

Jan.	Feb.	March.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
		….Mini tunnel…. Tomato (1)					Cabbage (1/4)				
							Cauliflower (1/4)				
							Sweet Pepper (1/4)				
							Tomato (2/4)				

- Sharecropper's farm in the eastern desert

Jan.	Feb.	March.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
		Tomato (4/5)					Tomato (1)				
		Water melon (1/5)									

- Sharecropper's farm in the suburban area

Jan.	Feb.	March.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
		Tomato (1/3)					Zucchini (1/3)				
			Zucchini (1/3)				Tomato (1/3)				
		Cauliflower (1/3)					Bean (1/3)				

- Rented farm in the Yarmouk Basin

Jan.	Feb.	March.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
			Potatoes (1/4)					Short fallow		Carrots (1)…	
… Carrots (1) continued			Zucchini (1/4)			Zucchini (1/4)					
			Carrots (1/2)								

pepper, zucchini, cabbage, cauliflower). Tomato is predominant in almost all the farming systems[153] while watermelon is important for the rented farms in the desert[154].

In the eastern desert, one variant of cropping pattern can be described. Farmers cropped a smaller surface (50 to 100 dunums) with high-value crops (Parsley, Mint Sage). These crops are more water-consuming, need less inputs, and more work for the weeding and the harvesting. Their price is more stable and the gross output expected is higher than for classical crops[155]. In this case half of the farm is planted with these high value crops, the remaining with 'classical crops'.

- Economics

The table presented below shows that Net Returns are highly variable from one year to another due to important fluctuation both in yields and market prices. The most important variations occur in the owned farms which are the most extensive, while the sharecropping system allows stabilizing the revenue around a low range.

Each time farmers develop particular crops, the revenue they can expect is higher than with classical crops. Added to this summarized table we present on the page besides a chart to have an idea of the profit brought out per familial worker. As most of these farming systems are familial farms, this character is actually pertinent to describe the reality of this kind of agriculture.

		Average Surface (dunums)	Water use (m3/farm) average surface	Water price ($/m3)	Net return bad year ($/du)	Net return in good year ($/du)
Rented farm	Upper Yarmouk Area	50 to 100	45 000	0,35	60	340
	Eastern desert classic crops	200 to 250	215 000	0,225	40	180
	Eastern desert particular crops	50 to 100	??	0,225	55	235
Owned farm	Eastern Desert classic crops	200 to 250	215 000	0,14	5	100
	Eastern Desert particular crops	200 to 250	215 000	0,14	50	180
	Eastern Desert intensive classic crops	200 to 250	215 000	0,14	50	220
	Eastern Desert intensive particular crops	50 to 100	215 000	0,14	60	220
	Eastern Desert absentee owner	200 to 250	215 000	0,14	5	115
Farm with sharecropping arrangment	Eastern desert sharecropper	15 to 45	30 000	0	10	15
	Eastern Desert owner	100 to 200	144 000	0,14	15	25
	Suburban Sharecropper	20 to 30	12 500	0	60	109
	Suburban owner	100 to 200	75 000	0,14	391	513

Table 15. Net return ($/dunum) in Open Field farms in the Highlands

[153] Tomato has been defined by farmers as the *« dairy cow »* of farming in the *Highlands.*
[154] In these more intensive farms watermelon always represent 60 to 80% of the surface cropped during spring. Watermelon is interesting for the farmers because there is less variation in prices than for other vegetables (in particular tomato) and it seems to be less water-consuming. On another hand, watermelon needs better soil quality and that can be identified as one of the reasons explaining the annual-displacement of farmers from one plot to another. Another reason is the high level of fertilizer and chemicals put into the fields and the contamination which can be linked.
[155] These farmers are mainly Palestinian. Actually these particular crops where traditionally cropped in Palestine.

The chart presented on the following page shows a large diversity of situations:

- Some farms are very profitable with an important average net profit per familial worker (higher than 7.500 $/ca/year). It is the case of the rented farms in the *Upper Yarmouk Area,* as well as the intensive owned farms planted with classing crops or water-consuming crops like mint and parsley

- Non profitable farms with an average Net profit per familial worker lower than the poverty line. It is the case of the sharecroppers both in the *Eastern Desert* and in the *Suburban Area*. We think we have underestimated the effective net revenue in these farming systems since sharecroppers are, in most of the cases, part-time farmers beneficiating from another source of revenue (cf. above). For us, this can explain the persistence of these economically non-sustainable agricultural systems.

  The case of the owner who has several sharecropping contracts is interesting since the chart shows the revenue bringing out by the contract is not even enough to counterbalance the initial investments (the line is under the abscissa axe) unless considering a lower depreciation and thus a lower maintenance of the equipment of the farm. That can be explained by the fact that, like for the sharecropper, agriculture is not the only source of revenue of the owner who has another very profitable activity often not in the agricultural sector. We can see here that the owner is also a part-time farmer[156].

- The classic owned farm and the rented farms constitute a third group of farms.

  Farms planted with classic crops allow bringing out mean revenue per familial worker higher than the poverty level if the surface cropped per familial worker is higher than 50 dunums (rented farms) or 85 dunums (owned farm).

  For rented farms with particular crops, a worker must take cares of more than 40 dunums to earn an equivalent amount of the one earned by an agricultural permanent worker.

  For these three kinds of farms, the limit of profitability seems to be reached and we can suppose that the depreciation non proportional to the surface we have considered (and which corresponds to the needed maintenance for an optimal use of the equipment) is higher than the effective depreciation in the farm where the equipment should be less maintain. By considering a lower depreciation, the revenue bringing out in these systems should be higher than the considered poverty line. On another had, for owners who often have a governmental pension and are breeders (ancient Bedouins), the livestock farming is also another source of revenue, allowing to exceed the poverty line (and even maybe the sustainable line).

(ii) Greenhouses vegetables farm

- <u>Land tenure</u>

Farms equipped with greenhouses are mainly located in the surroundings of the cities. They are rare within the *Eastern Desert and the Upper Yarmouk Area* and more frequent within the *transition area* and the *suburban area*. Farmers located in the eastern desert, the Upper Yarmouk Area and the Transition area have the same story: they fled from the suburban area because of the high water prices linked to the urban pressure. According to the four agricultural areas, we have defined four farming systems.

[156] An other possibility to explain these low revenues could be that farmers gave us figures voluntarily underestimated during the surveys.

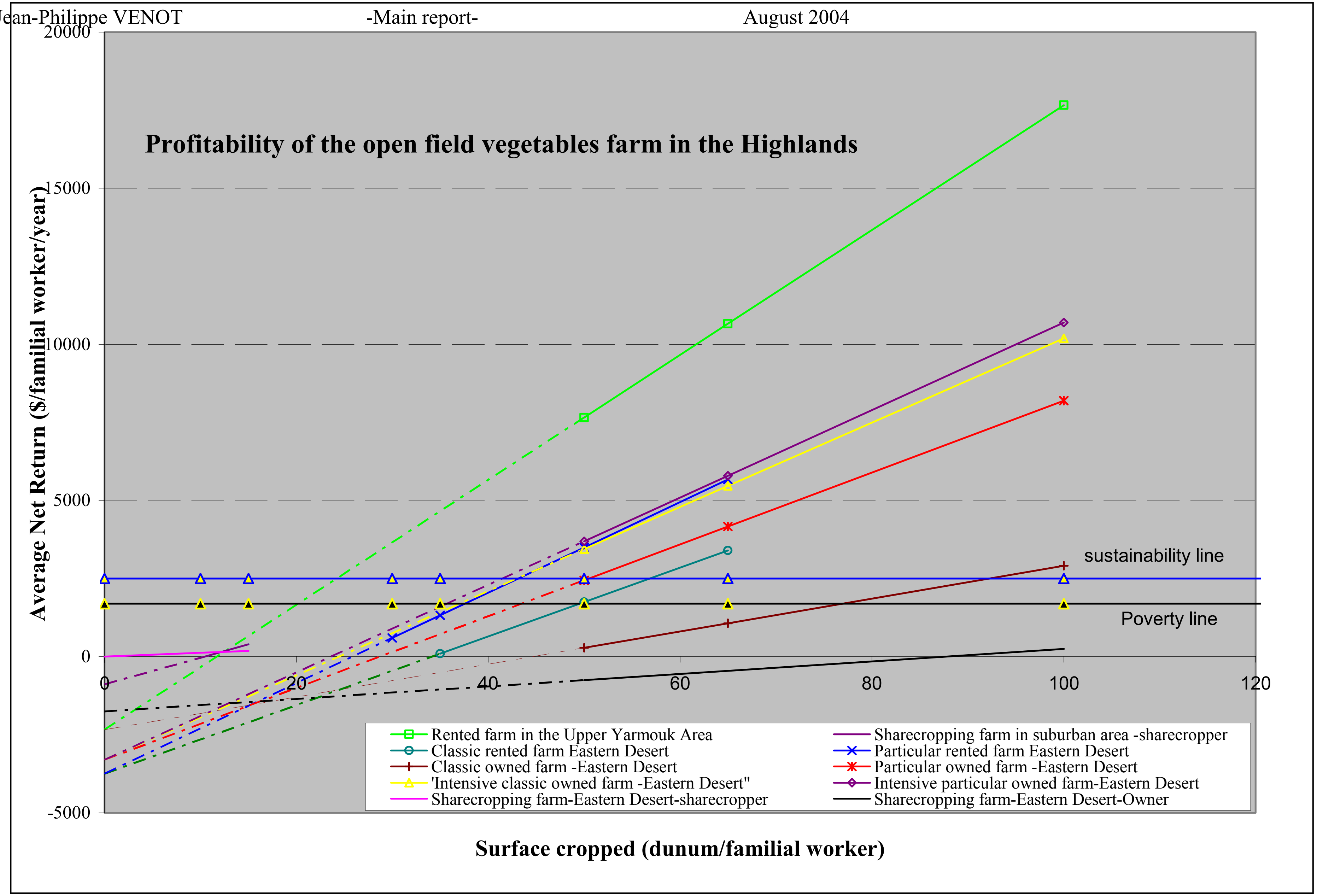


Figure 17. Profitability of the open field vegetables farms in the Highlands

Picture 24. A greenhouses farm in the Eastern Desert (Source: MREA, 2003)

- In the *Eastern Desert*, farmers own or rent a well to irrigate a surface included between 100 to 200 dunums. A third of the farm is equipped with greenhouses. Farm in ownership are familial farms, while rented farms are entrepreneur's farm (the renter is involved in the management but not in the field work).

- In the *Upper Yarmouk Area*, farms can be rented or under a sharecropping arrangement. For rented farm (40 to 50 dunums) the tenant, who is only involved in the management, buys water to a well owner at a fixed fee of 0,25 to 0,35 JD (0,35 to 0,5$) per cubic meter. If the farmer is a sharecropper, he is involved in the farm management on 20 to 30 dunums. Costs (wages excluded) and products being shared between the sharecropper and the well's owner who brings water and land at a 1:1 rate.

- In the transition and suburban areas, farmers are tenant of their farms and develop the same cropping pattern (cf. tables in the following page) but farming systems differs mainly because of the water tenure.

    - In the transition area, farmers rent a well and irrigate 100 to 200 dunums. They manage the farm and all the field work is done by permanent employees.

    - In the suburban area, farmers rent 30 to 60 dunums and buy the water to a well owner who charges farmers at a fixed fee of 0,45 JD/m^3[157]. One third of the work is done by the family.

- Yield and Prices

We observed on the table besides that prices are the lowest in the eastern desert. That is due to the low quality of the product and to the existing distance between the central markets (Amman and Irbid) and the farms.

- Cropping pattern

We can see that the cropping patterns are quite similar between these farming systems. Cucumber is the main crop grown under greenhouses (tomatoes, strawberries can also be found but more rarely) on about one quarter of the farm surface while the other share of the farms is planted with vegetables in open field. Farms located within the *Upper Yarmouk Area* are very different since the entire surface is equipped with greenhouses.

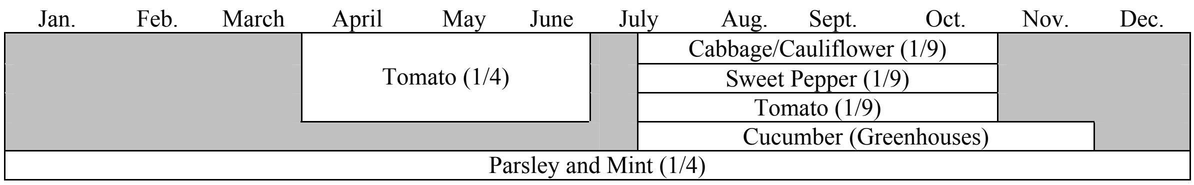
Like in the Jordan Valley, greenhouses have several advantages compared to open field: it allows maintaining a relatively high temperature (that is quite important in the desert where the temperature can decrease a lot during the night notably in autumn) while the wire stakes allow a vertical development of the plants implying a higher and longer production. Moreover, the plastic protects the plants from the wind occurring in these regions.

[157] Several farmers use the same well and water meters allow evaluating the quantity pumped by each of them.

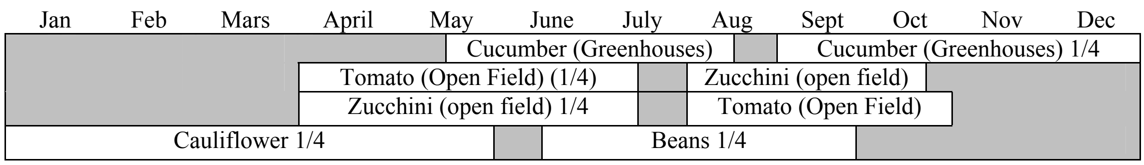
Vegetables	Yield (T/cropped ha)		Price (JD/T)		
G for 'Greenhouse'	Eastern Desert & Yarmouk Basin	Transition/ Suburban Areas	Eastern Desert	Yarmouk	Transition/ Suburban Areas
Cucumber (greenhouses)	100 to 130 (7 to 8,5 T/G)		130 JD (180 $)	140 JD (195 $)	
Sweet pepper (greenhouses)	18 to 23 (1,2 to 1,5 T/G on two lines)		100 JD (140 $)	120 JD (170 $)	130 JD (180 $)
Cauliflower (OF)	Same Yields than in for the open field vegetables described above	30 to 35	Same Yields than in for the open field vegetables described above		85 JD (120 $)
Zucchini (OF)		35 to 45			115 JD (160 $)
Beans (OF)		12 to 15			300 JD (420 $)
Tomato (OF)		50 to 60			80 JD (110 $)

Table 16. Yield and prices in 'greenhouses farming systems' in the Highlands

- Cropping pattern in the eastern Desert in greenhouses farms



- Cropping pattern in farms equipped with greenhouses in the Transition and suburban areas



- Cropping pattern in farms equipped with greenhouses in the Yarmouk Basin

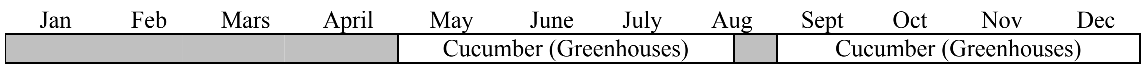


Table 17. Cropping pattern in greenhouses farms in the Highlands

Concerning the farm equipment, farmers rent the land preparation material while they own the trucks to transport the production (expected tenants in the Yarmouk Basin who rent also the trucks when it is needed).

- Economic return

	Eastern Desert		Upper Yarmouk Area			Transition Area	Suburban Area
	Rented Farm	Owned Farm	Tenant	Sharecropper	Landlord (sharecropping)		
Net Return in bad year (JD/du)	-17 JD (-25 $)	120 JD (170 $)	28 JD (40 $)	125 JD (175 $)	20 JD* (30 $)	85 JD (120 $)	10 JD (15 $)
Net Return in good year (JD/du)	90 JD (125 $)	250 JD (335 $)	195 JD (275 $)	320 JD (445 $)	290 JD* (410 $)	255 JD (360 $)	215 JD (300 $)

Table 18. Net return ($/dunum) in greenhouses farms in the Highlands

We can observe on the table above that there is an important variability of revenue per dunum according to the farming system considered.

Some of the systems we have presented above allow bringing out a Net Profit quite similar to the one expected in the south of the valley in greenhouses farming systems[158]. In this case, within an agricultural area, the profit is thus higher in greenhouses farms than in open field systems. The farming systems which are in this situation are the owned farms in the Eastern Desert, the farms under a sharecropping arrangement in the Upper Yarmouk Area and the farms located in the Transition area.

On another side, the rented farms both in the Eastern desert and in the Upper Yarmouk Area allow bringing out a very low Net Profit but as they are not familial farms but farms managed by an entrepreneur, the profit per familial worker is relatively high.

Finally, the last farming system: greenhouses farm in the suburban area allows the farmer to earn a low amount of money and as it is familial farm, the sustainability of this system has to be questioned. The chart of the following page allows us evaluating the sustainability of the different greenhouses farming systems located in the *Highlands*.

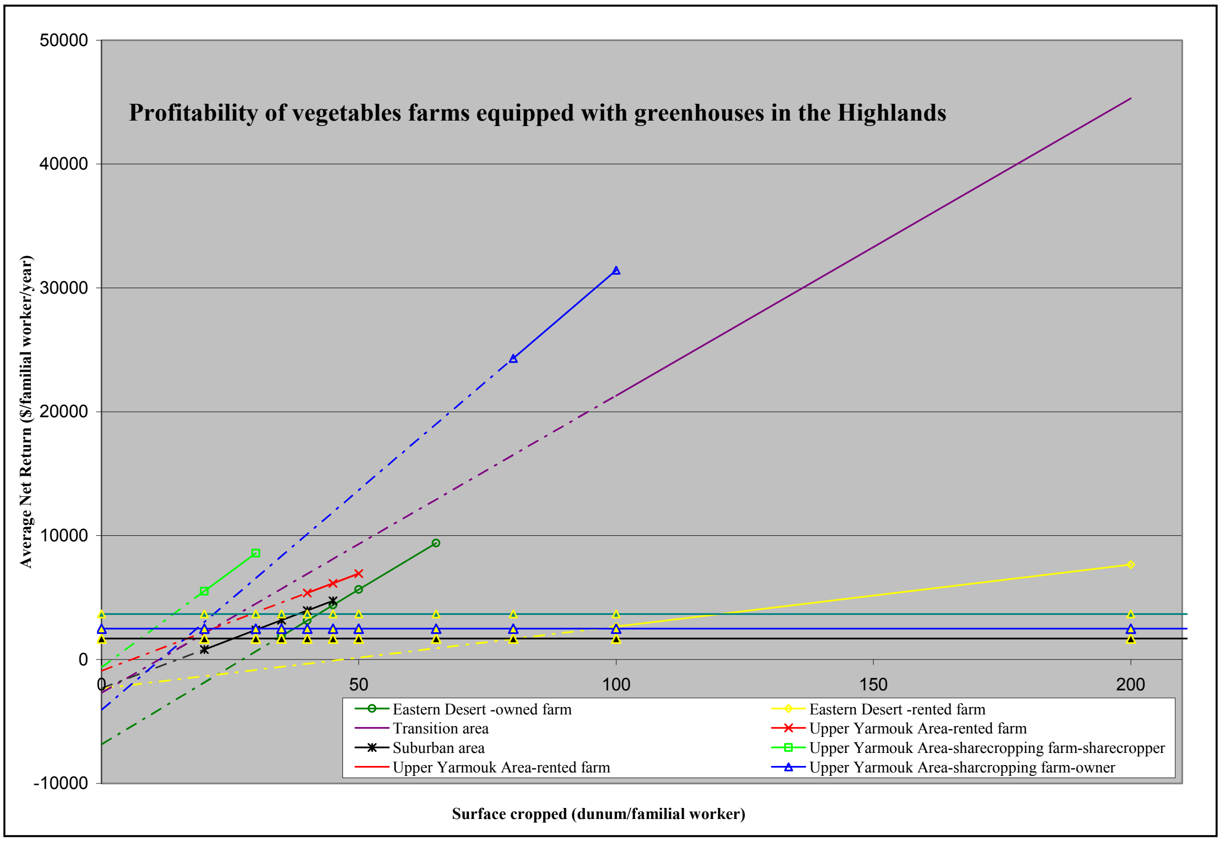


Figure 18. Profitability of the vegetables farms equipped with greenhouses in the Highlands

158 The profitability of greenhouses farms in the north and the middle of the valley being very higher (cf. above)

We can therefore differentiate two main kinds of farming systems:

- The Entrepreneur farms (rented farms in the eastern desert and farms in the Upper Yarmouk and in the transition areas). These ones are very profitable with a high average Net profit per familial worker which allow investing to renew the equipment and even develop the farm.

- The Familial farms (owned farms in the eastern desert and farms of the suburban area) are less profitable and allow bringing out an average profit higher than the sustainability line only if the surface cropped by one familial worker is higher than 35 dunums.

(iii)Fruit trees farm[159]

- Land tenure

All fruit trees farmers are owner of the land and of the well they use. The long-term and high investments which are actually needed to implement an orchard necessitate a certain security in terms of access to the land and to the water. Two main farming systems can be identified:

Picture 25. Familial fruit trees farm in the Eastern Desert (Source: MREA, 2003)

- Familial farms: The owner and its family are involved in the field work on a surface included between 100 and 200 dunums. These farmers are ancient Jordanian Bedouins who settled down in the area in the beginning of the 1980s. After cropping vegetable, they progressively shift to fruit trees orchards because of their high profitability in the late 1980s, early 1990s. After the first Gulf war (1990/1991), the shifting process became more pronounced since the marketing of vegetables was more difficult.

Added to their orchard, these farmers can have an olive trees orchard they extensively crop (around 100 dunums)[160] or can rent another plot were they plant vegetables (100 to 150 dunums) irrigated thanks to their well. They develop then the farming system described above for large rented farms in the *Eastern Desert*[161].

[159] This generic term refers to all trees, olives being excluded.
[160] A description of these orchards will be done in a following section.
[161] Moreover, the farmer who is an ancient Bedouin has often kept a small herd. He thus can have a triple activity: orchard, vegetables and livestock farming. However it is worth noticing the association of an orchard with some vegetables planted in open field becomes very rare. Most of the farmers who were developing this strategy at the end of the 1990s have actually already abandoned or are still abandoning their vegetable activity because of its low profitability. The new By-Law aiming at taxing the agricultural abstracted water should accentuate this already developed tendency which consists in an abandonment of the vegetables activity when this one is considered as a secondary activity because it is added to a fruit trees orchard

Picture 26. Entrepreneur's fruit trees farm in the Eastern Desert (Source: MREA, 2004)

- Entrepreneur's farms: The owner and its family are in charge of the management of the farm which is a true 'agricultural firm'. The family has, in most of the cases, a Palestinian origin and can own between 200 and 3.000 dunums generally organized around plots of 200 to 400 dunums irrigated thanks to one deep well and surrounded by fences (walls and wire netting)[162]. The owner is much involved in the commercial aspect while a foreman who often belongs to the owner's family manages the field work realized by permanent qualified employees. Two different way of cropping can be identified:

  - Very intensive farming systems with very modern and even high-tech techniques imported from France, Italy and Spain. The owner is closely involved in the management of the farm and investments are important. The management unit is around 200 to 400 dunums.

  - Less intensive farms owned by an absentee owner not really involved in the management. This one owns 400 to 800 dunums. Half of the farm's surface is planted with fruit trees orchard, the remaining with olive trees. Most of the time, there are two wells on the farm. We will refer to these farms as *investor's farm*

It is worth noticing that the sector of fruits production within the *Highlands* is still in expansion notably if we consider the peaches production. Actually, despite the absence of incentive to invest in agriculture because of the government's willingness to reduce the agricultural water abstraction, some familial and entrepreneurs farmers continue to invest on fruit trees orchards by renting in wells or even by purchasing land and wells.

- Cropping pattern

We can see on the table below that peaches and nectarines are the most common trees. Their importance is higher in familial farms than in entrepreneur farms. Actually, entrepreneurs farmers develop others trees (Plums, Apricot, Apples) which needs more attention and more care but which allow a better return. Even for peaches and nectarines, the entrepreneurs develop early or late varieties in order to insure better prices on the markets.

Trees (% of the farm's surface)	Familial Farm	Entrepreneur farm
Peaches	50%	30%
Nectarines	25%	
Plums/Apricot	25%	30%
Apples/Grapes and others		30%

Table 19. Typical Cropping pattern of the fruit trees farms in the Highlands

[162] Familial farms are just surrounded with small stone walls -see pictures in appendix.

(iv) Yield and Prices

The tables below show that yields are higher in the entrepreneur's farm than in familial farms. Moreover, as the proportion of the exported production in entrepreneur's farms is higher than in familial farms (50% instead of 30%), the average expected prices are also higher. Intensive entrepreneur farmers often have their own export channel to the Gulf countries, Syria and Lebanon

	Yield observed (T/ha)		Local price market (JD/T)	period of production
type of fruits	familial farms	entrepreneur's farm		
peaches	30 to 40	30 to 45	400 (565 $)	may to september
nectarines	30 to 40	30 to 45	400 (565 $)	may to september
apricot	20 to 40	30 to 40	300 (420 $)	may and june
apple	25 to 30	30 to 40	500 (705 $)	july to december
grapes	30 to 40	40 to 50	400 (565 $)	july to october
plums	20 to 40	40 to 50	400 (565 $)	june to august
pears	20 to 30	20 to 30	600 (845 $)	july to september

Table 20. Yield and Prices observed in Fruit trees farm in the eastern desert

(Note: the export price is 30 % higher than the local prices)

- Economic return[163]

As these farms are very profitable and need an important initial investment, we have deliberately chosen to present the return on investment of these farming systems.

	Familial Farm		Intensive Entrepreneur's farm		Absentee Owner Investor's farm	
Surface cropped per familial worker (dunum)	30 to 85				The return on investment is calculated on the fruit tree orchard (the olive activity is not considered)	
Return on investment in bad year (JD/du)	270 JD (385 $)	We have considered a remuneration of 1000 JD per month and per person and 5 familial workers	930 JD (1310 $)	We have considered a remuneration of 1000 JD per month and per person and 2 familial workers	835 JD (1180 $)	We have considered a remuneration of 1000 JD per month and per person and 1 familial worker
Return on investment in Good Year (JD/du)	700 JD (985 $)		1345 JD (1900 $)		1240 JD (1750 $)	
Initial investment (JD/du)	1700 JD (2865 $)		1635 JD (2285 $)		1105 JD (1550 $)	

Table 21. Net Return ($/dunum) in Fruit Trees Farm in the Highlands

In the familial farms, the possible added vegetables activity can bring out a Net profit of 40 to 180 $/du/year. The table above clearly shows that initial investments are very high and reach at least 1.500 $/du. On another hand, intensive entrepreneur's farms are the more profitable since the return on investment reaches, on average, 1.600 $/du/year that is more than the double of familial farms in

[163] For more information on the needed investment (price of land, of a well, of an orchard installation…) in such farms, see Appendix IV.

which the Net Profit (family remuneration not subtracted) reaches 945 and 1.545 $/du/year in bad/good year.

For the investor's farms owned by an absentee owner, if the return on investment is calculated on the entire farm (olive orchard included) it is thus divided by two to 'only' reach 600 and 915$/du/year respectively in bad and good years. That is due to the non profitability of the olive orchards.

The comparison of the initial investments done in each of the farming systems shows that an economy of scale is possible since the investment per dunum is lower in the larger farms even if the system developed is more intensive. That is mainly due to the fact that prices of wells are similar even if the surface cropped is higher

- Conclusion

Farming systems irrigated thanks to groundwater are very diverse. A large range of initial investments and economic return can be found. To the highest investments (between 500.000 and 1.000.000 $/farm) correspond the large intensive fruit trees farms which allow bringing out a return on investment superior to 1.500 $/du/year.

On another hand, some farming systems developed thanks to groundwater exploitation in the *Highlands* are the lowest profitable agricultural systems within the Basin (Net Profit lower than 150$/du/year). These farms are frequently familial farms where vegetables are cropped in open field thanks to a high quantity of inputs (water and fertilizer) and the land (and the private well) can be owned or rented (the initial investment is thus very variable).

Finally a last kind of farmers can be presented: they are absentee owners letting the management of the farm to a sharecropper who extensively crops vegetables. The net profit brought out is also very low (inferior to 50 $/du/year) and does not allow to maintain the equipment of the farm. Both the owner of the land and the sharecropper are part time farmers beneficiating from another source of revenue. On a general perspective and concerning vegetables farms, the quotient Net Profit divided by Total costs is low (below 20 % against 30 to 70% in the valley), that reveals a more extensive way of cropping than in the valley: larger surfaces for a lower net Profit.

IV.4.4 'Surface water farming systems' in the Highlands

These farms are mostly located in the *Uplands Area* and along the *Side Wadis* incising the mountains (notably the Zarqa River). Moreover, these farming systems are what remain of the historical irrigated agriculture developed within the *Basin* since the beginning of the process of water mobilization in the region. Farming systems are diverse and it is possible to find vegetables planted in open field or under greenhouses as well as fruit trees orchards.

(i) Open field vegetables farms

- Land tenure

The farmer can be a sharecropper or a tenant working on 10 to 25 dunums. In both cases, the family is involved in the field work. The sharecropping system is more frequent mainly because of a high land pressure which leads to high renting costs: 180 JD/du/year (225 $) for a plot which can be irrigated thanks to a spring or a shallow well[164]. In the sharecropping contracts, water and land are furnished by the owner while costs (wages excluded) and products are shared at a 1:1 rate. An owner has 5 to 6 arrangements on a total surface reaching 50 to 100 dunums irrigated thanks to one well (in most of the case there are 3 farmers per well).

Concerning owners of the land, they are Jordanian, always have been in the area, doing livestock farming, and cereals cropping to feed their herd. Following the development of the agriculture during the 1970s, there were less and less pasture lands. They thus begin to reduce their breeding activity to reclaim their land along the river banks with irrigated vegetables (an activity

[164] In the Eastern Desert the price was around 100 $/du/year

Picture 27. Mint and Parsley farm along the Zarqa River
(Source: MREA, 2003)

Picture 28. Open field farm with classic crops along a small Side Wadi
(Source: MREA, 2003)

Picture 29. Greenhouses farm irrigated thanks to direct pumping in a small Side Wadis
(Source: MREA, 2003)

Picture 30. Forage farm irrigated thanks to treated waste water along the Zarqa River
(Source: MREA, 2004)

which was very limited before). In the beginning of the 1990s, because the profitability of agriculture decreased they began to rent out their land to other small farmers. Most of the time the owner has also an olive trees orchard, extensively cropped he continues to manage, while the other plots along the river are cropped with vegetables by other farmers, and the hilly land is rented to the remaining livestock farmers who plant rain fed cereals (Barley & Wheat) for their herd.

- Cropping pattern

Two cropping patterns can be identified according to cultural and historical reasons and to the agricultural knowledge of the farmers:

- ✓ The "*Jordanian*" cropping pattern is organized around two main crops: Potatoes and Cauliflower. Potatoes are planted in December and harvested in April. Cauliflower planted in Mid-April is harvested in Mid July.

- ✓ The *"Palestinian"*[165] cropping pattern is organized around particular crops as mint and Parsley. Mint stayed 3 to 4 years on the same plot. Parsley planted every year is cut 3 to 4 times per year. This two crops are planted on half the surface of the farm[166]

  Most of the farmers are using surface irrigation (without any mulch). But, due to the high profitability of their farms, tenants are now switching to drip irrigation on half the farm surface[167]. The farmer owns the truck to do the transport and rents the land preparation material.

- Market prices and Yield observed

vegetables	Yield (T/ha)	Market price (JD/T)
Potato[168]	20 to 25	220 JD (310 $)
Cauliflower	38 to 50	85 JD (120$)
Mint	20 to 25	350 JD (495 $)
Parsley	25 to 30	250 JD (350 $)

- Economic Return

	Sharecropping farm				Rented farm	
	sharecropper		*Owner*			
	Classic crops	Particular crops	Classic crops	Particular crops	Classic crops	Particular crops
Net return in bad year (JD/du)	140 JD (195 $)	150 JD (215 $)	165 JD (235 $)	215 JD (300 $)	100 JD (140 $)	200 JD (280 $)
Net Return in good year (JD/du)	300 JD (420 $)	190 JD (270 $)	255 JD (360 $)	270 JD (380 $)	285 JD (405 $)	285 JD (405 $)

Table 22. Net Return ($/dunum) in open field farms along the Side Wadis

[165] When we speak about Palestinian it can be Palestinian or Jordanian with a Palestinian origin.
[166] This model is a simplified one because, on the field, such farmers plant a lot of different herbs to diversify their production and to free themselves from the market fluctuations.
[167] We will only describe the "surface irrigated" farms because we do not have data for "drip irrigated" farms. The switching seems to be really recent. The switch to drip irrigation is interesting because an increase in the irrigation and the fertilization efficiency can be expected; it implies a decrease of water pumping costs and a decrease of fertilizer costs thanks to fertigation technique. But in the land pressure context of the area, an increase in surface cropped does not seem to be possible for such little tenants. Profitability ameliorations will be linked to savings on the surface already cropped. Saving of labor costs can be expected too.
[168] The level of profitability seems to be reached for a yield of 15 Tons/ha

We can see that in each farming system, particular crops (Mint, parsley and other herbs) allow bringing out a Net Profit higher than the classic crops. We can see that being a sharecropper softens the variations between one year and another. Compared to the other vegetables farm in the Basin, these one are very small but a relatively high profit can be expected because of low production costs.

(ii) Fodder farms

- Land tenure and cropping pattern

These farms are located upstream of the Dulheil/Samra river and use the treated waste water of the As-Samra Treatment Plant[169]. The farmer is often an absentee tenant who rents 40 to 50 dunums and crops Alfalfa under surface irrigation (the water being directly pumped in the river). This crop stays 4 to 5 years on the same plot and is cut every month.

The tenant manages the farm, but farming constitutes a secondary activity for him. There is one permanent employee for the field work and daily workers are employed for the harvest. The yield is around 8 to 10 tons/du/year, and one ton of Alfalfa is sold at 25 JD (35 $) to the livestock farmers located in the area. Concerning water, the government charges the retreated waste water at 10 JD per dunum, and on average farmers use 1.000 m^3/du/year.

- Economics

Fodder farms permits to bring out a Net Profit close to 45 $/du/year in bad year and 105$/du/year in good year, that provides an annual revenue included between 1.800 and 2.820$/year/farm.

(iii)Greenhouses vegetables farm

Two farming systems can be described here:

- Rented farm of 10 to 15 dunums totally equipped with greenhouses. The tenant does not own any material, he rents everything and does the entire field work.

- Owned farm of 30 to 50 dunums, half equipped with greenhouses. The owner owns trucks and land preparation material and one third of the work is done by the family, the remaining by permanent employees.

In both cases and like for the "open field farmers" located in the uplands, these family farmers always lived in this area reclaiming small plots of land thanks to a spring and direct pumping in the *Side Wadis*. From the 1970s, they gradually shift from a herding activity to an agricultural one, they left their pasture land on the hills side to reclaim plots nearby the sources of water but still keep a small herd of sheeps and goats.

- Cropping pattern in rented farms

jan	feb	mars	april	may	june	july	aug	sept	oct	nov	dec
		cucumber (greenhouses) 1/3						cucumber (greenhouses) 1/3			
		beans (greenhouses) 1/3					beans (greenhouses) 1/3				
			eggplants under greenhouses (1/3)								

[169] This plant is the larger in Jordan and receives the waste waters from Amman, Zarqa and the surroundings cities.

- Cropping pattern in owned farms

jan	feb	mars	april	may	june	july	aug	sept	oct	nov	dec
		cucumber (greenhouses) 1/2						cucumber (greenhouses) 1/2			
			tomato/zucchini (open field) 1/6				beans (open field) 1/6				
			beans (open field) 1/6				tomato/zucchini (open field) 1/6				
				eggplants under greenhouses (1/3)							

- Market prices and Yield observed

Vegetables	Yield (T/ ha/year)	Yield (T/greenhouse/year)	price (JD/t)
cucumber	100 to 130	7 to 8.5	140 JD (200)
beans	36 to 46	2.5 to 3	300 JD (420)
beans open field	20 to 25		200 JD (280$)
eggplant	90 to 110	6 to 7	140 JD (200 $)
eggplant open field	70 to 85		140 JD (200 $)
tomato	40 to 60		80 JD (110 $)
zucchini	30 to 40		70 JD (100 $)

- Economics

In rented farms, the Net Profit brought out is close to 160 $/du/year in bad year and reaches 350 $/du/year in good year. For farms in ownership the Net Profit brought out is higher and reaches 510 and 740 $/du/year in bad/good year.

(iv) Fruit trees farm

- Land Tenure

Some farms are entirely planted with fruit trees. The farmer then owns 100 to 200 dunums[170]. As it was the case in the *Eastern Desert*, we can find familial farms and very modern entrepreneur's farm. Generally, the owner of the orchard also owns an olive trees plot on 100 to 200 dunum on the hills bordering the *Side Wadis*. The owner is Jordanian (originating from Transjordan) and began to have an agricultural activity by irrigating vegetables thanks to shallow wells in the 1970s and shifted to fruit trees in the 1980s. The opening of a new market in the Gulf states, the apparition of new agricultural techniques (drip irrigation, fertigation) are some of the reasons which can explain this switching which requires a high initial investment but which brings an higher revenue too.

On another hand, mixed farms (with a surface of about 200 dunums) can also be found in the uplands. They mostly are familial farms, rented or owned, developed by Jordanian historically settled in the region and which like the majority of the population of this area have shifted from a livestock farming activity to an agricultural one. One third of the field work is done by the family which always had an agricultural activity in the area.

- Cropping pattern

For fruit trees farms, the cropping pattern is quite simple and similar to the one develop in the Eastern Desert with Peaches, nectarines and Apples (each one on one third of the

[170] Large families can own until 1.000 dunums organized in several plots.

surface). For mixed farms, we can differentiate three plots: one plot of olive trees (1/4 of the surface); one plot with fruit trees under surface irrigation (3/8 of the surface; mainly apricot, plums and cherries equally distributed on the surface), another one with vegetables under drip irrigation (Zucchini, Beans, Tomato…). In the two cases, the farmer owns the trucks to do the transport and rents the land preparation material.

crops				
	yield observed (T/ha)		local price market (JD/T)	
	fruit trees farm	mixed farms	fruit trees farm	mixed farms
peaches	30 to 40		400 JD(565 $)	
nectarines	30 to 40		400 JD(565 $)	
apple	25 to 30		500 JD (705 $)	
apricot		12 to 15		400 JD (565 $)
plums		12 to 15		400 JD (565 $)
cherries		6 to 8		800 JD (1130 $)
beans		10 to 15		200 JD (280 $)
tomato		20 to 30		80 JD (110 $)
zucchini		20 to 30		130 JD (185 $)

Table 23. Yield and Prices in Fruit trees farms and mixed farms in the Uplands

Jan.	Feb.	March.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
		Beans (1/2)						Tomato/Zucchini (1/2)			
			Tomato /Zucchini (1/2)					Beans (1/2)			

Table 24. Typical vegetables cropping sequence in mixed farms in the Uplands

- Economics

	Familial fruit trees farms	Entrepreneur's fruit trees farms	Mixed farms
Net return in bad year (JD/du)	405 JD (575 $)*	730 JD (1025 $)*	110 JD (155 $)
Net return in good year (JD/du)	730 JD (1025 $)*	1055 JD (1475 $) *	310 JD(435 $)

Table 25. Net Return ($/dunum) in fruit trees farms along the Side Wadis

We can see on the table above the high profitability of fruit trees farms which allow bringing out a Net Profit reaching the same ranges that the familial fruit trees farms located in the Eastern Deserts. On another hand, the mixed farms allow bringing out a lower Net Profit, quite similar to the one expected in open field systems located in the *Uplands.* The advantage of fruit trees orchards is thus not directly economic but consists more in an easier way of farm management. Orchards are actually less-time-and-input consuming than vegetables, orchards need less attention and in the same time, the fruit trees production is more reliable because prices are more stable.

IV.4.5 Irrigated Olive Trees

(i) Irrigated Farming systems

According to the work of *ASAL-JORDAN (1994)* and to our surveys, the production at maturity for rain fed olive trees is about 300 to 400 kg/dunum/year (average on two years), it means 60 to 80 Kg of Oil/du (one fifth of the olive fruit production in quantity).

For irrigated olive trees, the expected yield depends on the way of cropping. For extensive farms, the expected yield is about 450 Kg of Olives (90 Kg of Oil), for "intensive farm"[171] the expected yield is around 700 Kg (140 Kg of Oil)/du/year.

On another hand, the olive production is delayed. Actually, the full production is not reached before the trees become mature (around 12 years old). The evolution of production of an olive trees orchard can be summarized in the following table:

Age	1 to 3	4	5	6	7	8	9	10	11	12 to 35	After 35 years
% of full production	0	15	25	40	50	60	70	80	90	100	The production is declining

In our economic analysis, we will consider an average year of production and we will present the present situation of production (young trees producing half of their potential) and the future situation when the trees will be mature[172].

As we have seen before, the largest irrigated surfaces cropped with olive trees are located in the Transition Area, in the Eastern Deserts and along the Zarqa River. In the Lower Jordan River Basin in Jordan, irrigated olive trees are rarely planted alone: Irrigated olive trees farms exist but they are rare. In most of the cases the olive trees activity is added to another activity (vegetables or fruit trees cropping). Thanks to our surveys, we have been able to identify different way of cropping irrigated olive trees. We can classify them from the more extensive to the more intensive.

- The more extensive way of cropping: Olive trees can be found in a vegetables or fruit trees farm owns by an absentee owner. Olive trees, planted on a 100 to 200 dunums-plot are under furrow irrigation and the owner sells the "production on trees", before harvest. Permanent workers take care of the orchard. The yield expected at maturity (in an average year) is around 450 Kg of olive fruits per dunum. The net profit brought out this system is negative when the trees are young (present situation, the owner is losing money): - 31 $/du/year and it will only reach 5 $/du/year when the trees will be mature. This kind of plots is mainly found in the Eastern desert.

Picture 31. Characteristic irrigated olive trees farm in the Eastern Desert (Source: MREA, 2003)

- The second kind of farming system is characterized by an intermediate way of cropping. Two sub-groups based on similar olive trees plots under drip irrigation can be identified: familial olive trees plots on 100-to-200 dunums or olive trees plots of 200 to 400 dunums owned by an absentee owner developing what can be qualified as a 'social prestige farming' (Cf. table besides)

171 Each time the expression 'intensive farming system' will be used in this chapter devoted to olive trees farming it will be to characterize a 'relatively intensive way of cropping' (both in terms of labour and inputs) within the particular set of farming systems based on olive orchards. However, it is worth noticing that any kind of olive trees farming is very extensive (in terms of capital, labour, inputs) in comparison to vegetables or stone fruit trees farming

172 To predict the Net Profit within the next few years we considered that the Olive oil price will not change. We took 27 JD (38 $) for a 17 Kg-box of oil (price which has been paid during the two last years 2002 and 2003). We consider also that the price of oil is the same on the local and on the export markets.

FARMING SYSTEM	Rainfed		Furrow Irrigation		Drip Irrigation		Drip Irrigation « Intensive farming »	
	Young orchards	Mature orchards	Young orchards	Mature orchards	Young orchards	Mature orchards	Young orchards	Mature orchards
Characteristics of the farming system	Familial Farm Easy Farming		Absentee Owner Easy farming Production sold before harvest		Familial Farm or Absentee Owner and 'Social Prestige Farming'		Large Entrepreneur Farmer	
Water use (m^3/du)	0	0	350	350	350	350	350	350
Water use (m^3/farm/year)	0	0	52500	52500	52500	52500	105000	105000
Land tenure	OWNER	OWNER	OWNER	OWNER	OWNER	OWNER	OWNER	OWNER
Range of surface (dunums)	30 to 50	30 to 50	100 to 200	100 to 200	100 to 200	100 to 200[173]	200 to 400	200 to 400
Yield (Kg of Oil/du)	35	70	45	90	45	90	70	140
Mean Gross Output	**78**	**155**	**42**	**85**	**99**	**205**	**157**	**313**
Mean water Costs (well depreciation + pumping costs)	0	0	75	75	75	75	75	75
Mean production costs	**31**	**38**	**52**	**59**	**52**	**59**	**74**	**88**
Mean net Margin	**47**	**117**	**-10**	**26**	**47**	**146**	**83**	**225**
Permanent Wages Cost (mean)	0	0	21	21	21	21	28	42
Daily Wages Costs (mean)	28	56	0	0	35	71	49	99
Total Wages Costs	**28**	**56**	**21**	**21**	**56**	**92**	**77**	**141**
Total costs	**59**	**94**	**73**	**80**	**108**	**151**	**151**	**229**
Mean Net Profit	**19**	**61**	**-31**	**5**	**-9**	**54**	**6**	**84**
Net Profit/Total costs (%)	32	65	-42	6	-8	36	4	37

Table 26. Main characteristics of the Olive Trees Plots within the Lower Jordan River Basin in Jordan

[173] Surface considered for familial farms. For absentee owner farms, the surface is included between 200 and 400 dunums for a total water consumption reaching, on average, 105.000 m^3/farm/year. The economic characteristics of the olive plots are similar between familial farms and absentee owner farms.

- Familial olive trees plots: The olive plot is generally linked to another farming activity which can be either vegetables cropping or stone fruit trees cropping. Farmers are generally ancient Bedouins settled since the 1970s either in the Eastern Desert or along the Zarqa River[174]. The owner and his family are closely involved in the management of the entire farm and they are working on the field helped by permanent and daily employees[175]. Olive trees are planted on a 100 to 200 dunums-plot under drip irrigation; the harvest is done by the family helped by some daily employees. The expected yield is the same than in the system described above (450 Kg/dunum in an average year).

- Absentee owner olive trees plots: These plots constitute the only true 'olive trees farms' within the *Basin* since the olive plot is not associated to any other kind of agricultural activity. The olive farm, also under drip irrigation, is larger (200 to 400 dunums) than a familial plot, all the work is done by permanent employees. The owner comes very rarely in the field and because the social and the prestige value of the farm seems to be more important that their low economic value, we qualified this system as a 'social prestige farming'.

- On an economic point of view, the net profit brought out in these systems is negative when the trees are young (actual situation): -9 $/du/year and will reach 54 $/du/year when the trees will be mature.

▪ The last way of planting olive trees is a more intensive one. Only very large entrepreneurs developing also stone fruit trees orchards (essentially in the Eastern Deserts and on the hilly side of the Zarqa River) have this peculiar way of olive trees management. The plot planted with olive trees is large (200 to 400 dunums), and is actually "added" to another plot (nearly of the same surface) planted with other fruit trees (peaches, nectarines, apple trees….). The owner of the farm is involved in the management of the farm. The yield expected at maturity is around 700 Kg of fruits/dunum in an average year. The net profit brought out in this system reaches 6 $/du/year today (young orchards) and will reach a higher (but still low) amount at maturity: 84 $/du/year.

It is worth noticing the two first ways of cropping are the most important in terms of number of farms and surface considered within the Basin. The third way of cropping is actually very rare.

Picture 32. Rainfed olive trees orchard (Source: MREA, 2002)

For information, a classic rainfed farm of olive trees (average surface of 30 to 50 dunums) employs two familial workers and allow bringing out a net profit of 19 $/du/year (non-mature trees) and 61 $/du/year (mature trees). We highlight that the rain fed olives trees are already- and will be- more profitable (when the trees will reach their maturity) than the majority of the irrigated olives trees farming systems developed within the Lower Jordan River Basin in Jordan.

[174] They can thus be identified as 'historical land-owner'

[175] Some few exceptions exist along the Zarqa River where some owners only involved in the management of their 'familial olive trees orchard' and renting out, in the same time, some plots to other farmers (cropping vegetables on their side) can be found.

(ii) The Olive sector in Jordan

- Data on Surface and Production

During the 1990s, some governmental policies have facilitated the implantation of new olive trees surfaces[176]. In a country where olive tree has a cultural importance[177], this led to a strong increase of the orchards of olives trees which do not need an important care and thus constitute an "easy way of farming". The table besides shows that between 1994 and 1999[178], the irrigated surfaces planted with olive trees have more than doubled from 9.960 ha to 20.060 ha. Regarding the rainfed surfaces, these ones increase by 25% from 48.290 ha to 63.590 ha. In conclusion, even if the share of irrigated olive trees has increased during the last few years, most of olives trees planted in Jordan are thus rainfed (83 % in 1994 and 76% in 1999).

Within the Lower Jordan River Basin, the total surface of olive trees has been evaluated, in 1999, at 77.000 ha (it represents 92 % of the entire surface cropped with olive trees in Jordan), 13% of this surface (10.200 ha) being irrigated and mainly concentrated in the Amman-Zarqa Basin (cf. section dealing with agricultural zoning).

- Production

The chart besides allows us visualizing an increase in the olive fruit production in Jordan since the end of the sixties. We can see the alternation between good year and bad year of production. If we take into account a two-years-average production (one good and one bad year) the total production increased from 18.150 tons in 1968/1969 to 133.800 tons in 2000/2001.

Moreover, due to the delay in production and to the recent development of the olive trees orchards, it is planned that the surfaces presently producing will see their production increase while new surfaces evaluated at 22.000 ha in Jordan[179] will come into production (Picture for the year 1999, according to the Ministry of Agriculture). The chart below shows the evolution of the production expected to be registered within the next years in Jordan.

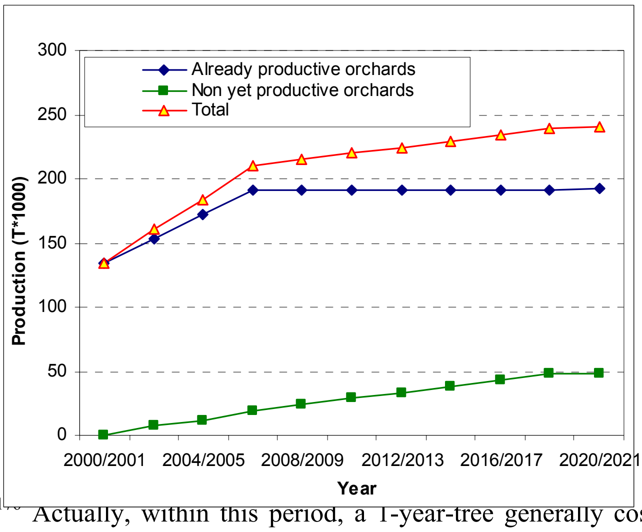


Figure 19. Expected evolution of Olive Production in Jordan until 2020[180]

In these conditions, the Jordanian production is expected to increase by more than 70% by the year 2015. While at the same time the local market seems to have reached its maximum of absorption since the last five years. We can actually see on the two charts besides that the exportations of both the non processed fruits and the olive oil are slightly increasing since 1999 (even if remaining very low).

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[176] Actually, within this period, a 1-year-tree generally cost 1 JD (1,4 $) because of important governmental subsidies. The government even gave trees from its nursery in 1997 and 1998.

[177] Jordanians as all the Mediterranean populations actually have a strong attachment to the olive production and the olive trees orchard.

[178] Since 1999 we do not have any evaluation of the irrigated surfaces planted with olive trees and on another hand we can notice the rainfed olive trees areas stayed almost constant since this date.

[179] On these 22.000 ha, 20.000 ha are located within the *Lower Jordan River Basin in Jordan*. Moreover, irrigated olive trees to come into production account for 5.000 ha in Jordan (of which 4.000 in the *Basin)*

[180] We assumed the non productive surfaces in 1999 (according to the Ministry of Agriculture) began to produce in 2003. Concerning the already productive orchards, we assumed that the 2000/2001 production is about 70% of the production at maturity. Moreover, in both cases, the production at maturity will be reached according to the evolution presented in the table above.

Year	Surface (dunums*1000)		Total Surface	Total Production of Olives (T*1000)
	Irrigated Olive trees	Rainfed Olive trees		
1990				56
1991				33
1992				83.5
1993				70
1994	99,6	482,9	582,5	96,5
1995	107,6	519,1	626,7	64,9
1996	125,3	547,1	672,4	128,9
1997	148,3	559,9	708,2	82
1998	232,3	644,3	876,6	177
1999	200,6	635,9	836,5	42,5
2000		637.6		180
2001		641.2		87.7
2002		644.8		180,9

Table 27. Evolution in olive trees surface and olive production in Jordan[181]

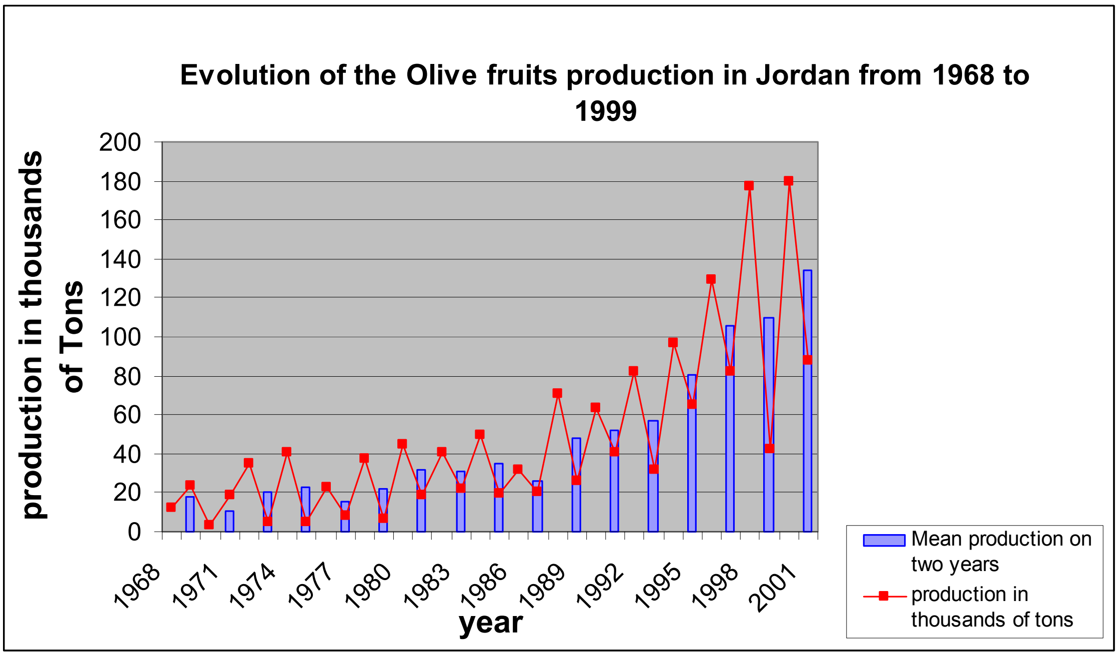
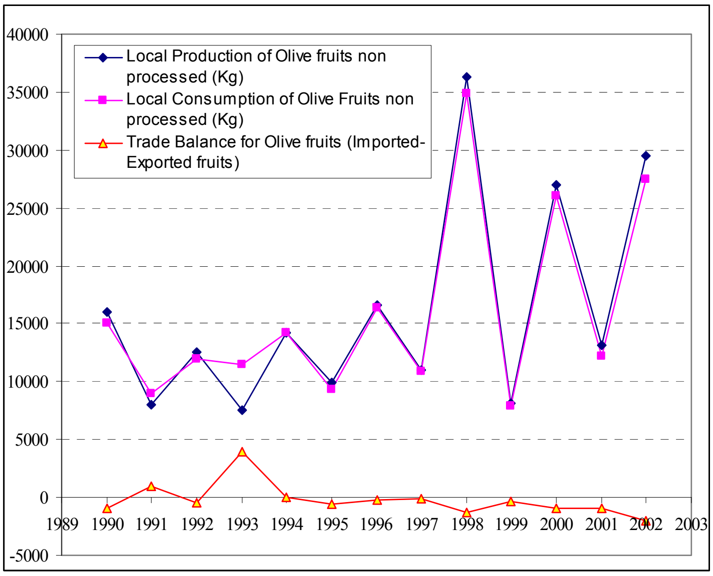
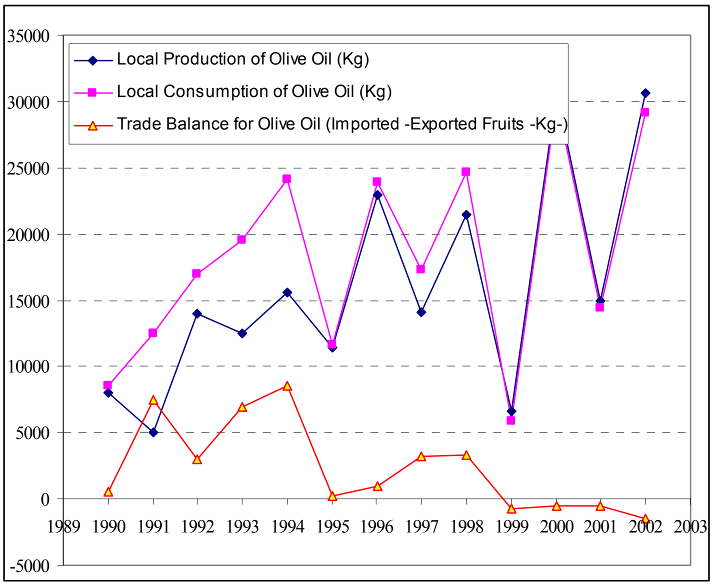


Figure 20. Evolution of Olive production in Jordan[182].

[181] For data concerning the 1994-1999 period, please refer to:
Ministry of Agriculture (MoA). (2000). *Agricultural Data from 1994 to 1999*. Department of Development and Planning, Ministry of Agriculture, Hashemite Kingdom of Jordan. Amman, Jordan.
For data concerning the 1968-1994 and 1999-2002 period, please refer to www.internationaloliveoil.org/
[182] Ibid.

Box 8. ***Olive Fruits and Olive Oil Market in Jordan***





The previous chart shows that concerning non-processed Olives, the Jordanian consumption closely follows the local production since the beginning of the 1990s. Moreover, since 1999, exportations are slightly increasing (but still remaining very low).

The olive oil market is more important that the non-processed-olives market in terms of volume produced and consumed, and its situation is different. The second charts leads actually to the identification of two main periods:

- *The first period before 1995*. Jordan showed a deficit as far as its local olive oil production is compared to the local consumption. The national demand was satisfied thanks to some importations of Olive Oil.
- *A second period from 1995*. The local Olive Oil consumption seems to follow the local production. Exportations are even slightly increasing since 1999 (but remaining very low)

The Jordanian market of Olive trees' products since 1990
(Source: MoA, 2003)

Figure 21. Jordanian market of Olive tree's production since 1990

It is worth noticing the Jordanian market of the olive trees' products is particular since it is a very fluctuating market from one year to another, following the fluctuation of the local production. This market seems actually able to absorb a high production during good years of production and to content itself with a low production (bad years of production) without importing any foreign products. This is mainly due to the fact that olives and olive oil productions are two "self sufficient productions" of which only a small share is marketed. Farmers actually plant olive trees to meet their own consumption and only after that they market the remaining production (if there are some remaining products). Moreover, Jordanians very rarely buy olive trees products (fruits or oil) outside their family and the market thus stayed a really limited traditional market.

In conclusion we can say that the Olive and the Olive Oil market in Jordan do not depend on the local production. The consumption follows the production year after year. During the early 1990s, and due to lower productions; importations were recorded but since 1994 olive oil (and fruits) trade stayed negligible in regard to the local production. Moreover, since 1999, the local market seems to have reached his maximum capacity of absorption: the balance is stabilized and Jordan exports a little quantity of oil.
If this tendency is confirmed, that will cause several problems to locally market the production. Prices regularly decreasing since the end of the 1990s will continue to drop and this will cause a decline of the already very low profitability of the olive trees farms. In these conditions, the only way to market the olive trees production will be to export it. Most of the Jordanian farmers who have olive trees will not be able to do it. Due to these marketing conditions and to the government willingness to reach a more sustainable water management, planting and cultivating irrigated olive trees seems to us to be one of the largest aberrations within the *Lower Jordan River Basin in Jordan*. To reach a more sustainable water management (aiming among others at avoiding the deterioration of the groundwater resources), increase of irrigated areas planted with olive trees orchards has thus to be stopped (maybe by the way of drastic measures as subsidies to farmers for digging up the irrigated trees) and that for several reasons

- For the farmers, irrigated olive trees are less profitable than rain fed olive trees (cf. above) and the situation will become worse within the next years because of the water taxation in the *Highlands* and because of an olive-overproduction which will imply a decrease in prices.

- At the country scale, rainfed olive trees surfaces are planning to increase and so on for the rainfed olive production. This latter will therefore be sufficient[183] to supply the Jordanian market in the future.

- As the Jordanian production is not competitive on the regional market, the export can not be seen as a solution to market the overproduction.

- These irrigated olive trees farms are developed for cultural reasons and their social and prestige value has more importance than their economic one. They are, actually, non profitable but deplete the Jordanian aquifers by high amounts of the best-quality water resources Jordan has at its disposal. It is therefore evaluated that irrigating olive trees lead to deplete the Amman-Zarqa Basin of some 25,4 Mcm/year and the Yarmouk Basin of about 6,2 Mcm/year[184].

[183] In 2004/2005, the productive rainfed olive trees orchards actually allow alone to insure a production equivalent to the national production in 2000/2001 for which the market seemed to have reach its maximum of acceptance. Moreover as we said it before, the rainfed surfaces to come into production are expected to increase of about 17.000 ha which will reach their maturity within 15 years. All the production of irrigated orchards could thus be seen as an additional production difficult to market.

[184] Figures obtained by multiplying the irrigated surfaces of olive trees orchards as evaluated in this paper by 350 m^3/dunum/year (average water consumption).

IV.5 *SYNTHESIS: FARMERS' CHARACTERIZATION AND STRATEGIES DEVELOPPED*

Despite the 'structural differences' we have observed and described within the set of farming systems developed in the *Lower Jordan River Basin in Jordan*, it is possible to draw some general dynamics to do a socio-economic characterization of the farmers and of the strategies they develop.

Based on the farming systems' description done above, on a little number of parameters and on some graphical representations (presented in appendixes) we have therefore identified **five main categories of farmers**. These groups are present all over the *Lower Jordan River Basin in Jordan*. Sole the strategies developed by the farmers to optimize their revenue differ in function of the area where they develop their activity. We will try in the following paragraph to draw the main characteristics of the farming systems respectively implemented by each of these farmers' groups.

IV.5.1 A 'socio-economic characterization' of the farmers[185]

(i) The intensive entrepreneurial farmers: farming system characteristics

- In most of the cases, farmers are owners of the land they crop (the sole exception is the large greenhouses farmers in the middle of the valley[186]). It is actually a kind of security to develop time-and-money consuming farming systems in which the profitability is often delayed (it is notably the case for orchards). They mostly belong to Palestinian families.

- These farmers can not be Part-time farmers because farming systems developed are time-and-money consuming. The agricultural activity represents the main activity and the main revenue of the owner who has the financial means to invest in expensive modern techniques.

- The farm needs a close management and a fine tuning.
  - The owner is present on the farm everyday; he is dynamic and he is a *leader* with high technical skills.
  - He supervises all the work done in the farm (workers and purchase of inputs), giving precise and technical directives, verifying the packaging of the production to avoid any theft.

- The farm is oriented towards an export market and there is an important post harvest work (packaging, commercialisation…)[187].

- The farming systems are characterized by very high Initial Investments (notably in terms of value per unit of surface; that is a characteristic of farming systems in terms of capital) mainly due to orchards (in the *Highlands*), greenhouses, trucks, land preparation material and other modern and "high-tech" techniques.
  - In the Valley, Initial investments are thus included between 4.000 and 250.000 $/farm (i.e. 700 to 2.600 $/dunum according to the farming system considered);
  - In the *Highlands*, Initial investments are included between 125.000 and 685.000 $/farm (i.e. 400 to 2.300 $/dunum according to the farming system considered).

[185] For further information on the figures and on their correspondence with the different farming systems considered, please refer to appendixes and to the graphical representations presented. We consider in this classification that permanent employees (mainly Egyptian) receiving a salary for their field or management work are not *farmers*. The term farmer refers both to what has been previously called *'Fellahin'* and *'Muzzarehin'*

[186] The existence, in the valley, of intensive entrepreneurial farmers renting the land they crop is due to the fact that until 2001, there has not been any land market. Land transfer (purchase and selling) was impossible and these farmers who were not originating (in most of the case) from the area did not beneficiate from the land reform of 1962. As they have not been granted any land, they thus have, afterwards, to rent plot to develop their intensive agricultural activity.

[187] The sole exception is the bananas farms in the Jordan Valley, since their production is only marketed in Jordan.

- The cropping techniques developed are intensive both in terms labour (salaried workers) and inputs (fertilizers, seeds…) and the annual costs are thus very high.
    - There is always a salaried manager supervising the permanent qualified and specialized employees (the manager often belongs to the owner's family while the employees are, in most of the cases non Jordanian –mainly egyptian) as well as the purchase of inputs.
    - In the Valley, annual costs are very variable because of the diversity of farming systems developed and generally included between 650 and 2.450 $/dunum/year.
    - In the *Highlands*, annual costs are more homogeneous and included between 600 and 850$/dunum/year according to the farming system considered.

- These intensive farming systems (in terms of labour, inputs and capital) allow to insure an important annual Net Profit included between 400 (case of greenhouses) and 2.600 $/du/year (case of bananas) in the Valley and between 1.300 and 1.700 $/dunum/year in the *Highlands* (case of fruit trees).

(ii) Absentee Entrepreneurial farmers: farming system characteristics

- These farmers are capitalist investors. They develop a strategy of diversification to put their capital to work in different economic sectors. In agriculture, they invest in costly and productive techniques. These farmers can **only** be found in the Highlands. They can be owner of the land they crop (fruit trees farmers) or tenant (greenhouses farms)

- They are Part time farmers. The agricultural activity is a secondary one and it is not the main source of revenue of the owner.

- The farm is not closely managed. Admittedly, the farming systems developed would need technical skills and a close management but in the reality there is no fine tuning because of an owner's lack of agricultural knowledge. By doing high initial investments, the owner thinks he has implemented a modern, productive and immutable farming system which can function on its own.
    - The owner does not intervene regularly in its farm ;
    - All the management is done by a manager who takes the technical and practical decisions and supervises the permanent employees.

- Farming Systems are characterized by high initial investments[188] (both in gross value and in value per unit of surface) mainly due to orchards and greenhouses and is included between 75.000 and 950.000 $/farm (i.e. 500 to 1.500 $/dunum according to the farming system considered. We can note it is lower than for intensive entrepreneurial farmers; the systems developed are thus less intensive in terms of capital even if it remains still highly intensive).

- There are also high annual costs both in terms of labour (salaried workers) and Inputs (fertilizer, seeds). Because of the lack of agricultural knowledge and fine tuning, these costs are higher than necessary and also higher than the costs paid in the farms implemented by intensive entrepreneurial farmers (while they should be equivalent -or even lower- on a simple technical point of view). They reach 850 to 2.600 $/dunum/year according to the farming system considered.

- The Net profit brought out in these systems is variable: very high for fruit trees farms (around 1.500 $/dunum/year) and relatively low for greenhouses farms (100 to 350$/dunum/year) because of the 'rough-tuning' characterizing the farm.

[188] There is one exception: greenhouses farmers cropping under a sharecropping arrangement. The sharecropper does not invest in the farm but is an extensive entrepreneurial farmer.

(iii)Absentee Owners: farming systems characteristics

- These farmers are capitalist investors, owners of the land they crop. They develop a strategy of diversification to put their capital to work in different economic sectors (multi-resources economy). In agriculture they invest in extensive, *easy managing,* farming systems (citrus and olive trees orchards, vegetables in open field…).

- They are Part time farmers. The agricultural activity is a secondary one and it is not the main source of revenue of the owner. The owner does not have any agricultural skills.

- The farming system, which does not need peculiar technical skills, can be characterized by a 'rough tuning'. We can speak of *'rough-easy-farming'.* The owner never intervenes in its farm, all the work being done by a manager and some permanent employees (mostly Egyptian)

- Farming Systems are generally characterized by low initial investments (notably in terms of value per unit of surface) in the Valley and very variable in the *Highlands*[189].

  - The initial investment is actually included between 0 and 30.000 $/farm (i.e 0 to 300 $/du according to the farming system considered) in the Valley mainly depending on the presence of a citrus orchard.
  - In the *Highlands* two sub-groups can be identified: some farms have necessitated very low investments (0 to 20.000 $/farm; i.e. 0 to 300 $/dunum); while other have necessitated high investments mainly linked to well's digging (250.000 to 400.000 $/farm i.e.1.500 to 4.000 $/dunum according to the farming system considered)

- Because these farming systems do not need a close management and because of the rough tuning, the annual costs are relatively low and in most of the cases not closely adapted to the real needs[190]. These farming systems do not need a lot of work and the use of inputs stay relatively limited.

  - Annual costs are included between 150 and 300 $/dunum/year in the valley, according to the farming system considered.
  - In the *Highlands,* annual costs are included between 80 and 400 $/dunum/year, according to the farming system considered.

- These extensive (in terms of capital, labour and inputs) and *easy managing* farming systems developed allow producing a low (case of orchard)-to-medium (case of vegetables in open field) annual Net Profit included between 50 to 300 $/dunum/year in the valley and between 5 and 450$/dunum/year in the *Highlands.*

(iv) Familial Farmers: farming systems characteristics

- **Familial farmers work on their farm.** They are *'full-time' farmers* (thus contrasting with part time farmers); agriculture is their sole activity but they have a tendency to diversify it to better insure their revenue and to put the familial workforce to advantage. In a country where herding has an important cultural place (Bedouin society), farmers often have, for example, a breeding activity based on a small herd (sheep's and goats). This breeding

[189] In the *Highlands*, we can actually find farming systems characterized by very low initial investment and other with high initial investments. The latter situation is the case of landlords having a deep well but who 'reclaim' their land thanks to several sharecropping arrangements. They thus do not have any agricultural activity and only beneficiate of 'agricultural revenue' according to their sharecropping contracts. In this situation we can also find some landlords having large irrigated plots of olive trees in the *Eastern Deserts*
[190] They can be higher or lower that necessary.

activity, which remains secondary compared to the agricultural one (fruits and vegetables cropping), has to be considered as a security: the herd is a 'living capital' which can be used during bad years.

- Familial farming systems are also characterized by a *multi-resources economy*. Actually, even if farmers are *'full-time farmers'*, the family always beneficiates from another source of revenue. This added revenue is often a civil servant salary (earned by one of the sons of the family participating to the family's expenses) or a civil servant pension (directly earned by the family's head, now retired *and* working on the farm)[191]. However, this revenue is not central, it remains marginal. The functioning as well as the profitability of the farming system do not depend on this 'alternative' source of revenue.

- There is no clear tendency concerning the land tenure: familial farmers can be owner, tenant or even sharecropper on the land they crop. Generally, the family does not have access to modern and very productive techniques too costly for their financial means.

- The farming systems developed are characterized by a close management (there is no part time farmers) since the family is involved in the field work. However, generally, the farmers' technical skills remain insufficient for an optimal management of the cropping techniques.

- The farming systems developed are characterized by a **very variable level of initial investment** both in terms of gross value and value per unit of surface. That is linked to the variable investment capacities of the farmers and thus to the diverse production systems and cropping methods developed (orchards, greenhouses, open field…)[192].

  - In the valley, the initial investments are actually included between 2.000 and 100.000$/farm (i.e. between 85 and 2.000 $/dunum according to the farming system considered)
  - In the *Highlands* the initial investments essentially depends on the land-and-water tenure (they are higher when the farmer owns a well). They are thus included between 1.000 and 500.000$/farm (i.e. between 60 and 1.000 $/dunum according to the farming system considered if there is no well on the farm and between 1.500 and 4.000 $/du if there is a well).

- The familial farming systems are very intensive in terms of labour. It is mostly the familial workforce which is used. Occasionally, when it is necessary some workers can be employed for the peaks of work (seedling, weeding, harvest),. Generally wages costs represent less than one third of the total annual costs.

- Farming systems can be more or less intensive in terms of inputs (fertilizers and seeds) according to the cropping techniques developed and to the financial means of the farmers. Generally, farmers have a 'fine-tuning' of their inputs to limit their annual costs.

- In familial farming systems, the cropping methods are very diverse but generally inputs highly-consuming and that lead to medium-to-high annual costs.

  - In the valley, annual costs are variable and included between 200 and 1.800 $/dunum/year according to the farming system considered.
  - In the *Highlands*, annual costs are also variable and included between 150 and 1.500$/dunum/year according to the farming system considered.

[191] These civil servant sources of revenue are particularly important within a country where almost half of the population has been employed, during one period of its life, in governmental services (army, police, ministries….)

[192] In consequence the parameter 'initial investment' is not pertinent to differentiate the familial farming systems from the other farming systems existing in the *Lower Jordan River Basin in Jordan.* The pertinent parameter is the use or not of the familial workforce on the farm.

- The profitability of the familial farming systems is very variable according to the cropping methods implemented, to the investment capacities of the farmers and to their *annual* financial means.
    - In the valley, Net profit brought out in vegetables farming systems are included between 200 and 550$/dunum/year. In citrus farm, the net profit only reaches 100 to 150 $/dunum/year while it can reach 900 to 2.500 $/dunum/year in bananas farms in the south of the valley.
    - In the *Highlands*, vegetables farms allow bringing out a profit included between 100 and 400$/dunums/year while in fruit trees farm, the farmer's revenue can is included between 400 and 1.300$/dunum/year

(v) Poor Farmers

- **All the Poor farmers are familial farmers**. The family is closely involved in the farm field work and the familial workforce constitutes the main resource in such farming systems.

- The surface cropped by the family is generally low and, in most of the cases, farmers are tenant or sharecropper of the land they cropped (the sole exception is large open field vegetables owned farms located in the *Eastern Deserts*).

- These farmers always have several activities, they are **part-time farmers** and have other sources of revenue (they can have a waged-work in public services, in private company, they can be taxi or bus driver…). Farmers clearly develop a **strategy of diversification** to put the familial workforce to advantage. They always have, for example, a small breeding activity (the herd being considered as a 'living capital' to be used during bad years) and the female familial workforce is often sold when it is not needed in the familial farm. These other sources of revenue are, at least, equivalent to the low revenue brought out thanks to the agricultural activity and essential to the already precarious livelihood of the farmer and its family. Farming systems are characterized by a *multiple resources economy* and farmers are highly concerned by the problems of indebtedness and poverty.

- Farming systems are characterized by an 'appreciative' management leading to a non-optimal development of the cropping methods and to average-to-bad results (both in terms of yields and quality of the production). That is linked firstly to the absence of the needed financial means and secondly to the farmer's lack of technical skills and knowledge.

- The farming systems developed are characterized by a low level of initial investment[193] both in gross value and in terms of value per unit of surface. These investments are included between 15.000 and 40.000 $/farm (i.e. 200 to 750 $/dunum according to the farming system considered) often corresponding to one or two trucks allowing the transportation of the production

- Farming systems developed are intensive in terms of familial workforce. Daily workers are rarely hired (during the peaks of labour: seedling, weeding, harvest…) and wages costs thus remain very limited (inferior to 15% of the total annual costs)

- Farming systems are extensive in terms of inputs, but the provision of fertilizers is not finely tuned due to a lack of agricultural skills and annual costs are medium, included between 300 and 700 $/dunum/year

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[193] There is one exception to this observation. Owners of well (and of desert land) cropping large plots of vegetables in open field in the *Eastern Deserts* have actually done high investments decades ago (during the 1970s) mainly to dig their well.

Box: Technical characteristics of the production systems within the Lower Jordan River Basin in Jordan

	Vegetables in open field	Vegetables under greenhouses	Stone fruit trees	Bananas Orchards	Citrus Orchards	Olive trees orchards (Easy & Prestige Farming)
Climatic conditions	Nothing particular	Nothing particular	Do not withstand very high temperature in summer	Do not withstand cold wheater in winter	Do not withstand cold wheater in winter	Do not withstand very high temperature in summer
Location	The entire Basin	The entire Basin	Highlands	Jordan Valley Only	Jordan Valley Only	Highlands and northern valley
Initial Investments	**Low to Medium** (irrigation systems, mulch...)	**High** (Greenhouses, irrigation system, mulch...)	**Very High** (Plantation, irrigation system…) Profitability delayed	**Very High** (Plantation, irrigation systems...)	**Medium to High** (Plantation, irrigation System) Profitability delayed	**Medium to High** (Plantation, irrigation System)/ Profitability delayed
Annual Costs (production and wages)	**Medium to High** (inputs, daily or permanent workers)	**Very High** (Seeds, soil fertigation, fertilizers and pesticides, permanent workers)	**Very High** (Inputs and permanents workers)	**Medium**	**Very Low**	**Very Low**
Peculiar Technical skills requirements	**Low to Medium**	**Medium to High**	**High** (modern and 'high-tech' techniques -trees pruning-)	**Low** (There isn't any modern and 'high tech' technologies, there isnt any peculiar pathologies, no need of peculiar knowledge,)	**Nul** (there isn't any problem of fungus or other peculiar pathologies)	**Nul** (there isn't any problem of fungus or other peculiar pathologies)
Time and management requirement	**High** all the year long (fine tuning of the irrigation, of fertigation and phytosanitary treatments to free oneself of the risks) CLOSE MANAGEMENT	**Very High** all the year long (fine tuning of the irrigation, of fertigation and phytosanitary treatments to free oneself of the risks) CLOSE MANAGEMENT	**Very High**, all the year long (control of irrigation's quality and quantity, of the production's quality, of the employees' work especially at harvesting, of the production marketing) CLOSE MANAGEMENT	**Very High**, all the year long (control of irrigation's quality and quantity, of the production's quality, of the employees' work especially at harvesting) CLOSE MANAGEMENT	**Very Low**	Nul
Inputs requirement	**High** (fertilizers, pesticides treatments)	**Very High** (fertilizers, pesticides treatments)	**Very High** (fertilizers, pesticide treatments…)	**Very High** (important quantity of fertilizers)	**Very Low**	**Nul**
Labour force requirement	**High** all the year long (seedling, weeding, harvesting and control)	**Very High** all the year long (seedling, weeding, harvesting and control)	**High** all the year long (essentially control)	**Medium**	**Very Low** (excepted for the harvest)	**Nul** (excepted for Harvest)

Water quality	**Low to Medium**	**Low to Medium**	**High** all the year long	**Very High** all the year long	**Medium**	**Nul**
Water quantity	**Medium**	**Medium**	**High** all the year long	**Very High** all the year long	**High** (notably in summer)	**Very low**
Irrigation's fine tuning	Very High during the 8 months-cropping-season	Very High during the 8 months-cropping-season	**Very High** all the year long	**Very High** all the year long	**Medium** (notably in summer)	**Very low**
Risks inherent to the production system	**Very High** (crops sensible to vagaries, losses can be important)	**High** (even if greenhouses allow softening the risks). Need of a close management to avoid important losses.	**High** (risky production system, need of a fine tuning to insure the quality and the quantity of the production)	**Nul to Very Low**	**Low**	**Nul**
Profitability ($/dunum/year)	**Low to Medium**	**High**	**Very High**	**Very High** (peculiar marketing conditions in Jordan with customs duties)	**Very Low** (since the mid of the 1990s)	**Very Low**
Prices of production	Fluctuating and Low	Fluctuating and Medium	Stable and High	Stable and Very High	Stable but Low	Fluctuating and Very Low
Marketing conditions	Difficult (overproduction + problems of quality)	Medium (periods and quality of production more favourable than in open field)	Good (if time is granted to post harvest work)	Very Good	Difficult (overproduction + problems of quality)	Difficult (overproduction)

In this table we used a coloured code to organize the characteristics of the production systems into a hierarchy. For each indicative used in the table, the characteristics of the production systems can be arranged according to five different *levels*. In other words, to the question: What is the importance of the parameter *X* in the production System *Y*? ; There are five possible answers:

- **Very High** (in red in the table)
- **High** (in orange in the table)
- **Medium** (to High) (in green in the table)
- **Low** (to medium) (in blue in the table)
- **Nul to Very Low** (in black in the table)

Box 9. ***Technical Characteristics of production systems within the Lower Jordan River Basin in Jordan***

- The profitability of the farming system is very low and the net profit expected in an average year only reaches 10 to 270 $/dunum/year[194].

Through the description of these five sub-classes of farmers we have underlined that the same dynamics are occurring in the Jordan Valley and in the *Highlands*, and that the same kind of farmers can be found in the two main regions of the *Lower Jordan River basin in Jordan*. Moreover, in each sub classes, the same phenomenon can be observed: the initial investment is always higher in the *Highlands* than in the Jordan Valley (if we do not consider the land-value in the Jordan valley)[195], and the related Net profit lower in the *Highlands* than in the valley. In each sub-group of farmer, the quotient Net Profit/Initial Investment is always higher in the Valley than in the *Highlands*. That reveals that farms in the Jordan Valley are generally more intensive (in capital, labour and inputs) than in the *Highlands*.

IV.5.2 Strategies developed by each kind of farmers

Thanks to the farmers classification we have done above and thanks to the main technical characteristics of the production systems we have listed besides (cf. box on the previous page) we can try to identify the strategies developed by each kind of farmers. They are presented below and in the following summary table.

(i) Intensive entrepreneurial farmers

These farmers are full time farmers, true leaders, with important financial means (money is not a limiting factor). They develop an agricultural logic consisting in choosing the productions allowing the highest profit margin even if the needed techniques to implement are risky, costly and time consuming.

In the valley, they thus develop bananas orchards if they have the possibility to do so (it is mainly conditioned by access to land and water). If no, they thus implement greenhouses to develop a high-quality vegetable production oriented towards an export market[196].

In the *Highlands*, these farmers develop stone fruits trees orchards if they own the land they cropped. If not they implement, like in the Jordan Valley, greenhouses to have a high-quality vegetable production oriented towards an export market

(ii) Absentee entrepreneurial farmers

These farmers can only be found in the *Highlands*. They are Part-Time farmers and their agricultural activity only constitutes a secondary source of revenue linked to a peculiar logic of complementary development of their capital. Moreover, they have important financial means and choose to invest in risky, costly and time-consuming techniques to insure a high profit. However they want to invest neither their personal time nor their workforce in the agricultural activity and all the work is done by employees. That leads to an approximate management and to a 'rough tuning' of the production system. Economic results are thus lower that it could be.

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[194] It is worth noticing we do not have accounted here the primary results of familial solidarity which is the circuit of resources as forms of aid, exchange, mutual assistance and indeed are relevant resources for this peculiar kind of farmers.

[195] It is justified by the fact that between 1962 and 2001, there was no land market within the Jordan Valley (cf. previous section)

[196] Some example of high-quality date production can also be found. Some intensive entrepreneurial farmers located in the middle of the valley, actually developed some large date palm trees orchards. However, it remains still marginal, limited to the middle of the valley. We will see in one of the following section that a high-quality date production may constitute an interesting opportunity in the Jordanian Context within the following decade.

According to the area, they implement stone fruit trees orchards or vegetables under greenhouses and in a second time they choose to rent out their land or to contract several sharecropping arrangements.

(iii) Absentee Owners

Like for the absentee entrepreneurial farmers, absentee owners are Part-Time farmers; their agricultural activity only constitutes a secondary source of revenue. The main difference with the previous group of farmers in that they choose to do medium investments in more stable and non-risky techniques even if the profit remains low. They feel a strong attachment to their land and the social and the prestige value of the farm seems to be more important that their low economic value. We can thus qualify the systems developed as some 'social prestige farming' systems.

Their agricultural activity is linked to a peculiar logic of complementary development of their capital. They want to invest neither their personal time nor their workforce. They thus develop "easy farming" systems like citrus orchards in the valley and open field vegetables plots (approximately managed) with olive trees orchards in the *Highlands*. In a second time, they choose to rent out the land they owned.

(iv) Familial Farmers

Familial farmers are looking at insuring sufficient revenues thanks to their labour force. They put the familial workforce to advantage. According to their labour-force capacities and to their financial means, they will thus choose to implement production systems insuring the highest possible revenues and softening the risks at the same time.

In the Jordan Valley, they thus prefer implementing bananas farms if they have the possibility to do so (it is mainly conditioned by access to land and water). If not they thus develop vegetables farming systems from the more intensive to the more extensive (it is mainly conditioned by the familial capacities to invest): greenhouses; mini-tunnel; mulch and drip irrigation; surface irrigation.[197]

In the *Highlands*, they first choose to implement fruit trees orchards if they have the capacity to do the needed high investments otherwise they developed vegetables farming systems according to the same process of intensification than in the Jordan Valley.

(v) Poor farmers

These farmers are familial farmers looking at optimizing the familial workforce. They have access neither to land nor to water and have very limited financial means: they can not invest in their production system. They thus develop extensive vegetables farming systems (surface or mulch and drip irrigation) and diversify their activities (breeding, renting out of the female familial workforce….) both in the Jordan Valley and in the *Highlands.* Farming systems are characterized by a *multiple resources economy* and farmers are highly concerned by the problems of indebtedness and poverty.

IV.5.3 Summary table: farmer's strategies

[197] Familial farmers rarely develop citrus orchards since the revenue brought out is very low. That is only the case for old farmers who do not have an important familial work-force and who want to develop easy farming systems non time consuming.

Net profit is naturally closely linked both to the initial investment and to the character (intensive or extensive) of the farm since strategies allowing maximizing the Net Profit are the more costly. The description done above allows us elaborating a rough ‘classification’ of the irrigated farming systems in the Lower Jordan River Basin in Jordan. Five different groups of farmers have thus been identified: Intensive entrepreneurial farmers, absentee entrepreneurial, absentee owners, familial farmers and poor farmers.

According to the agricultural area considered, these different groups are more or less important in the agricultural landscape and farmers develop different strategies according to the characteristics of the area (the relative importance of each group of farmers is indicated in % in parenthesis)[198].

On the following table, we identified the strategy according to four main agricultural areas: north, middle, south of the Jordan Valley and *Highlands*. We used a doubled- coloured code:

- For each area, red indicates the very widespread farmers (proportion superior to 25%), blue indicates existing farmers (proportion included between 10 and 25%), black indicates rare farmers (proportion inferior to 10%).
- For each kind of farmer (in one given area), green indicated very widespread strategy (farming system), brown common strategy and grey very rare strategy.

Strategies developed by the different kinds of farmers		**First choice**	**Second choice**	**Third choice**
North of the valley	Intensive entrepreneurial farmers (10%)	Bananas with drip irrigation and high level of fertilizer	Vegetables for export under greenhouses	Citrus with plot irrigation, high level of fertilizer, new varieties and frequent renewal of the orchard
	Absentee entrepreneurial farmers	*There is no farmer of this kind in this area*		
	Absentee Owners (40%)	Citrus with surface irrigation with a low level of fertilizer	Renting out	Wheat and olive orchards
	Familial farmers (45%)	Maximum of bananas trees	Maximum of citrus orchards	A varied production of vegetables in open field
	Poor farmers (5%)	Mixed farms (citrus & bananas)	A varied production of vegetables	
Middle of the valley	Intensive entrepreneurial farmers (40%)	Vegetables for export under greenhouses		
	Absentee entrepreneurial farmers	*There is no farmer of this kind in this area*		
	Absentee Owners (20%)	Citrus with surface irrigation with a low level of fertilizer	Renting out	Wheat
	Familial farmers (25%)	Vegetables under greenhouses	Vegetables in open field	
	Poor farmers (15%)	A varied production of vegetables in open field + wheat +breeding activity. Surface or drip irrigation		

[198] Figures have only to be considered as rough evaluations and guidelines, they are not based on a statistical work.

	Intensive entrepreneurial farmers (30%)	Bananas with drip irrigation and high level of fertilizer Very intensive way of cropping	Vegetables for export under Greenhouses and in open field	
	Absentee Entrepreneurial farmers	*There is no farmer of this kind in this area*		
South of the Valley	Absentee Owners (10%)	Renting out		
	Familial farmer (45%)	A maximum of banana trees under drip irrigation/ bananas plantation developed in relation with vegetable crops	Vegetables in open field with a high level of Inputs and work	
	Poor farmers (15%)	Mixed farms bananas-vegetables in open field + breeding activity	A varied production of vegetables in open field + breeding activity	
Highlands	Intensive entrepreneurial farmer (25%)	Stone or pipes fruit plantation with drip irrigation and high level of fertilizer	Vegetables for export under greenhouses	
	Absentee entrepreneurial farmer (10%)	½ Stone fruits under drip irrigation and ½ of olive trees Approximate management *Eastern Deserts* Vegetables under greenhouses Approximate management *Upper Yarmouk, Transition and Suburban Areas*	Renting out or sharecropping	
	Absentee Owners (25%)	½ Vegetables in open field with an approximate management ½ of olive trees	Very large plantation of Olive trees under drip or furrow irrigation	Renting out
	Familial farmer (25%)	Stone or pipes fruit plantations if the land is in ownership	Vegetables under greenhouses High level of Input	Vegetables in open field + olive trees orchard if land in ownership High level of Input
	Poor farmers (15%)	A varied Production of vegetables in open field + breeding activity		

Table 28. Strategies developed by the different kinds of farmers within the Lower Jordan River Basin in Jordan

Box 10. **Farmer's Relations to Water**

We will focus here on the water-tenure and on the importance water costs have for each kind of farmers we have identified above. We will present in this box the panel of effective water prices in the different farming systems within the *Lower Jordan River Basin*. For farmers supplied with 'public water', the effective price of water corresponds to the amount charged to the farmer by the Jordan Valley Authority (JVA). For farmers supplied by a private source (i.e. a private well), the effective water price corresponds to pumping costs, maintenance costs of the well and renting (for tenants) or depreciation (for owners) costs of the well.

Let us do first a preliminary remark: we can say that there isn't any clear dynamic as far as the average water price per cubic meter is concerned. The figures observed are actually quite similar for four of the five kinds of farmers we have identified: intensive and absentee entrepreneurial farmers, absentee owners and familial farmers. These average effective water prices are summarized in the table below.

Farmers' group	Intensive entrepreneurial farmers	Absentee entrepreneurial farmers	Absentee owners	Familial Farmers	Poor Farmers
Average Price of water ($\$/m^3$)	0,051	0,065	0,064	0,061	0,04

Table 29. Effective water prices ($/m3) for each kind of farmers in the Lower Jordan River Basin in Jordan

As the table above illustrates it, sole the poor farmers group is actually an exception since the average water price per cubic meter is significantly lower (average of 0,04 $\$/m^3$) than in the other groups of farmers. That is due to the high proportion of sharecroppers (for which water is *'free'*[199]) within the group constituted by the poor farmers.

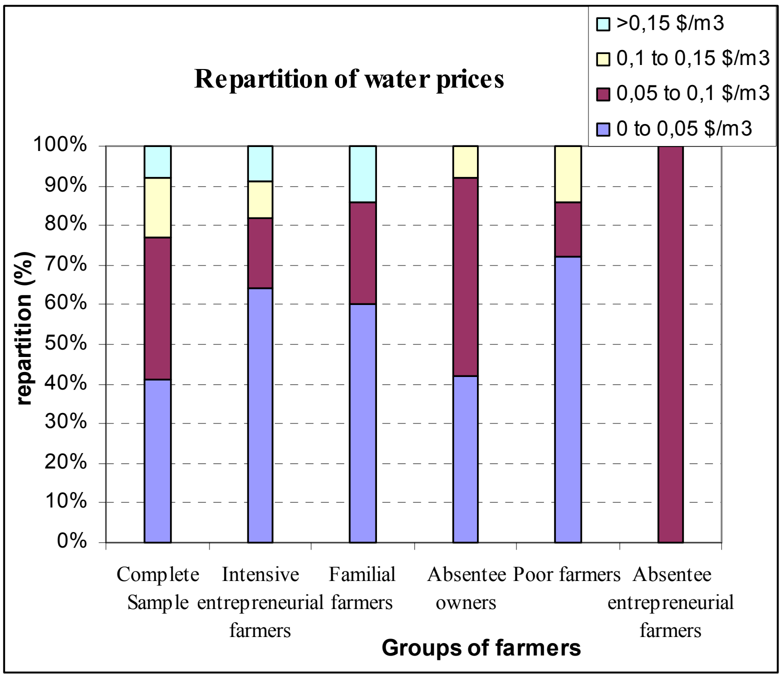

Figure 22. Repartition of effective water prices ($/m3) within for classes of prices according to the different kinds of farmers

It is important to note that agricultural effective water costs are very low. On average, in the Valley, water is actually charged at 0,02 $\$/m^3$ by the JVA while in the Highlands costs are generally included between 0,06 and 0,2 $\$/m^3$[200]. Moreover, in the five groups of farmers, average effective water prices (in $\$/m^3$) fluctuate within the same range from 0 to 0,2 $\$/m^3$ and the repartition is as illustrated in the chart besides

Concerning effective water prices in terms of $/dunum, a clear dynamic can be underlined as illustrated by the chart presented on the following page; the average effective water prices are actually different from one class of farmer to another. Firstly we can say that water prices in $/dunum are, in most of the cases, included between 0 and 150$/dunum[201]. Moreover, their variability within a class of farmers is directly linked to the diversity of farming systems which are implemented within this class. We can therefore observe a very important variability of the situations for familial farmers and intensive entrepreneurial farmers (who can develop different kinds of farming systems -Cf. The farmers' classification above) while the panel of situations is less important for poor farmers and absentee owners who have less technical possibilities. Finally, the rare farming systems developed by absentee entrepreneurial farmers are characterized by similar water prices.

[199] The costs linked to water exploitation (pumping, maintenance of the well…) are actually paid by the landlord contracting the sharecropping arrangement and not by the sharecropper.
[200] These costs can be compared to the governmental fees implemented on water pumped for industrial or domestic purposes which are higher and reach 0,35 $\$/m^3$.
[201] Lower costs of water correspond to farms with a sharecropping arrangement, while higher costs are for farms in which the water is bought and charged per cubic meter.

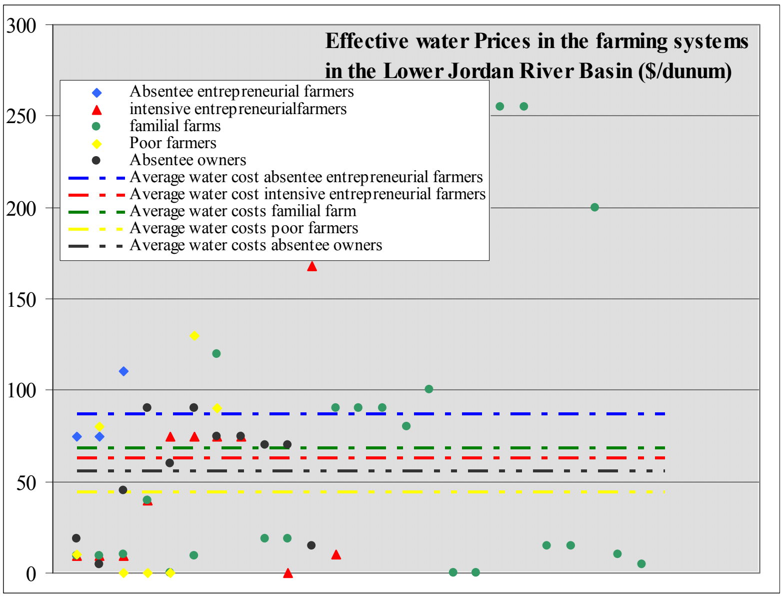

Figure 23. Effective water prices ($/dunum) in the different farming systems within the Lower Jordan River Basin in Jordan.

We can observe on the chart besides that, in average, poor farmers pay the lowest costs (44$/dunum) of water within the Basin (that is due to the high proportion of sharecropper within this peculiar class of farmers -Cf. Above), then come the absentee owners (56 $/dunum) developing non water consuming farming systems in the *Highlands* (olive orchards) or beneficiating from the very low water prices of the Jordan Valley for their citrus orchards. Concerning the three other classes of farmers who generally develop farming systems requiring more water than the two first classes; intensive entrepreneurial farmers have lower water costs than familial farmers while the highest costs are finally paid by absentee entrepreneurial farmers. This hierarchy can be explained by the management of the production systems developed by these three kinds of farmers and we observe that **closest is the management, lowest are the water costs**. We can actually find similar production systems developed within the three classes of farmers (stone fruit trees orchards, vegetables under greenhouses… cf. above), but their way of management differs a lot. Intensive entrepreneurial have actually an important agricultural knowledge, are closely involved in the management of their modern technical farm: they developed a fine tuning of their production system and of their modern irrigation system and thus reduce their water costs because of an adapted irrigation to the crop requirement (costs reach 63 $/dunum). Familial farmers are closely involved in their farm management but generally have neither the modern techniques nor the necessary technical skills, the irrigation's tuning is thus less adapted and the water costs a little bit higher (69 $/dunum). Finally, absentee entrepreneurial farmers admittedly develop modern techniques but they are not involved in the farm management, all the work is done by employees lacking the needed technical skills and the water costs are thus higher (87 $/dunum) because irrigation is not finely tuned.

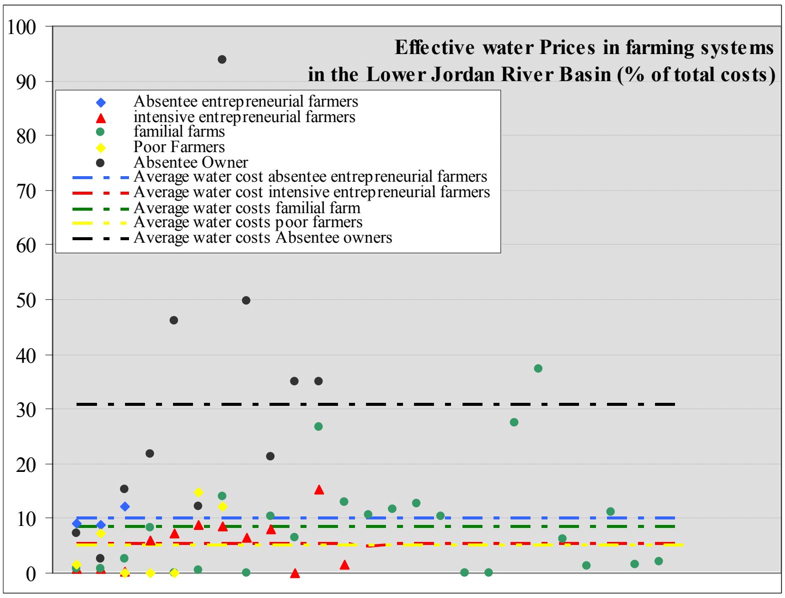

Figure 24. Effective water prices (% of total costs) in the different farming systems within the Lower Jordan River Basin in Jordan.

The chart besides clearly shows that water costs only represent a small share of total costs for poor farmers (5%, that is because of the high proportion of sharecroppers in this peculiar class of farmers) and for intensive entrepreneurial farmers (5%, it is because these farmers develop very intensive and costly farming systems in which inputs and wages costs are very high). For familial farms, water costs only represent 8,6% of total costs (familial farmers actually generally have an intensive use of inputs -fertilizers, pesticides- in their production systems while they reach 10% for absentee entrepreneurial farmers (who have high costs of labour and inputs because of the rough tuning characterizing their production system). Finally, water costs are very important for absentee owners developing extensive production systems both in terms of inputs and works and reach, on average, 31 % of the total costs.

The differences we can observe in the relations the farmers have to their agricultural water let us suppose that they will react differently to the water policies to be implemented in Jordan within the next few years. An increase in effective water prices will actually have more consequences on the revenue brought out in absentee owners farming systems than in the very intensive farming systems developed all over the basin. If the expected decrease in the revenue would be higher, it does not mean these systems will know the most important changes. The most affected systems would actually be the systems having a more social-and-prestige value than an economic one and a high decrease of the revenue brought out in such farming systems could have less importance that a low decrease of the revenue in familial farming systems.

Based on this qualitative and peculiar understanding of the processes occurring at the farming system scale, we will try in a following section to identify what could be the general tendencies of evolution of the irrigated agriculture, in relation to the new policies of water management to come, at the Lower Jordan River Basin Scale.

V. WATER MANAGEMENT CHANGES' IMPACTS ON THE FARMING SYSTEMS PROFITABILITY

V.1 FOREWORD ON THE METHODOLOGY USED

In Jordan, we firstly envisaged to realize an important field work based on interviews with farmers. These interviews should allow us complementing the knowledge of the farming systems we had since our surveys done in 2003. These semi-directive surveys (cf. guideline in appendix VI) would have been turned to water concerns and their aim would have been to identify the position of farmers regarding to the changes in water management to occur

Within this vision, we began by one week of surveys within the north of the Jordan Valley. In our mind, we interviewed farmers as the representatives of one of the farming systems we had identified in 2003 and which are described above. The observation of the farm landscape added to some questions about cropping pattern, cropping method and equipment were enough to 'class' the farm according to our farming system classification. The aim was to identify the different positions farmers could have concerning water according to the farming system they developed. However, we quickly understood that we do have neither the needed time nor the necessary skills to lead such interviews -more sociological than technical- and that it was useless if we pursued the aim of developing our knowledge of the Jordanian agricultural sector. Information we have obtained were not new but have confirmed what we already know, what is a result in itself. In the valley, the general acceptance of the principle of an increase of water prices, and on another hand the general ignorance of the studied shift from freshwater to treated waste water in the north of the valley were really clear, even in the few surveys we have done.

Concerning, the water price increase in the valley, there is a true acceptance of the principle but from the very moment when it is question of quantification in term of amount of money, farmers do not have –or do not want to have- any idea of what could happen. We did not want to deal with willingness to pay -which is another problem-, we thus do not have deepen our surveys on this point. Aiming to quantify the water policies' impacts we preferred have chosen 'objective' scenarios (cf. below) to quantify the consequences of the two measures we wanted to study.

We thus have modify our methodology and have lead few open discussion with farmers we met in 2003 and which have been identified as interested in our approach. In the valley, we mainly have discussed with relatively high-skills farmers developing high-value crops and/or modern cropping method in the middle of the valley in order to have a better knowledge of the impact of the treated waste water on their farming systems (conclusions drawn from these surveys are presented in the paragraph V.2)

In the *Highlands*, the situation concerning water concerns was clearer since the changes in water management we wanted to study were already implemented –See the following section. We also have led some open discussions with several farmers met last year, trying to have a representative sample of the different farming systems of the region[202]. The aim was to identify the strategies the farmers could develop to adapt their farming system to the new water-conditions. Results are presented in the paragraph V.3.

[202] We limit ourselves to the eastern desert region, identified as the most important concerning agricultural groundwater abstraction. As far as the *Highlands* are concerned, it is actually within this area that the main modifications following the changes in water management should occur.

V.2 CHANGES IDENTIFIED IN WATER MANAGEMENT

V.2.1 Introduction

We have identified two main changes in the water management in Jordan which mayoccur within the next few years and will have some important consequences on the farming systems of the Lower Jordan River Basin in Jordan.

The first one results from the 'demand management' principles and consists in an increase of the agricultural water-prices. According to the duality of the water supply within the Basin (public supply in the valley and private supply in the *Highlands*) we will work on a double evolution. We will try to evaluate what could be the consequences of an increase in the public water prices in the valley. This measure is not already taken but constitutes a natural evolution in the Jordanian water context. We will then quantify the measures already taken in the *Highlands* and aiming at reducing the groundwater abstraction by increasing the effective price of water for the farmers.

The second change proceeds from a 'supply management' principle and consists in supplying the north of the valley with treated waste water instead of freshwater. It is also one of the probable evolutions which could occur in Jordan since the domestic freshwater demand is growing while the amount of waste water increases and since freshwater coming from the north of the valley is already pumped to Amman in increasing quantities.

V.2.2 Water price increase

(i) First taxes already implemented

Two taxes have already been implemented on water abstraction from groundwater. The first one in 1994 concerned abstraction for industrial and tourist purposes. Owner of wells are charged 0,250 JD (0,35$) for each cubic meter they pump. Since 2002; 0,35 dollars are charged for each cubic meter sold for drinking purposes[203]. We will see this fee had important consequences on the profitability of farming systems located within the suburban area.

On governmental wells, the fees are not the same: 0,35 $\$/m^3$ have to be paid for beautification purposes (public gardens…)while it is 0,14 $\$/m^3$ for groundwater pumped for drinking purposes.

(ii) Increase of public agricultural water prices

- The present situation: Water prices and quotas

In the Jordan valley, the irrigation network is (mainly) managed by the Jordan Valley Authority which is in charge of the water billing. Historically[204], quotas have been implemented and were the following:

	vegetables		citrus	bananas
From the 16/4 to the 15/12	2 mm/day/du	From the 1/5 to the 31/10	4 mm/day/du	8 mm/day/du
Others period	On demand		On demand	On demand

The orchards (citrus or bananas) planted after 1990, were only supplied as vegetables. This allocation corresponds to a supply of 480 m3/du/year for vegetables; 720 m3/du/year for Citrus; 1440 m3/du/year for bananas if the 'on-demand' period is excluded[205].

[203] This last measure has been taken in order to limit private water supply in Amman to induce important water consumers (hotels, restaurant) to be connected to the public supply network of Amman.
[204] According to technical studies developed during the 1950s and the 1960s
[205] During the controlled period, when crops require it and if there are enough farmers demanding it, the pumping station can deliver extra-hours of water supply.

Prices were the following[206]:

Public Water Prices in the Valley			
	Q (m^3/month)	Price (Fils/m^3)	Price (\$$m^3$)
FU= or < to 35 dunums	0-2500	8	0,0112
	2500-3500	15	0,021
	3500-4500	20	0,028
	>4500	35	0,049
FU> 35 dunums	Q (m^3)	Price (Fils/m^3)	Price (\$$m^3$)
FU surface=A	0-(2500*A/35)	8	0,0112
	(2500*A/35)-(3500*A/35)	15	0,021
	(3500*A/35)-(4500*A/35)	20	0,028
	>(4500*A/35)	35	0,049

Table 30. Public Water Prices in the Jordan Valley

According to the volume concerned and to the water-prices, vegetables farmers used to pay 0,015 \$/m^3, citrus farmers 0,025 \$/m^3 and bananas farmers 0,035 \$/m^3. On average, it has been calculated that water price reach 0,02 \$/m^3 of water supplied. Bills have to be paid every month.

- <u>Changes in quotas</u>

Recently (beginning of 2004), the JVA introduced new rules concerning the water allocation:

<table>
<tr><th colspan="2">Vegetables</th><th colspan="2">Citrus</th><th colspan="2">Bananas</th></tr>
<tr><td>Period</td><td>New allocation (m^3/du/day)</td><td>Period</td><td>New allocation (m^3/du/day)</td><td>Period</td><td>New allocation (m^3/du/day)</td></tr>
<tr><td>16/3-15/4</td><td>1,5</td><td>1/4-30/4</td><td>2</td><td>1/4-30/4</td><td>3</td></tr>
<tr><td>16/4-15/6</td><td>2</td><td>1/5-15/6</td><td>3</td><td>1/5-15/6</td><td>5</td></tr>
<tr><td>16/6-15/8</td><td>= or < 1</td><td rowspan="2">16/6-15/9</td><td rowspan="2">4</td><td rowspan="2">16/6-15/9</td><td rowspan="2">7</td></tr>
<tr><td>16-8/15-9</td><td>1</td></tr>
<tr><td>16-9/15-10</td><td>1,5</td><td rowspan="2">16/9-31/10</td><td rowspan="2">3</td><td rowspan="2">16/9-31/10</td><td rowspan="2">5</td></tr>
<tr><td>16-10/15-12</td><td>2</td></tr>
<tr><td>16-12/30-1</td><td>1</td><td rowspan="2">1/11-31/3</td><td rowspan="2">"on-demand" but = or < 2 m^3/j/du</td><td rowspan="2">1/11-31/3</td><td rowspan="2">"on-demand" but = or < 2 m^3/j/du</td></tr>
<tr><td>1/2-15/3</td><td>1</td></tr>
</table>

Table 31. Rules of water allocation in the Jordan valley

[206] This table shows that the different blocks of water prices have been defined according to quantities calibrated to irrigate 35 dunums which is the average surface of the irrigation unit implemented during the land reform in 1962.

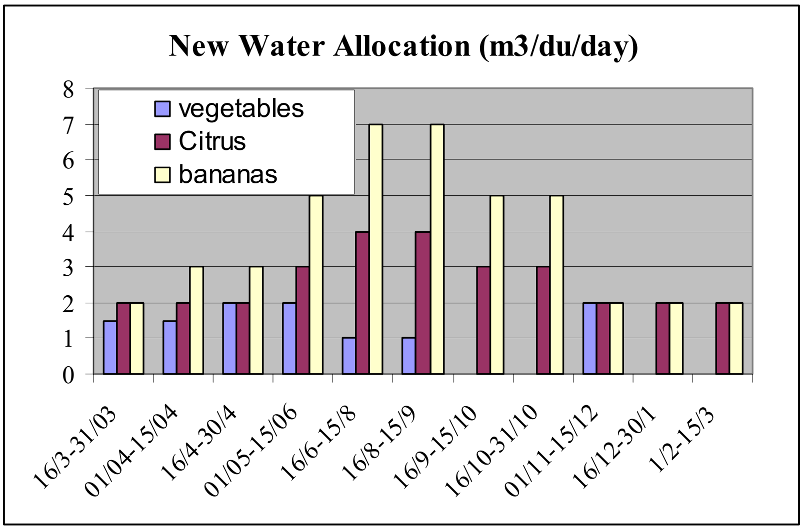

Figure 25. Water allocation in the Jordan Valley (new rules)

These rules have still not be implemented and the old rules still remain. These new rules would correspond to a supply of 510 m3/du/year for vegetables; 840 m3/du/year for Citrus; 1320 m3/du/year for bananas if the 'on-demand' period is excluded. These rules allow a better control of the water supply since the on-demand period is shortened (there isn't any 'on-demand' period for vegetables while this period is reduce by one month in April for Citrus and Bananas)

On the same time, the JVA legalized all the citrus plantations which have been planted between 1990 and 2001. It means that these plantations receive now 4 mm/day/du according to the historical allocation[207]. The new water prices enacted by this regulation are a little bit lower than the 'old prices': 0,014 $/m^3$ for vegetables, 0,022 $/m^3$ for citrus and 0,028 $/m^3$ for bananas. New low fees have also be implemented: 2 JD (2,8 $) per bill presented as a tax for the Operation and Maintenance Costs recovery and a fine has to be paid if bills are not paid within 45 days after reception.

- The different scenarios envisaged

An increase in the public agricultural prices is one of the main evolutions now discussed within the institution in charge of water in the Jordan Valley (JVA, MWI) and its need is recognized by all (even farmers!). This awareness of farmers can be mainly explained by the fact that for the majority of the farmers, water costs in the valley only represent a few percentage of their total costs - this will be discuss in further details in the following section of this report.

Three scenarios will thus be considered: prices' increase of 50, 100 and 200%. It is worth noticing that if water prices increase of 200%, they will reach the level of the Operation and Maintenance costs of the public network. That is one of the aim of the public services. In the quantification of our scenarios we will considered the prices of water linked to the new rules enacted by the JVA, and not yet implemented.

(iii)Increase of private water prices: the By-Law example

- Evolution of the By-Law since 2002

Despite a growing concern about over abstraction of groundwater since the mid 1990s, the By-law No.(85) of 2002 constitutes the first attempt to control the groundwater abstraction from private agricultural wells within Jordan. Since 2002, it is worth noticing what have been the evolutions it has known and which are revealing the social difficulties to implement such control aiming at alleviating old water rights.

[207] At a time, where the willingness is to reduce the water used by agriculture in order to reallocate it to other sectors, this legalization is a step backward. This reveals the difficulties the government is facing up to implement the measures alleviating the old water rights notably because of social pressure of influent persons. Here the social weight of the owners of citrus orchard in the Jordan valley –see the characterization above- even leads to a decision opposite to the different water policies to be implemented within the country.

- Licensed wells:

Quantity of water pumped	Water prices
Zero to 150 000 m^3	Free
151 to 200 000 m^3	25 Fils per m^3 (0.035 $)
More than 200 000 m^3	60 Fils per m^3 (0.085 $)

- Unlicensed wells[208]

Quantity of water pumped	Water prices
Zero to 100 000 m^3	25 Fils per m^3 (0.035 $)
101 000 to 150 000 m^3	30 Fils per m^3 (0.042 $)
151 to 200 000 m^3	35 Fils per m^3 (0.050 $)
More than 200 000 m^3	70 Fils per m^3 (0.098 $)

The fees are admittedly very low even if higher tariffs have been decided for the unlicensed operative wells.

We have actually seen that water pumped from industrial and drinking purposes is charged at 0,25JD/m^3.

Moreover, the abstraction limit considered is high. Whatever are the objections which can be done; this by-law is an important step towards a limitation of the agricultural water abstraction. In April 2004, the first bill according to the water consumption registered between the 1/4/2003 and the 31/03/2004 have been send to the farmers who have one year to pay it.

_NB:_ In Azraq, a peculiar regulation will be enforced and volume abstracted above 100.000 m^3/year will be charged at 0,02 JD/m^3

Table 32. Water prices according to the Volume abstracted in agricultural wells as it is mentioned in the By-Law No.(85) of 2002

Salinity	**Water prices (JD)**	
TdS< 1350 ppm	Application of the 'classic regulation'	
	Below 150.000 m^3/year	**Above 150.000 m^3/year**
TdS 1350-1500 ppm	Gratis	0, 015 JD/m^3 (0,02 $)
TdS 1501-2000 ppm		0,010 JD/m^3 (0,014 $)
TdS >2001 ppm		0,005 JD/m^3 (0,07 $)

Table 33. New rules concerning a taxation of water abstracted from Brackish Aquifers

[208] The status of these wells will be rectified and "if there are economic or social factors justifying continuation of extraction out of unlicensed wells prior enforcement of this regulation, the Board… shall be entitled to agree on water extraction from these wells for limited period and under specific conditions" *(By-Law Ni.85 of 2002).* In such cases the well's owner will have to pay an annual additional fee corresponding to an 'annual license' which could be renewed or not.

Firstly, the By-Law renders the *'old licenses'* null and void. Actually, two thirds of the licenses which have been delivered before 1992 defined maximum quantities of water the farmer could pump. Most of the time, volume mentioned by the licenses were 50.000 and 75.000 m^3/year. As the Water Authority of Jordan (WAJ), despite the growing concern about water abstraction, has never really attempted to enforce these licenses, farmers feel not concerned by the limits, even rarely mention it during the surveys, and always over-pass them. Instead of implementing the old licenses, the By-law opened the way to taxation on the water pumped above 150.000 m^3/year according to the rules summarized in the tables besides[209]. The consequences of the By-Law on the farming systems will thus be less drastic than if the ancient limits would have been enforced

- Description of the actual By-Law

Between May and August 2004, two amendments have modified the law: the first one is **a lowering of the already low fees** for the volumes abstracted between 151.000 and 200.000 in licensed wells which will be charged at 0,005 JD/m3 (0,007 $) instead of 0,025 from the year 2004. The second amendment concerns abstraction from brackish aquifer. The fees are summarized in the table besides

- Problems raised up

This By-law has certainly the merit to have introduced the idea of abstraction limitation (which has always been unfamiliar to farmers and to the society in general), and its recent implementation an important first step in the right direction of a necessary limitation of agricultural water abstraction for an agricultural use.

However, the recent evolutions show us that the **effective implementation of this By-law is not acquired and that it is still a highly sensitive question.** Some groups of influent farmers with strong relations are opposed to it and stop the process because they do not want that the water rights they obtained in the past change. They mainly consider that, because of the high investments they have done, they own the water they use and they do not have to pay any fees to pump it. These aquifers are some of the best-quality sources of water that Jordan has at its disposal and which can be used for municipal and industrial purposes. The actual water-table decline is threatening the quality of water and there is a risk that in the medium term the groundwater could not be used anymore for drinking purposes at a low cost. Some costly investments to treat the water should thus be needed. In order to avoid -or at least to limit – this increase in prices; the over abstraction has to be lowered and that can only be done thanks to a strong decline of the agricultural pumping which will be obtained if there is a strong governmental action.

Now, the implementation of the By-law is possible since all the wells are equipped with water meters. That allows a control of the groundwater pumped in each well. The equipment of all the wells constitutes an important improvement. However several problems can be underline. First there is an important lack of material and human resources since the controls are realized by a little number of employees of the water Authority of Jordan. Only three teams have to control the entire Lower Jordan River Basin. In our opinion it can not be correctly done in the actual situation[210].

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[209] It seems the representatives of the farmers have obtain, from the government, the withdrawal of the ancient limits against the 'acceptance' of the principle of a taxation of volume abstracted above a certain limit.

[210] According to the responsible of one of these teams, each team is composed by two engineers in charge of the water meters reading, one technician in charge of the maintenance of the meters and two drivers. The team in charge of the surroundings of Amman is supposed to control around 400 wells monthly; it means 10 wells per day and per group of readers (the team can be divided into two groups). To these regular controls, have to be added the maintenance actions and all the problems which can occur (notably the cars' availability for the controls). Given the fact that wells are very sparsely distributed, this workload seems to us being too important for the teams now in charge. We think it is necessary to develop these teams by increasing both the material equipment (cars) and by training other persons of the WAJ to the meters reading. Only such actions should allow an effective implementation of the By-law, based on accurate and frequent readings (checking electricity consumption could also be a mean to control the effective groundwater abstraction from wells)

Moreover, meters are still not protected. Experiences in the Jordan Valley have shown that if the meters are not protected in a box closed with a padlock, they could be broken or at least fiddled in order to show a lower consumption than the true one. As the meter is paid by the farmer, the risks of deterioration are limited but on another hand, fiddlings are quite easy and could be widely spread[211]. There is thus a need to invest in water-meters protection systems and it is *recommended* that the water Authority of Jordan looks very closely at this point in order to insure the water readings and to collect the due fees.

- Scenario envisaged

In the following paragraph, we will present the effects of the By-law in its ancient and in its new version on the profitability of farms. The comparison of these two versions will show us which farmers will be the main beneficiaries of the by-law's evolutions. According to the evaluation of the water consumption of each farming system, we will calculate the added costs the farmer will have to bear and we will quantify the consequences it could have on the farm's profitability. We will then present the adaptive strategy the farmer could develop to avoid this decrease in the revenue he brings out from his farm.

V.2.3 Shift from Freshwater to treated waste water

(i) Treated waste water quality in Jordan: the Jordanian and International (WHO)[212] Guidelines

The use of treated waste water in agriculture is being generalized in Jordan and in other water-scarce country. The rules used by the WHO are presented in appendix while besides is presented a summarized table of the guidelines currently in force in Jordan to control the use of treated waste water in agriculture (are indicated the main parameters considered to evaluate the water quality).

(ii) Lessons from surveys

To identify the consequences, a shift from freshwater to treated waste water could have in the north of the valley, lessons could be drawn from the shift which occurred in the middle of the valley when this area has been supplied with water coming from the King Talal Reservoir (KTR) at the end of the 1980s /beginning of the 1990s.

When the shift occurred in the middle valley and the network had been completely pressurized (199(-1996), some farmers fled the area of the Zarqa Triangle (area directly supplied thanks to the Zarqa Carrier coming from the KTR) and went to the north. This led to an increase of land rent costs in the north (area of Kreimeh). This process could also happen with the new shift considerd in the north in areas and notably in areas where freshwater will remain (essentially along *Side Wadis*). Some non–objective reasons can be found to explain this movement (fear of the new conditions and ignorance of the consequences treated waste water could have) but some objective reasons exists since 1995-1996 corresponds also to the period when the salinity of the water coming from the KTR and used in agriculture in the middle of the valley strongly increased because the effluent of the As-Samra treatment plant began to represent more than 50% of the influent of the KTR[213]. Other farmers stayed

[211] During one survey, a farmer said us that it takes him two days after he receives the water bill to make the meter's reader of the WAJ come into his farm in order to read the meter a new time. The conclusion was that the bill was not accurate since the consumption of the well 'only' reach 148.000 cubic meters during the last year !!! A mistake had been done, the bill has been cancelled. It costs one phone call to the farmer who, after all, saved 3.000 JD (4.200 $).

[212] World Health Organization

[213] The volume of the As-Samra plant's effluent increased in the middle of the 1990s because of the development of the city of Amman which follows the Palestinian migration after the first gulf war (cf. previous chapter). In the same time the Zarqa River flow strongly decreased, that leads to a water salinity increase in the KTR especially during dry years. More generally, it is worth noticing one of the major drawbacks of the use of

Quality parameters mg/L except otherwise indicated	Vegetables eaten cooked	Fruit trees, forestation, industrial crops and grains	Discharge to wadis and catchment areas	Artificial Recharge	Fisheries (2)	Public Parks	Fodder (1)
BOD_5 (3)	150	150	50	50	-	50	250
COD	500	500	200	200	-	200	700
DO	> 2	> 2	> 2	> 2	> 5	> 2	> 2
TDS	2000	2000	2000	1500	2000	2000	2000
TSS	200	200	50	50	25	50	250
PH	6 – 9	6 – 9	6 – 9	6 - 9	6.5 - 9	6 - 9	6 – 9
Color (PCU) (4)	-	-	75	75	-	75	-
FOG	8	8	8	Nil	8	8	12
Phenol	0.002	0.002	0.002	0.002	0.001	0.002	0.002
MBAS	50	50	25	15	0.2	15	50
NO_3-N	50	50	25	25	-	25	50
NH_4-N	-	-	15	15	0.5	50	-
T-N	100	100	50	50	-	100	-
PO_4-P	-	-	15	15	-	15	-
Cl	350	350	350	350	-	350	350
SO_4	1000	1000	1000	1000	-	1000	1000
CO_3	6	6	6	6	-	6	6
HCO_3	520	520	520	520	-	520	520
Na	230	230	230	230	-	230	230
Mg	60	60	60	60	-	60	60
Ca	400	400	400	400	-	400	400
SAR	9	9	9	9	-	12	9
Residual Cl_2 (5)	0.5	-	-	-	-	0.5	-
Al	5	5	5	1	-	5	5
As	0.1	0.1	0.05	0.05	0.05	0.1	0.1
Be	0.1	0.1	0.1	0.1	1.1	0.1	0.1
Cu	0.2	0.2	0.2	0.2	0.04	0.2	0.2
F	1.0	1.0	1.0	1.0	1.5	1.0	1.0
Fe	5.0	5.0	2.0	1.0	0.5	5.0	5.0
Li	2.5	5.0	1.0	1.0	-	3.0	5.0
Mn	0.2	0.2	0.2	0.2	1.0	0.2	0.2
Ni	0.2	0.2	0.2	0.2	0.4	0.2	0.2
Pb	5.0	5.0	0.1	0.1	0.15	0.1	5.0
Se	0.02	0.02	0.02	0.02	0.05	0.02	0.02
Cd	0.01	0.01	0.01	0.01	0.015	0.01	0.01
Zn	2.0	2.0	15	15	0.6	2.0	2.0
CN	0.1	0.1	0.1	0.1	0.005	0.1	0.1
Cr	0.1	0.1	0.05	0.05	0.1	0.1	0.1
Hg	0.001	0.001	0.001	0.001	0.00005	0.001	0.001
V	0.1	0.1	0.1	0.1	-	0.1	0.1
Co	0.05	0.05	0.05	0.05	-	0.05	0.05
B	1.0	1.0	2.0	1.0	-	3.0	3.0
Mo	0.01	0.01	0.01	0.01	-	0.01	0.01
TFCC (MPN/100 ml) (6)	1000	-	1000	1000	1000	200	-
Pathogens	-	-	-	-	100000(9)	nil	-
Ameba & Gardia (Cyst/L) (7)	< 1	-	-	-	-	nil	-
Nematodes (Eggs/L) (8)	< 1	-	< 1	-	-	< 1	< 1

(-): N/A
(1): Trace elements and heavy metals values are calculated based on the quantity of wastewater used for irrigation (1000 m^3/dunum/yr.), in case the quantity of water increases above the aforementioned figure the concentrations of trace elements and heavy metals decreases accordingly.
(2): these figures depend upon the type of fish, pH, TDS, and T^o.
(3): BOD_5 in WSP is filtered BOD_5, but in mechanical treatment plant is nonfiltered.
(4): Unit weight measured by unit of Platen Cobalt.
(5): Touching time not < 30 min.
(6): Most Probable Number/ 100 ml.
(7): One Cyst/ L
(8): Mean Ascaris, Enclostoma, and Trycus.
(9): Salmonella / 100 ml.

Table 34. Jordanian Guidelines for Reuse of Treated Domestic Wastewater
(Maximum allowable concentrations unless otherwise indicated.)

blended water in agriculture is the high variability of the water quality which can be registered from one year to another depending on the climatic conditions. This variability causes several difficulties for the farmer to closely manage his farm.

within the area and attendant measures have been taken to favour the acceptance of treated waste water. These measures have mainly consisted in a higher quantity of supplied water[214].

Through the few surveys we have realized in the middle of the valley we could have seen that there were no big differences in the middle-north part of the valley between the areas where treated waste water was use in agriculture instead of freshwater. The quality of water is not a parameter determining the kind of production system developed by the farmers[215] (the capacity to invest is, for example, more important in the definition of the farming systems). This has several reasons.

The first one is the fact that the drip irrigation is a well adapted system to the agricultural use of treated waste water (slight risks of contamination). By applying water only in the share of the soil explored by roots, the drip irrigation leads to form a bulb causing salts accumulation outside the roots area an allow reclaiming treated waste water with high salt contents. To avoid high salts concentration spots, it is needed to regularly leach the soil (*Massena, 2001*). The use of treated waste water in drip irrigation has however some drawbacks and notably the filters and emitters clogging (due to organic solids and above all to an important concentration of algae in the water used) but soften the impacts of treated waste water on crops and soils[216].

The second explanation is linked to the fact that farmers who receive treated waste water receive more water in summer than the one supplyied with freshwater. Actually, since several years, the water allocations are reduced[217] in summer for farmers receiving water from the King Abdullah Canal (KAC) while farmers supplied by the Zarqa Carriers conserve their allocation even in summer[218]. The quantity of water could counterbalance the lower quality of water and soften the differences between farms and farmers receiving fresh or treated waste water.

Nevertheless, some differences exist. In the middle valley landscapes, there are less and less greenhouses of cucumber when going southwards (according to the FAO, cucumbers are more sensible to salts than tomatoes). Farmers receiving water from Zarqa Carrier do not beneficiate of the filtration and the sediment deposit done in the pumping station of the KAC, the water they received is more loaded. When water is supplied, they need to let it stay more time in their pools, in order to let the water load settle[219]. That reduce their liberty to adapt the irrigation schedule to the crop requirements and a closer management is thus needed to counterbalance this disadvantage.

If the impact of the treated waste water used in the Jordan Valley is slight on classic and common crops (Tomato, zucchini, cucumber…) it is however impossible to crop sensible crops such as strawberries, beans or other high value crops which could disappear of the north of the valley if fresh water is replaced by treated waste water. We will quantify these impacts on crops in the following sections of this report.

(iii)Scenarios envisaged

- Technical aspects: impacts of a shift to treated waste water

In our impact assessment, we have considered that **the shift from fresh water to treated waste water only amounts to say that water of salinity *X* is replaced by water of salinity Y (with Y>X)**. Moreover, *Grattan (2000),* according to *FAO 29*, gives the relation existing between the water salinity and the soil salinity within the rootzone.

[214] The well-founded of such measures increasing the supply of salty water to farmers could be discussed and further studies would be needed on this point.
[215] We never have considered it in our modelling
[216] The effective impact of treated waste water on soils has not been studied but such effect clearly needs to be followed/monitored.
[217] Allocations have been reduced of 25% in 1999, 2002, 2003 and 2004 of 30% in 2000 and of 50% in 2001 due to shortages of water in summer.
[218] It seems also easier to obtain extra-hours of water when farmers are supplied with treated waste water compared to when they have fresh water.
[219] Pools have to be cleaned every year, while it is possible to clean it every two years when it is filled with water from the KAC.

We thus have: ECe =1,5 * ECw (with a leaching fraction of 15 to 20 %[220])
With: *ECe (dS/m) is the soil salinity within the rootzone and
*ECw (dS/m) the water salinity

We considered that the increase in soil salinity as well as in water salinity constitute the two main consequences of the shift from fresh to treated waste water[221]. It is possible according to *Grattan, 2000* to quantify the consequences of this salinity increase on yields obtain by farmers in the north of the Jordan Valley and then to calculate the expected decrease of the production's value and its impact at the farmer and basin levels. **We have done the assumption that market prices will stay constant and that the quality of the production will also remain**. We will only quantify the impact of a quantitative decrease of the yield. This can be justified by the actual situation in the middle-northern part of the valley (North of Deir Allah), where no differences concerning the product's quality are observed between farmers irrigating their crops with treated waste water and farmers using freshwater[222].

- The scenarios studied

We have quantified two scenarios according to two 'new water salinities' in the north of the valley[223]. In a first approximation, the electric water conductivity can be considered proportional to the quantity of Total Dissolved Solids (TDS) according to the general relation:

TDS (mg/L)= ECw (dS/m) * 640[224]

Thus, the salinity of blended water can be obtained by calculating the barycentre of the salinities of the waters which are mixed. We have considered that freshwater has an ECw=1 and that the treated waste water has an ECw egal to 1,9 (present ECw of the As-Samra treatment plant effluent)[225]. We thus obtain the two following scenarios:

- First Scenario: The water used in the north will have a salinity of 1,225. It corresponds to a mix of freshwater with treated waste water at a blending ratio of 3:1.

- Second Scenario: The water used in the north will have a salinity of 1,15. It corresponds to a mix of freshwater with treated waste water at a blending ratio of 5:1.

- Impacts on Yields

According to *Maas (1984)* and *Maas & Hoffman (1977), FAO 29* gives tables of yield potential of crops as influenced by irrigation water salinity and soil salinity in the rootzone (table

[220] The leaching fraction is defined as the fraction (or percentage) of infiltrated water that drains below the rootzone.
[221] it is however worth noticing that the possible contaminations linked to the microbiological quality of the retreated waste water -heavy metals, phytoestrogene, boron, pesticides residues- could have strong impacts on markets because of a consumer's lack of confidence
[222] Differences in products' quality exist between the middle-south and the middle-north of the valley (the village of Deir Allah making a 'rough' separation) but there are no indications that these differences being linked to the water quality. It is more linked to the way of cropping, to the farm management, to post-harvesting techniques and so on.
[223] These *new water salinities* have been considered according to the recommendations of the *WAJ, 2004 feasibility study for the re-use of treated wastewater in irrigated agriculture in the Jordan Valley.*
[224] For ECw between 0,1 and 5 dS/m at 25°C. The relation presented here is highly simplified since the true relation varies in function of the temperature, and the nature of the dissolved ions and solids. Due to the other approximations, such approximation is however accurate here
[225] Even if better treatments will probably be done to improve the micro-biological quality of treated waste water, we consider that the salinity of the effluents will be constant. Actually, salinity is not one of the main parameters considered in the waste water treatments (cf. part II.5) since it does not affect the public health.

presented below). This table allows us building some 'yield responses' to increase of water salinity. We present besides the equations giving yields (in % of yield potential) in function of the water salinity (Ecw) for the main crops considered and the results obtained for the particular level of water salinity we will consider in our evaluation (cf. table 38). We will present the impact of these considerations on gross output and on farmers' revenue in the following section.

NB. A scenario now studied by the government and several engineering departments is the supply of irrigated perimeters in the *Highlands* with treated Waste water. These projects will be difficult and costly to implement mainly because of the dispersal of the irrigated farms in the *Highlands* and should thus be limited to areas located near the treatment plants and/or in suburban areas. We will try to present the costs and benefits such a measure could have.

	Yield Potential (%)									
	100		90		75		50		0	
	ECe	ECw	ECe	ECw	ECe	ECw	ECe	ECw	ECe	ECw
Zucchini	4,7	3,1	5,8	3,8	7,4	4,9	10,0	6,7	15,0	10,0
Tomato	2,5	1,7	3,5	2,3	5,0	3,4	7,6	5,0	13,0	8,4
Cucumber	2,5	1,7	3,3	2,2	4,4	2,9	6,3	4,2	10,0	6,8
Potato	1,7	1,1	2,5	1,7	3,8	2,5	5,9	3,9	10,0	6,7
pepper	1,5	1,0	2,2	1,5	3,3	2,2	5,1	3,4	8,6	5,8
lettuce	1,3	0,9	2,1	1,4	3,2	2,1	5,1	3,4	9,0	6,0
Melon	1,1	0,7	2,3	1,5	3,9	2,6	6,8	4,5	12,6	8,4
Eggplant	1,1	0,7	2,6	1,7	4,8	3,2	8,6	5,7	16,1	10,7
Green Bean	1,0	0,7	1,5	1,0	2,3	1,5	3,6	2,4	6,3	4,2
Spinach (melokhia)	2,0	1,3	3,3	2,2	5,3	3,5	8,6	5,7	15,0	10,0
Citrus (Orange)	1,7	1,1	2,3	1,6	3,3	2,2	4,8	3,2	8,0	5,3
Bananas	1,5	1,0	2,0	1,3	2,7	1,8	4,1	2,7	6,5	4,3

Table 35. Yield potential of selected crops as influenced by irrigation water salinity (ECw) and soil salinity in the rootzone (ECe)

	Yield Potential= X*ECw – Y (% of yield potential)	
For ECw such as Yield Potential inferior to 100%		
	X	Y
Zucchini	-14,4718	-145,5137
Tomato	-14,9031	-125,0417
Cucumber	-19,5695	-132,6438
Potato	-17,9211	-120,0233
pepper	-20,8768	-121,0585
lettuce	-19,5695	-116,9883
Melon	-13,0208	-116,5846
Eggplant	-10,0000	-107,0000
Green Bean	-28,3286	-118,4363
Spinach	-18,7265	-128,1704
Citrus (Orange)	-24,0385	-127,3726
Bananas	-30,0300	-129,6216

Table 36.Equations of yields (in % of yield potential) in function of the water salinity (Ecw)
for some selected crops

ECw	Zucchini	Tomato	Cucumber	Potato	Pepper	Lettuce	Melon	Eggplant	Green Bean	Spinach	Citrus (Orange)	Bananas
1,15	100	100	100	99	97	94	100	96	86	100	100	95
1,225	100	100	100	98	95	93	100	95	84	100	98	93
1,9	100	97	95	86	81	80	92	88	65	93	82	73

Table 37. Yield potential for three given levels of water salinity for the main crops grown in the Jordan Valley

(Please Note than these tables have been done according to Grattan, 1984 and Maas & Hoffman, 1977)

V.3 Impacts of the Changes in Management on Farmers' Revenue

V.3.1 Foreword

This section aims to quantify the consequences the changes in water management in Jordan could have on the farming system profitability. It is mainly based on the two previous sections:

- Description of the farming system within the Lower Jordan River Basin and
- Description of the identified changes in water management.

For question of clarity and pertinence we will not present the effects of all the measures to be taken on all the farming systems described. We will thus present the consequences of the changes in management on a chosen panel of farming systems which are the more representative of the agricultural sector in Jordan in order to have an idea of the possible set of reactions within the Jordan River Basin.

V.3.2 Increase of public water prices in the Jordan Valley

In this section the calculation are done on the public water costs (i.e. the bills charged by the JVA to the farmers); the effective costs of water (purchase from private wells, depreciation of the equipment, pumping costs are not considered) are not considered. In the actual situation and until the JVA develop its control in the south of the valley[226] the increase of public water prices will mostly affect farmers located in the north and the middle of the valley.

On the two following pages are presented two summarized tables describing the consequences an increase in water prices could have on the farming systems in the Jordan Valley.

Several conclusions can be drawn[227]:

- Present water prices are very low within the Jordan Valley and represent a low percentage of the net income in all almost all the farming systems.

- Farming systems which will be concerned by this water price increase will be the **citrus farms** in which water costs can represent 15 to 50% of the Net Income. The income will be reduced by one third in familial farms while it will reach almost zero in farms owned by absentee owners. Moreover, two kinds of citrus farmers exist: farmers for whom agricultural activity is the principal one and other farmers (part time farmers) who have another source of revenue.

  *We can suppose that part time farmers will continue to manage their farm as they do it now. Their farm has a role of 'social prestige' more than a productive one and they do not *'need'* the revenue their farm brings to them. As the absentee owners are influent in the Jordanian society they will constitute the main obstacle to the effective implementation of this price increase. The recent 'legalization' of the citrus plantations is one example of their social weight slowing down the water-conservation measures.

[226] In the south of the valley, the management of the water resources is reduced to the strict minimum since tribal laws are still in places. Moreover, the perimeters corresponding to the south Ghor project (the last 14,5 km-long section of the canal) are not yet reclaimed.
[227] The figures presented in the following discussion are those presented in the case of an increase of 200% of the water costs (level needed to recover the Operation and Maintenance costs)

*On another hand, 'true citrus farmers' who are living from their agricultural activity will have to adapt themselves by intensifying their plantation, diversifying their production by the implementation of trees allowing a high return. This shift should however stay limited since the farmers have neither the financial means nor the knowledge to develop high value orchard needing an intensive management. The increase in water prices will thus be very difficult to bear in this farming system and it is possible one share of the citrus production in Jordan disappear.

- Bananas farms are the most water-consuming farms in the Jordan Valley but as the revenue of the farmer is very high, the impact of an increase in water prices will be relatively slight (a decrease of 5 to 10% of the revenue is expected). Only slight modifications should appear. We can for example suppose the extensive farms of the north will be intensified for example by using drip irrigation (largely already spread in the south of the valley). The weak impact of an increase of the public water prices on bananas farms is also linked to the fact that most of these farms are in the south of the valley and have develop other ways of water supply than the public one.

- Mixed farms in the north and the south of the valley will be highly concerned by an increase of prices as the revenue is expected to decrease by more than a quarter. We have seen that these farmers are very poor. We can assume that such farming systems will disappear and that farmers will probably have to switch to a new type of employment.

- Concerning vegetables farmers, an increase of 200% in water prices will imply in most of the cases a decrease in the farmer's revenue lower than 7%. Nevertheless, this slight expected impact of a water price increase should not make us forget the large diversity of the vegetables farming systems in the Jordan Valley. If this measure would not have any impact on some farming systems (mainly the one located in the north and developing greenhouses) other will be strongly affected. The poor farmers in the middle valley would not be able to bear such evolution and their existence is threatened. The debt and the familial solidarity, already very important in these social groups, should not appear as a solution and attendant measures would have to be taken to help the farmers to develop more intensive production systems or to switch to a new type of job according to the governmental orientations.
- In the south, the absence of any public management of the irrigation network limits the impacts of a water prices increase. However, it is worth noticing the vegetables farmers in the south of the valley are very poor so any increase in whatever would be the input will have important consequences on their revenue and their situation will become more precarious that it already is.

In conclusion we can say that a public water prices increase aiming to reach the Operation and Maintenance Costs Recovery level does not seem to be impossible to implement. Actually the most widespread farming systems which are also the most productive and which contribute to the main part of the Jordan Valley production will be only very slightly affected and no important evolutions should occur. **BUT,** the social difficulties raised by such measure should not be forgotten. Large absentee owners will do their possible to prevent this measure which will make their secondary agricultural activity non profitable. On another hand, the poor farmers in the middle of the valley would not bear this new decrease of their revenue and that could lead to social tensions. The Ministry of Agriculture as well as the JVA and the other institutions involved in the agricultural sector would have to play a role to educate, supervise, advise and help the farmers to develop more intensive and above all more profitable production systems in order to soften the needed evolution that is an increase of the public water prices in the Jordan Valley.

		Banana Farms					Citrus Farms		
Characterisation of the farming system		Investor's owned Farm	Intensive Investor's owned Farm	Small mixed farm	Small Familial farm	Large Intensive farm	Intensive Familial owned Farm[228]	Extensive familial farm	Absentee Investor's owned Farm
Plantation and Irrigation method		Surface	Drip	Drip	Drip (Owner of well)	Drip (Owner of well)	Drip	Surface/Drip	Surface
Location		North Ghor	North Ghor	South or North Ghor	South	South	North Ghor	North Ghor	North Ghor
Average surface (FU=35 dunums)		1	1	1,5 FU (1/7 of Bananas)	1,5 FU	6,5	1,5	1,5	4
Initial Investment ($/farm)		50 000	50 000	15 000	50 000	155 000	54 500	21 000	150 000
Public Water Costs	($/du/year)	35	35	9	35	35	19	19	19
	% of net income	5	3	14	2	1	13	17	48
Net Income or Profit ($/du/year)		700	1250	65	1670	2980	145	110	40
Capital Profitability (%)		49,0%	87,5%	22,8%	175,4%	100,9%	14,0%	27,5%	3,7%
Expected Decrease in the Net Revenu (% of the actual revenu) IF	Water Price increase of 20%	1,00%	0,56%	2,77%	0,42%	0,23%	2,62%	3,45%	9,50%
	Water Price increase of 50%	2,50%	1,40%	6,92%	1,05%	0,59%	6,55%	8,64%	23,75%
	Water Price increase of 100%	5,00%	2,80%	13,85%	2,10%	1,17%	13,10%	17,27%	47,50%
	Water Price increase of 200%	10,00%	5,60%	27,69%	4,19%	2,35%	26,21%	34,55%	95,00%

Table 38. Impact of Public water Price Increase on Citrus and Bananas Farms in the Jordan Valley

[228] This model corresponds to an average done on the two kinds of large intensive bananas farms described in the south of the valley (entrepreneur's and familial farm). In the south of the valley, farms have other sources of water than the one supplied by the JVA.

		Vegetable farms								
Characterisation of the farming system		Small familial rented farm	Small entrepreneur rented farm	small rented farm	large rented farm	sharecropping farm Drip Mulch Minitunnel		Familial rented or owned Farm (half/half)	Intensive Investor's rented or owned Farm (half/half)	Small owned farm
Plantation and Irrigation method		Average on Drip Mulch & Drip Mulch Minitunnel	Average on Drip Mulch & Drip Mulch Minitunnel	Average on Drip Mulch & Drip Mulch Minitunnel	Average on Drip Mulch & Drip Mulch Minitunnel	sharecropper	owner	Greenhouses (50%)	Greenhouses (75%)	Greenhouses (33%)
Location		North and middle-north ghor	North and middle-north ghor	middle-south Ghor	middle-south Ghor	middle-south Ghor	middle-south Ghor	North and middle-north ghor	North and middle-north ghor	middle-south Ghor and south ghor
Average surface (FU=35 dunums)		1	1	1	3	1,5	4,5	2	4	5
Initial Investment ($/farm)		2750	2750	15000	40 000	30000	160000 (land)	75 000	260 000	135 000
Public Water Costs	($/du/year)	9	9	9	9	4,5	4,5	9	9	27
	% of net income	2	2	3	4	2	2	2	1	7
Net Income ($/du/year)		435	370	360	250	205	295	440	920	400
Capital Profitability (%)				84,0%	65,6%	35,9%	29,0%	41,1%	49,5%	51,9%
Expected Decrease in the Net Revenu (% of the actual revenu) IF	Water Price increase of 20%	0,41%	0,49%	0,50%	0,72%	0,44%	0,31%	0,41%	0,20%	1,35%
	Water Price increase of 50%	1,03%	1,22%	1,25%	1,80%	1,10%	0,76%	1,02%	0,49%	3,38%
	Water Price increase of 100%	2,07%	2,43%	2,50%	3,60%	2,20%	1,53%	2,05%	0,98%	6,75%
	Water Price increase of 200%	4,14%	4,86%	5,00%	7,20%	4,39%	3,05%	4,09%	1,96%	13,50%

Table 39. Impact of Public water Price Increase on vegetables Farming systems in the Jordan Valley

V.3.3 Shift from freshwater to treated waste water in the north of the valley

Farming systems concerned by this measure are the systems located in the north of the valley. The table besides summarize, for each farming system, the 'yield loss' i.e. the decrease in the gross output of the farm and then the economic loss expected in the farmers' revenue.

It is worth noticing a shift from freshwater to treated waste water of an ECw=1,9 will be disastrous for the agriculture in the north of the Jordan Valley since it is expected the linked economic loss reaches between 20 and 81% of the actual farmer's revenue (and between 22 and 49% for the productive vegetables farms). In the south of the valley, water used in irrigation and coming from the KTR has precisely a salinity of 1,9. It is sure that, the quality of water can not explain alone the differences we have observed in farming systems' profitability between the northern part of the valley (north of Deir Alla) and the southern part of the valley. Climatic conditions, soil quality, way of management, cropping techniques and others should also be considered but the observation done above concerning the impact of the water salinity shows us clearly that the quality of water is one of the parameters which explains the important differences observed between the north and the south of the valley. Supplying water of the same quality than in the south to farming systems in the north, would actually have very important consequences even on the most intensive, productive and modern agricultural systems of the Jordan Valley. Some of the familial open field farms of the northern Ghor would, for example, see their profitability highly decrease to reach levels observed in the middle of the valley. As this scenario is not probable we will not come into details and will focus on the two other plans in which the treated water will have an ECw of 1,15 or 1,225.

We can clearly see that the small extensive mixed farms will be the most affected by the shift from freshwater to treated waste water since the Net revenue is expected to decrease by 28% at least. As it was the case when we have studied the impact of a water price increase, such changes in management threat the existence of such farmers. For entrepreneur's farms in open field, the net revenue will decrease of 6 to 18%; for familial farming systems, the revenue will decrease of 4 to 15%. Despite this relatively important decrease, the sustainability of these farming systems will not be modified in an important manner (cf. chart in appendix). The situation of the farmer will remain the same, even if the Net Profit brought out will be lower. For greenhouses farms, the expected net revenue decrease of 2 to 5 % will not have any consequences on the farming systems concerned. For bananas farms, the expected decrease in the revenue is also relatively high since it will reach 8 to 15%. But these farming systems are mainly developed by some absentee owners and they are highly profitable, so farming systems would be only slightly affected and no important changes should occur. However we can present two possible evolutions: an intensification of farming systems in the north (development of high investments like private desalinization plants) and a shift to other less sensible trees (dates, guava, figs) allowing also a high return. This shift could be important if the custom duties on bananas are effectively lifted (cf. above), otherwise it will remain limited to intensive bananas farmers who could bear high investments and close management (that is not the case for the absentee owners). For citrus farming systems, the net revenue will only decrease by 2%, we can thus suppose the supply of blended water will not have important impact on farms and farmers.

To conclude the shift to treated waste water would certainly have some consequences in terms of loss of production but will not lead to important modification of the agricultural landscape of the Jordan Valley.

FARMING SYSTEM			Gross output ($/du)				Net return ($/du)			
			Actual	Presumed			Actual	Presumed		
			Ecw=1	ECw= 1,15	ECw= 1,225	ECw= 1,9	Ecw=1	ECw= 1,15	ECw= 1,225	ECw= 1,9
Bananas Farms	Surface irrigation		1520	1444	1414	1110	700	624	594	290
	Drip irrigation		2110	2005	1962	1540	1250	1145	1102	680
Vegetables farms open field	familial farm	Drip Mulch	1360	1345	1330	1225	335	320	305	200
		Drip Mulch & Minitunnel	1763	1695	1680	1555	533	465	450	325
	entrepreneur farm	Drip Mulch	1360	1345	1330	1225	268	253	238	133
		Drip Mulch & Minitunnel	1763	1695	1680	1555	468	400	385	260
mixed farm			750	727	718	685	80	57	48	15
Vegetables farms Greenhouses		Familial farms	2200	2190	2180	2055	440	430	420	295
		entrepreneur's farm	3375	3355	3350	3175	920	900	895	720
Citrus farms	Extensive familial farm		295	295	289	242	110	110	108	90
	Absentee Owner extensive farm		300	300	294	246	40	40	39	33
	Intensive familial farms		440	440	431	361	145	145	142	119

FARMING SYSTEM			Gross output ($/du)				Net return ($/du)			
			Actual	Presumed (% of decrease)			Actual	Presumed (% of decrease)		
			Ecw=1	ECw= 1,15	ECw= 1,225	ECw= 1,9	Ecw=1	ECw= 1,15	ECw= 1,225	ECw= 1,9
Bananas Farms	Surface irrigation		0	5	7	27	0	11	15	59
	Drip irrigation		0	5	7	27	0	8	12	46
Vegetables farms open field	familial farm	Drip Mulch	0	1	2	10	0	4	9	40
		Drip Mulch & Minitunnel	0	4	5	12	0	13	15	39
	entrepreneur farm	Drip Mulch	0	1	2	10	0	6	11	50
		Drip Mulch & Minitunnel	0	4	5	12	0	14	18	44
mixed farm			0	3	4	9	0	28	39	81
Vegetables farms Greenhouses		Familial farms	0	0	1	7	0	2	5	33
		entrepreneur's farm	0	1	1	6	0	2	3	22
Citrus farms	Extensive familial farm		0	0	2	18	0	0	2	18
	Absentee Owner extensive farm		0	0	2	18	0	0	2	18
	Intensive familial farms		0	0	2	18	0	0	2	18

Table 40. Expected decrease in the profitability of farming systems in the north of the valley because of the shift from freshwater to treated waste water

V.3.4 Conclusion on the Jordan Valley

Two main changes in water management to occur in the Jordan Valley have been studied above. It is worth noticing that at the farming system level, the increase in water price would have more consequences than the shift from freshwater to treated waste water.

On a general point of view, the changes in management we have described should lead to the disappearance of the most extensive farming systems of the Jordan Valley. Are thus concerned the mixed farms (vegetables and bananas) in the north of the valley and the poor familial farmers in the middle-south of the valley. In the same time it is possible bananas trees (and citrus at a lesser extent) would slowly be replaced by other trees non sensible to salts and allowing high revenue (we can think to a development of date palm trees, but according to the fact the orchards in the north of the valley are generally extensively manage by absentee owner, this shift should remain limited). The disappearance of the extensive familial agriculture should not have important consequences on the fruit and vegetables production in Jordan since the most productive systems should not be highly affected by these changes and will remain unchanged. However it will raise important social problems, the government will have to focus on.

The north of the valley could be affected by the two measures in the same period (increase in water price and supplying with treated waste water instead of freshwater). However, if farmers will be effectively supplied with treated waste water, it is highly probable the price of water do not increase in the same time. This non-increase of water prices in the areas supplied with treated waste water could be a measure making the ‘farmer’s acceptance of the shift’ easier. To facilitate the measure, we could also think to a possible increase of the water quota (for example suppression of the quota’s reduction in summer).

V.3.5 Increase of Prices in the Highlands: Impact of the urban pressure

In our presentation of the farming systems we have seen the importance hold by the water in the suburban area. Actually since 2002 and the implementation of a new tax on water pumped for drinkink purposes, the price of agricultural water has more than doubled in the suburban area.(from 0,2 to 0,45 JD/m^3). The two systems we have described within this area have been highly affected. In this section we will try to evaluate the revenue which could have been brought out in these farming systems before the implementation of this tax.

- For rented greenhouses farm, we will assume that the only change to be consider is an increase in water prices from 0,2 to 0,45 JD/m^3.

- For farms with a sharecropping contract, we will assume that the increase in the effective water price has been accompanied by a change in the nature of the contract. We will consider the old contract was based on the same rules than in other parts of the Basin i.e. a share of costs (wages excluded) between the owner and the sharecropper. 65% of the product is for the owner and 35% for the sharecropper.

	Rented greenhouses farm	Sharecropping farm	
		sharecropper	owner
Current Net profit in bad year ($/du/year)	15	60	390
Current Net profit in good year ($/du/year)	300	110	510
Average Net profit ($/du/year)	157,5	85	450
Presumed former Net profit in bad year ($/du/year)	150	85	390
Presumed former Net profit in good year ($/du/year)	435	125	520
Average former Net profit ($/du)	292,5	105	455

Table 41. Impact of the water price increase on suburban farming systems

This table shows the increase in agricultural water price which occurred in the suburban area after 2002 lead to a decrease in the revenue of farmers in the area. Revenues have respectively decreased by 45% and 20% for greenhouses tenants and sharecropper while the revenue of owners stayed almost constant. Before the increase in water prices, the situation for sharecropper was also difficult since their farms do not allow bringing out a Net profit higher than the poverty line (they often have another source of revenue). On the contrary, the situation evolved a lot for the smaller tenants of greenhouses who have seen their production system becoming non sustainable (net return per familial worker below the sustainable line -cf. page 54) while he was sustainable and allowed having a high net return before the water price increase (3.500$/ca/year on average for the more extensive[229] systems of this kind). This important evolution can explain the widespread escape of farmers from the suburban areas to the eastern desert and even to the Jordan Valley we have identified thanks to our surveys. This movement initiated in the middle of the 1990s due to the growing pressure of Amman linked to the external causes we have already described (migration of Jordanian-palestinian from the gulf) is now still running and fuelled by the new water policies implemented in the *Highlands.*

V.3.6 Increase of prices in the Highlands: Impact of the By-Law No.85 of 2002

Thanks to the evaluation of the average water consumption of farms located in the *Highlands* we have realized, it is now possible to know which farming systems will be concerned by the By-Law and to what extent they will be affected. Our quantified impact assessment and the surveys done in 2004 will then allow us identifying the strategies developed by the farmers to face this increase in effective water prices. A first paragraph will quickly present the farms non concerned by the By-Law, we will then focus on the Eastern Desert and on the Transition area where are localized the farming systems to be affected by this measure. Lastly we will present the peculiar case of bananas farms in the south of the Jordan Valley.

(i) Non affected farming systems

- Farms located in the suburban area. It is due to the fact that farms have relatively low water consumption (around 500 m^3/du/year). The limit of 150.000 m^3/year is thus generally not reached. One point has however to be underlined. Owner of wells in this area sell water for domestic purposes. It is thus possible that the total abstracted water (drinking + agricultural) passed over the limit of the By-Law. The taxes will thus be shared between the users of water and according to the already low profitability of the farm in the suburban area; this new increase could not be borne by the farmers who will continue to leave the area for other places in Jordan. The classic agriculture (tomatoes, cucumbers…) in the suburban area would disappear in the next few years while it is probable that high-value crops (cut flowers) continue to be developed in very-intensive and profitable farms beneficiating from the proximity of Amman and from the consumption centres.

- Farms in the Upper Yarmouk Area are not concerned by the By-Law since their water consumption is below the abstraction limit mainly because of their small size (maximum 100 dunums)

- Extensive sharecropping farms within the Eastern Desert. Only largest owners with several sharecropping arrangements and an olive trees plot could be concerned by the By-Law[230]. The owner will not assume the water price increase. There are thus two possibilities: the owner will not renew some of his contracts (in order to save enough water to be below the limit) or will increase his share of the production in order to counterbalance the water taxes. The

[229] Extensive as far as labour is considered

[230] They are not mentioned in the following tables since this case is relatively rare within the Lower Jordan River Basin.

already low profitability of the sharecropper's farm will continue to decrease, the situation becoming completely unbearable. We can suppose they will stop their agricultural activity.

- Farms in the uplands and along the Zarqa River are not considered in this quantification since they are often irrigated thanks to shallow wells and/or spring located along the *Side Wadis.* Moreover, sole the large fruit trees farms could have a water consumption higher than 150.000m^3/year and as they often have several sources of water (in general two) they would not be concerned by the By-Law implementation.

(ii) Farming systems affected by the By-Law

The table besides summarizes our observations and quantifications. As there is not many unlicensed wells in the *Highlands* (inside the Lower Jordan River Basin in Jordan) [231], we have used the rules concerning the licensed wells in our economic assessment. We present the impact of the By-law according both to the old rules and to the new rules according to the recent amendments in order to know which farmers will be the main beneficiaries of these recent modifications.

<u>Note on methodology</u>: There were no water bills in the *Highlands*. To evaluate the effective water costs we thus have considered the costs of well's operation (diesel or electricity of the pumps) and the renting costs (for tenants) or maintenance/depreciation costs (for owners) of the well. Return on investment is defined as usual[232] for entrepreneur's farms.

- We can see farms in the Highlands are characterized by a high level of investments (between 40.000 and 90.000 $/farm for rented farms and above 300.000 $/farm for owned farm). The highest investments are done in fruit trees farms.

- The effective costs of water are high (between 0,06 and 0,145 $/m^3 .In comparison water is charged 0,02 $/m^3 in average in the *Jordan Valley*)

- Concerning vegetables farmers, and according to the new By-Law rules[233], a large diversity of situation can be described[234]. The amount to be paid will be included between 210 and 1610 $/farm according to the kind of farming system. It represents between 0,5 and 13% of the Net revenue of the farmers. Due to this range, the economic consequences and the strategies adopted will be different according to the characteristics of the farming systems.
  - Greenhouses farming systems in the transition area and in the Eastern desert should not be modified. The farmer will pay the very low fees without changing his management (maybe will he takes more care to the water he uses but no true modification should occur)
  - Concerning open field farms in the eastern desert and according to the new rules, the impact of the By-Law is important since a decrease of 5 to 13 % of the farmer revenue is expected. The farmers will have to adapt themselves to these new conditions. Two main evolutions could be envisaged:

Table 42. Impact of the By-law on the revenue of farmers in different farming systems in the Highlands

[231] The unlicensed wells are mostly limited to some areas: shallow wells producing mostly brackish water in the south of the Jordan valley (Hisban-Kafrein triangle), some in Jafr desert and in Azraq Area (out of the Lower Jordan River Basin in Jordan).

[232] The family remuneration (1000 JD/month/ca) is subtracted to the Net Profit.

[233] Fees of 5 Fils/m^3 for volumes abstracted between 150.000 and 200.000 m^3/well.

[234] The table does not present the cases of the farms planted with particular crops. Firstly, these farms are relatively rare and represent neither a large number of farmers nor large surfaces. Secondly conclusions presented for each kind of farming systems with classic crops are also accurate for the corresponding farming system with particular crops. Strategies and behaviour adopted by the farmers result from the same dynamics. The sole difference is that, because of profitability a little bit higher, the changes could be less pronounced and more progressive.

		Eastern Desert									Transition Area
		Fruit Trees Farm			Vegetables Farm						
Characterization of the farming system		Familial Farm	Large Intensive Entrepreneur's Farm		Open Field Rented Farm	Open Field owned Farm			Greenhouses farms		Greenhouses farms
'Land and Water' Tenure		Land and well owned	large intensive farm	Absentee land investor (half olive/half fruit trees)	Land and well rented	Absentee owner	Classic Familial Farm	Intensive Familial Farm	rented entrepreneur's farm	Owned familial farm	entrepreneur's rented farm
Average Surface (dunum)		100 to 200	200 to 400	400 to 800	200 to 250	200 to 250	200 to 250	200 to 250	100 to 200	100 to 200	100 to 200
Water Consumption	mm/day/du	4	4	3	4	4	4	4	5	5	5
	m^3/du/year	1000	1000	515	960	960	960	960	1 200	1 200	1 200
	m^3/farm/year	150 000	300 000	405 000	215 000	215 000	215 000	215 000	180 000	180 000	180 000
Initial Investment ($/farm)		475 000	675 000	930 000	40 000	325 000	325 000	435 000	90 000	410 000	75 000
Net Profit or Net Revenue ($/du)		1265	1685	1485	110	55	60	135	110	250	240
Return on investment ($/du)		705	1605	1465		2			0		130
Net Profit / Total Costs (%)		195	195	165	12,5	8	8	15	10	26	21
Water Costs	$/$m^3$	0,08	0,075	0,145	0,135	0,095	0,095	0,095	0,14	0,08	0,06
	$/du/year	80	75	75	130	90	90	90	170	100	75
	$/farm/year	12 000	22 500	45 000	29 250	20 250	20 250	20 250	25 500	15 000	11 250
	% of total Costs	12,5	9	8,5	15	12	12,5	10	15	10	6
New Water Costs: Scenario 1 old rules	$/du/year	80	109	107	143	103	103	103	177	107	82
	$/farm/year	12 000	32 650	63 970	32 260	23 260	23 260	23 260	26 550	16 050	12 300
	in % of total Costs	12,5	17,3	16,9	16,3	14,1	14,3	12,1	16,1	11,2	7,1
New water costs Scenario 2 new rules	$/du/year	80	104	104	137	97	97	97	171	101	76
	$/farm/year	12 000	31 250	62 570	30 860	21 860	21 860	21 860	25 710	15 210	11 460
	in % of total Costs	12,5	16,5	16,6	15,6	13,3	13,5	11,4	15,6	10,6	6,6
Expected decrease in Revenue (% of the Actual Net Revenue)	Scenario 1 ($/du)	0	2	2	12	24	22	10	6	3	3
	Scenario 2 ($/du)	0	2	2	7	13	12	5	1	0,6	0,6
	Gross Loss 1 ($/farm)	0	10 150	18 970	3 010	3 010	3 010	3 010	1 050	1 050	1 050
	Gross Loss 2 ($/farm)	0	8 750	17 570	1 610	1 610	1 610	1 610	210	210	210

* A decrease in the area cropped to avoid the fees' payment;
* A decrease in the water allocated to each dunum in order to decrease the total water consumption of the farm;

We will present the feasibility and the consequences of these two strategies in the following section.

- It is worth noticing the main beneficiaries of the new amendment lowering the already low fees are these vegetables farmers. This observation reveals the important weight these farmers should have in the Jordanian society. Owner of wells are often ancient Bedouins of large tribe who settled down during the 1970s and the 1980s and the government need their support. As they are the most affected by this By-law (their revenue was expected to decrease of 10 to 24% with the ancient rules), they should have 'negotiated' this recent lowering in order to soften the impact of this new water-regulation.

  - Greenhouses farmers are the most favoured since the amount they have to pay has been divided by five. If the payment of the first bill they received (1st April 2004) could be difficult to pay (especially for farmers renting their greenhouses farm in the eastern desert), the next one will be more easily bearable. No change should occur.
  - For open field vegetables farmers the total bill will be divided by two thanks to the new amendments. However the impact of the revenue will stay relatively high and farmers will still have to develop the strategies presented above and we will describe in the next section
  - Fruit trees farmers will not really beneficiate of the fee lowering since the impact of the old and of the new version of the by law have the same consequences on their revenue

- Related to their high water consumption and to the large surface of the farms, fruit trees farmers will pay the highest amount of money (from 8.750 to 17.570 $/farm/year according to their farming system) but because of the high profitability of their farms, this water price increase only represents 2% of their Net revenue even if the effective water price increase by almost 25%.

  * If we consider an average farm, **familial fruit trees farm will not be concerned** by the By-Law. Even by considering the largest farms, the economic impacts of the by-law would be negligible (decrease of the revenue lower than 1%) and we can suppose the farmers will pay their fees without changing anything.
  *The entrepreneur's fruit trees farm will be concerned by the By-law. They will pay the added water costs but several ways of payment can be envisaged:
    - A direct payment to the government;
    - The renting of an additional well to an agricultural owner who would stop its activity or to an absentee owner who was renting his well to a vegetables farmer who would stop his activity. This will allow dividing the water pumped in each well to irrigate the farm and thus avoiding a share of the governmental fees.

- The peculiar case of Olive trees plots has to be considered. The plots in themselves do not use enough water to be concerned by the By-Law. The rare olive trees farms (drip irrigation on 200 to 400 dunums) will not be concerned by the By-Law. However, as olive orchards are mainly associated to another activity (vegetables or fruits), the consumption of water can not been considered alone. The existence of an olive tree orchard could lead the farmers to develop some strategies in order to decrease the fees they will have to pay since the 150 dunums-olive plot will correspond to a net outlay of 5.720 $ (4.370 $/farm for water costs[235] and 1.350 $ of net loss due to the maintenance of the non yet profitable orchard)

V.3.7 Current and future evolutions to be recorded

(i) Vegetables farms

The large diversity of vegetables farming systems within the Basin implies a large diversity of strategies which could be developed by the farmers. The charts on the following page[236] shows that:

- The 5 to 13% decrease in the tenant's revenue will decrease the already low profitability of the farming system (Net profit per familial worker higher than the poverty line only if the surface cropped per members of the family higher than 50 dunums, the sustainability line is reached for 55 dunums). We can suppose the farmers will try to reduce their water abstraction. To avoid any fees, farmers have to save 65.000 m^3. That can be done by reducing the surface cropped by 65 dunums (almost 30%) or by reducing by one third the allocation of water on each dunum from 960 m^3 to 670 m^3/dunum. This amount of water still being a little bit higher than the crop water requirements[237]. The first possibility does not seem to us to be probable, the second one is possible on an agronomic point of view but we don't think farmers will decrease their water consumption in this proportion. **A third evolution is possible: farmers will pay the fees for the 50.000 first cubic meters above the limit (it corresponds to a bill of 250 JD -350 $-, it means 1,5 $/dunum) and will continue to irrigate their entire surface by decreasing the water allocation to 900 m^3 per dunum.**

  We can see here that the recent evolution of the By-law with the lowering of the fees (May 2004, after the government send the first water bills to farmers) for the first block tariff (150.000 to 200.000 m^3/year) which have been effectively divided by 5 has the effect of decreasing the possible water savings. Actually, in the first version of the By-Law, it would not have been economically bearable for tenants of open field vegetables farms to pay for the 50.000 cubic meters above the limit. They thus would have decreased their water consumption to a level they were able to economically hold (either by a decrease in the surface or by an allocation decrease, possible since the effective allocation is very higher than the crops requirements), but we can suppose that they would have pumped less than 200.000 m^3/year. Now, it seems highly probable that tenants of wells in the highlands will manage their farm in order to pump 200.000 cubic meters a year.

- The intensive classic farms will not be highly concerned by the By-Law (a decrease in net revenue of 5% is expected) and given the profitability of these farms, no important changes should occur. Maybe farmers will reduce a little bit their consumption to 200.000 m^3/year in order to avoid paying the 'expensive share' of the bill but such evolution is not sure at all. If farmers have an olive trees plot, they could even afford to irrigate their olive trees orchard without threatening the sustainability of their farm. Absentee owners with classic farms are also in this situation and no change should occur within these systems.

[235] 52.000m^3 pumped at 0,06 JD/m^3. We consider here that farmers pump in priority for their vegetables or fruit trees (main activity) and then for their olive trees. If we consider a mature orchard, the plots under surface irrigation will also be loss making (-3.620 $/farm) while plots with drip irrigation will bring out a net revenue of 3.730 $ (i.e. 25 $/du ; 0,07 $/$m^3$ of water)

[236] Economics have been calculated thanks to the new rules of the By-Law. Considering modelling with olive plots, we present the results for an olive trees orchard of 150 dunums under drip irrigation. As it is now loss making we have consider that the olive trees activity was an added costs decreasing the profitability of the vegetables activity.

[237] Evaluated at 615 m3/dunum by *Fitch (2001)*

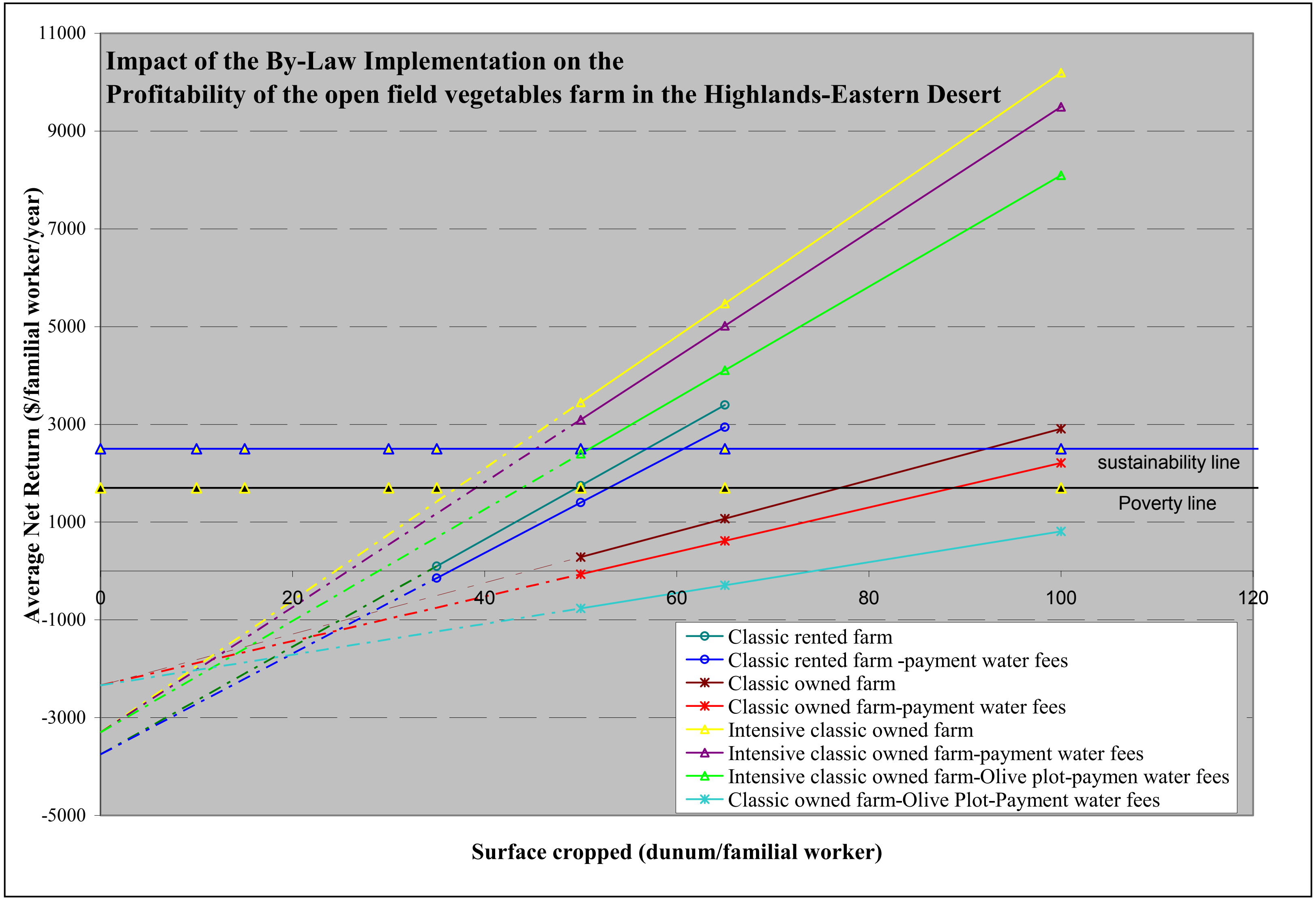

Figure 26. Impact of the By-Law Implementation on the profitability of open field vegetables farms in the Eastern Desert

- Classic owned farms are in a bad situation. Already not profitable, the by law implies a decrease of 12 % of the Net Revenue. The farmers should not bear this situation. It is highly probable that such farmers develop the same strategy that the tenants of wells. It means: a decrease of the water consumption to 200.000 m^3/year in order to avoid the 'expensive share' of the bill (corresponding to the volume pumped above 200.000 m^3/year) and a small decrease of the water allocation. Owners of olive plots will not be able to take cares of their orchard unless they get in debt. For cultural reasons, and personal attachment to the orchard, a simple disappearance of this orchard seems difficult to envisage in the actual situation (even if it would be justified both on the farmer and on the national level). It is probable the owner will keep one part of his olive trees orchards and decrease the surface he crops with vegetables. Some peculiar measures aiming at decreasing the irrigated surfaces planted with olive trees are thus needed if the government want effectively decrease the impact of these orchards on the groundwater abstraction.

In conclusion, we can say that the By-Law will lead to some water savings, very lower that it could have been without the recent amendment. The possible reduction in surfaces cropped remains unknown and should stay relatively limited. However, trough our surveys we have seen that prices of well's rent were decreasing since the two last years because the number of non operating wells increased in the area. According to the description we have done, it can be linked to a phenomenon concerning two kind of farmers. Well tenants or owners with classic open field farming systems could have stopped their activity because of the low profitability of their farm, and switch to a new type of employment. We think that owners of wells are those who could have more easily quit their agricultural activity since they often has other sources of revenue (livestock farming, non-agricultural income, pension…). That is rarer for tenants for which agriculture is the main activity. We will see that this new important availability of wells interests the fruit trees farmers

(ii) Fruit trees farms

We have seen that fruit trees farmers would probably pay their fees without changing their farming systems. But, instead of directly paying the fees to the government they can rent another well in order to decrease the quantity of water they pumped from their own well. Could this behaviour be generalized? We have seen that until 2003, renting a well to irrigate 200 to 250 dunums costs around 22 500 $ (3150 $ for the land). In 2004, it seems these prices have decreased and that it could be possible to rent a well around 15.000 $. We can see on the table p.79 that for large intensive fruit trees farms pumping more than 375.000 m^3/year from one well (surface higher than 375 dunums); it is as interesting to rent a new well or to pay fees to the government.

One problem has however to be underlined. It is actually forbidden to transfer water from one well to a distant plot since the well's license indicates 'an authorized area which could be irrigated' around this well. In these conditions, fruit trees farmers often rent a well and a plot around it (generally around 100 dunums)[238], develop an orchard around the well, use one share of the water they pump on this orchard and discreetly transfer the other part of the water they pumped to the other farm. On a strictly economic point of view, and during the first years, it is more costly to rent a well and to develop a new orchard than to pay the fees to the government. However, after a few years, the high profitability of the fruit trees sector allow bearing easily the renting costs of the well and the initial investment has been quite lower than if the farmer had to buy a well (cf. example besides).

The renting costs' decrease due to the problems met by vegetable farming in the *Highlands,* are thus some incentives for large intensive fruit trees farmers to develop their activity. In these conditions, the volume of water which could have been saved because of the disappearance of some vegetables farmers will not be effectively saved since fruit trees farmers will pump it.

[238] The renting contract is long since farmers generally rent for a period of 15 years allowing to invest and to have his money back -cf. Appendix IV.

Box 11. **A short story about a large intensive entrepreneur's farmer**

We will give an example drawn from a survey and will quantify it on the economic aspect.
*Let a fruit trees farms of 400 dunums irrigated thanks to one well.
Without changing anything the farmer will have to pay 17.150 $/year each year to the government.

This one has another possibility:
*Let the farmer rent a well and 100 dunums of land for 18.000 $/year
*The needed investment to implement an orchard reaches 70.000 $ (700 $/dunum)

The following table can be drawn:

year	1	2	3	4	5	6 and more
Water used by the new orchard (m^3/dunum)	300	300	500	750	1000	1000
Water used in the 100-dunum plot (m^3)	30.000	30.000	50.000	75.000	100.000	100.000
Volume 'over abstracted' per well if the two wells are considered (m^3)	65.000	65.000	75.000	87.500	100.000	100.000
Total Fees to be paid to the government ($)	3.200	3.200	4.500	6.300	8.050	8.050
About the new Orchard						
% of production	0	15	25	50	75	100
Gross Output ($/du)	0	380	630	1.250	1.900	2.500
Costs ($/du)	420	490	490	630	700	850
Net Profit ($/du)	-420	-110	+140	+620	+1.200	+1.650
Cumulated Net profit if payment of fees	-17.150	-34.300	-51.450	-68.600	-85.750	-102.900
Cumulated Net Profit if investment in the new plot ($/100 du)	-132.200	-162.200	-167.500	-125.300	-25.050	121.950

This table clearly shows that it is much more interesting for this farmer to invest in the new plot of 100 dunums by renting a new well. Actually, after five years, it has been less costly to invest in the orchard than to pay the annual fees to the government and after six years a positive profit is brought out by the new plot.

Moreover, the total investment realized on the new plot before this one become profitable (it means allows bringing a profit higher than the renting costs) which reaches 163.000 $ could have been paid by the production of the 'ancient' plot of 400 dunums since this one allows an annual return on investment which reaches 640.000 $ (1.600 $/dunum *400 dunums)

To conclude, this economic quantification clearly shows the interest large entrepreneurs have to rent wells in order to develop their activity and to avoid the payment of the governmental water fees. Moreover, this behaviour leads to an increase of the volume abstracted by the fruit trees farmers since he develops another plot. If the aim pursued by the government is the strict implementation of the different laws aiming at controlling and at limiting the groundwater abstraction, a particular attention would have to be given to this behaviour. This one is linked to the economic dynamism of large and influent fruit trees farmers but seems to have an illegal basis since water is transferred from one plot to another and will lead to a decrease of the effective amount of water 'saved' as well as of the amount of money the government could have expected to collect within the framework of this By-Law. If the increase of the governmental income in the water sector should not - and is not- the main objective of the measures, it is however one of their advantages in a country where the main share of the water exploitation costs are supported thanks to governmental subsidies[239].

[239] It is generally admitted that agricultural public water in the Jordan Valley is charged at a price only allowing to recover one third of the operation and maintenance costs of the supply systems.

t is worth noticing that the rent fee of 15.000 $ is higher than the average revenue brought out in large owned vegetables farms which only reached 10.800 (for a farm of 250 dunums) before the By-law implementation. After the implementation of the new rules of the By-Law, this amount will only reach 9.200 $[240]. This rough economic description confirms the observations we have done during our surveys according to what, some vegetables farmers preferred stopping their agricultural activity to switch to other sectors. For owners of wells, the renting of their well guarantee them a fixed income during 15 years (long renting contract), higher than the one they could have with an agricultural activity and drive them to stop cropping vegetables all the more if they are absentee land investors (it could also be the case of owners closely involved in the farm which have a very low revenue)[241].

An evolution of the irrigated agriculture in the *Highlands* is still running. Because of difficult marketing conditions, vegetable farming became less and less profitable during the 1980s while fruit trees farming allowed having high revenue. Since then, fruit trees surfaces have been developed while vegetables areas were decreasing. The implementation of the By-law should not lead to new dynamics but should enforce this old tendency by driving the vegetables farmers to quit their activity. Fruit trees farmers would be the main beneficiaries of this evolution since they could develop their very profitable activity by renting existing wells, avoiding very high and not easy investments linked to well purchase.

Concerning the volume of water abstracted for agricultural purposes in the *Highlands*, the strategies we have presented, according to the technical characteristics of the farming systems, let us think that water savings would be limited if no other measures are taken. The recent amendment of the By-law actually implies a decrease of the potential water savings, while wells which will not be used anymore by vegetables farmers could be rent by fruit trees farmers still developing their activity. We will try in the chapter VI to quantify the possible savings and will present some measures which could be taken to increase them. In short term, the implementation of the By-law in its ancient version could be an important mean to effectively decrease the agricultural abstraction as is the lowering of the limit considered still very high (150.000 m^3/year) in the medium term.

(iii) The Case of the bananas farms in the south of the valley

In the south of the valley, there are appreciatively 350 private wells[242] of which some of them are illegal. We present here an economic quantification of the impacts of the new By-Law according to rules for licensed and unlicensed wells. According to the National Water Master Plan (2004), wells in the Jordan Valley are slightly brackish (ECw included between 1,5 and 2,5 dS/m i.e. TDS included between 960 and 1600 ppm) and according to the By-Law the rules for brackish aquifers could apply.

In the tables 44 besides, we present the consequences the current version of the By-Law could have on the bananas farmers in the south of the valley. We assumed that the water allocation is around 4.000 cubic meters per dunum and that large intensive farms have two wells on their farm.

- First of all, we can observe that water costs represent a variable share of the total costs in these different farming systems. It is worth noticing that the case of water purchase is rare but illustrates very well the high profitability of bananas since in spite of the very high cost of water (900 $/dunum), the revenue of the farmer is still very high.

- **If wells are legal, no modifications of the farming systems should occur**. Actually, the expected decrease in revenue should not exceed 4% of the present revenue (large intensive familial farms) and given the high profitability of the bananas activity this decrease is easily bearable by the farmers. In the better case, we can hope the large intensive familial farms

[240] For farms owned by absentee land investors, the revenue brought out in the farm reached 11.700 $ before the by law implementation and will be reduced to 10.100 after (farm of 250 dunums)
[241] The only owners not interested in renting their wells are owners with an intensive vegetables farm and who rent a plot of land to crop their vegetables and owners who plant particular crops. The revenue they brought out in their farm is actually very higher than 15.000 $.
[242] Southwards of the village of Karamah until the shores of the Dead Sea. Data from the MWI GIS-database

Characterization of the farming systems		Small Familial farms		Large intensive farms	
		Owner of well	Purchase of water	Entrepreneur farm	Familial farm
Average Surface (dunum)		30 to 60	30 to 60	200 to 400 (1/4 of bananas)	100 to 200 (3/4 bananas)
				There are two wells on the farm	
	m^3/du/year	4000	4000	4000	4000
	m^3/farm/year	180000	180000	300000	450000
Initial Investment ($/farm)		**50 000**	**30 000**	**200 000**	**110 000**
Net Profit or Net Revenue ($/du)		**1673**	**933**	**2625**	**2530**
Return on investment ($/du)				1060	1765
Net Profit / Total Costs (%)		**197**	**57**	**256**	**226**
Present Water Costs	$/$m^3$				
	$/du/year	120	900	75	80
	$/farm/year	5400	40500	5625	9000
	% of total Costs	14	55	7	7
Future Water Costs					
Scenario 1 Licensed wells	$/du/year	125	905	75	185
	$/farm/year	5610	40710	5625	13900
	in % of total Costs	15	55	7	17
Scenario 2 Licensed wells salinity level 1	$/du/year	134	914	75	162
	$/farm/year	6030	41130	5625	12150
	in % of total Costs	16	56	7	14
Scenario 3 Licensed wells salinity level 2	$/du/year	129	909	75	148
	$/farm/year	5820	40920	5625	11100
	in % of total Costs	15	55	7	13
Scenario 4 Unlicensed wells	$/du/year	277	1057	224	400
	$/farm/year	12470	47570	16825	30000
	in % of total Costs	33	64	22	36
Expected decrease in Revenue (% of the Present Net Revenue)	Scenario 1 ($/du)	0	1	0	4
	Scenario 2 ($/du)	1	2	0	3
	Scenario 3 ($/du)	1	1	0	2
	Scenario 4 ($/du)	9	17	9	18
	Gross Loss 1 ($/farm)	210	210	0	4900
	Gross Loss 2 ($/farm)	630	630	0	3150
	Gross Loss 3 ($/farm)	420	420	0	2100
	Gross Loss 4 ($/farm)	7070	7070	11200	21000
Expected Net Revenue once free trade agreements enforced($/dunum)		**681,75**	**-58,25**	**871,25**	**776,25**
Expected decrease in Revenue (% of the Revenue expected once free trade agreements enforced	Scenario 1 ($/du)	<1		0	13,5
	Scenario 2 ($/du)	2		0	10,5
	Scenario 3 ($/du)	1,3		0	9
	Scenario 4 ($/du)	23		17	41

Table 43. Impact of the By-Law on bananas farms in the south of the Jordan Valley

- will reduce their abstraction of 50.000 cubic meters in order to reach 200.000m^3/year/well and to avoid the 'expensive share of the water bill'.

- It is worth noticing farmers pumping less than 200.000 m3/year are disadvantaged if the amendment concerning brackish aquifer is applied.

- If wells are illegal the situation is badly for the bananas farmers since their revenue is expected to decrease of 9 to 18 % according to the farming system[243]. The farming systems the most affected being the small familial farm purchasing water and the large intensive familial farms. Even if the profit brought out in the farm will stay very high, some water savings could thus be possible. If we consider that farmers will continue to crop bananas, two possibilities exist: a decrease in the surface cropped and a decrease in the water allocated to each dunum. As the bananas yield is highly dependant on the quantity of water supplied, the farmer will have to find a balance between his water savings to decrease the water fees and the decrease in yield which is linked and which also implies some losses in his revenue. Therefore, the decrease in gross output should not exceed 185 $/dunum (maximum expected cost of water fees), an amount corresponding to a loss in yield of 305 Kg/dunums with the current farm gate price of the bananas and to 615 Kg/dunum if the customs duties on bananas are raised[244].

  For indication the table 45 presented besides shows the By-Law impacts on farmer's revenue on several farming systems according to given quantity of water pumped. Consequences on surface cropped and water allocation are also presented. (In colour are presented the scenarios we consider as the most probable for each farming system).

The results presented before and the two tables below clearly shows that the By-Law should not have important impacts on banana farming systems in the south of the valley if it is considered as the sole measure to be implemented. However this measure could accentuate the deeper evolutions linked to other measures such as the free trade agreements' enforcement. Therefore a more global change could occur in the south of the Jordan Valley: a generalized shift from bananas production to date palm trees production in large intensive bananas farms. Actually, the large intensive bananas farmers have the financial means to shift to a date production allowing a high economic return as well as important water savings. A production of dates is now being developed in the middle of the valley and we can suppose that the same phenomenon could occur in the south. Actually if bananas farmers have illegal wells this shift could be economically attractive for them.

In the middle of the valley, palm trees received a 'citrus allocation' reaching 840m^3/du/year during the controlled period and allowing an average net return of 2.250$/dunum/year. By shifting to the dates palms, bananas farmers could decrease their water consumption by 5. Even by considering that in the south of the valley dates palms need 1.000 m^3/year/dunum, the total water consumption will only represent 25% of the current consumption.

Entrepreneur farms will thus use 75.000 m^3/farm/year (allocation of 1000m^3/dunum), the fees to be paid will reach 2 625 $/farm/year i.e. a 'saving' of 8.575 $/farm/year if we compare to the fees paid according to the bananas consumption. On the other hand, the dates palm trees would bring, at maturity, 2.250 $/dunum. It corresponds to a financial loss of 28.125 $ on the farm if we compared to the revenue now brought by bananas but a net gain of 103.405 $/farm if we consider that following the free trade agreements the customs duties on bananas will be raised up (implying a drop in prices of bananas production). The shift is thus very interesting for this kind of farmers. This remark is also true for familial farms since they will use 112.500 m^3/farm/year, the fees to be paid will reach 3.940$/farm/year i.e. a 'saving' of 16.970$/farm/year if we compare to the fees paid according to the bananas consumption. The economic loss between a date and the present banana production reaches

[243] And between 17 and 41% if we consider the expected revenue after the enforcement of the different free trade agreements to be considered in Jordan

[244] In order to have a more precise idea on what could be the behaviour of bananas farmers in the south of the valley and to evaluate the water savings which would result; it would thus be needed to study the answer of the bananas yield to the water effectively supplied to the trees

For a water consumption of 100.000 m³/well/year		Amount to be paid ($/farm)	Expected decrease in the revenue (%)	surface cropped per well if allocation of 4.000 m³/du/year		surface cropped per well if allocation of 3.200 m³/du/year (20% decrease)	
				dunums	% of the current surface	dunums	% of the current surface
Small Familial farms	Owner of well	3.500	5 (11,4)	25	56	31	69
	Purchase of water	3.500	8 (negative revenue)	25	56	31	69
Large intensive farms	entrepreneur farm	7.000	6 (10,7)	25	67	31	83
	familial farm	7.000	6 (8)	25	44	31	55
For a water consumption of 150.000 m³/well/year		Amount to be paid ($/farm)	Expected decrease in the revenue (%)	surface cropped per well if allocation of 4.000 m³/du/year		surface cropped per well if allocation of 3.200 m³/du/year (20% decrease)	
				dunums	% of the actual surface	dunums	% of the actual surface
Small Familial farms	Owner of well	5.600	7 (18)	38	83	*With this water allocation, the total surface cropped is reached with 144.000 m³/well/year for a amount paid of 5.350 JD/farm i.e. a decrease of 7% in the revenue*	
	Purchase of water	5.600	13 (negative revenue)	38	83		
Large intensive farms	entrepreneur farm	11.200	9 (17)	38	100	*With this water allocation, the total surface cropped is reached with 120.000 m³/well/year (240.000 m³/farm) for a amount paid of 8.680 JD/farm and a decrease of 7% in the revenue*	
	familial farm	11.200	10 (12,8)	38	67	47	83
For a water consumption of 200.000 m³/well/year		Amount to be paid ($/farm)	Expected decrease in the revenue (%)	surface cropped per well if allocation of 4.000 m³/du/year		surface cropped per well if allocation of 3.200 m³/du/year (20% decrease)	
				dunums	% of ther actual surface	dunums	% of the actual surface
Large intensive farms	familial farm	16.100	14 (18,4)	50	89	*With this water allocation, the total surface cropped is reached with 180.000 m³/well/year (360.000 m³/farm) for a amount paid of 14.200 JD/farm and a decrease of 12%*	

Table 44. Possible strategies developed by bananas farmers in front of the By-Law if their wells are illegal[245]

We can thus conclude that:

- Small familial farmers will probably decrease their consumption until 150.000m³/year, that could allow them to crop between 83 and 100% of their present surface (according to the water allocation per dunum), the impact on the revenue will thus be included between 7 and 13% (instead of the 9 to 17% now expected).

- Large intensive entrepreneurs will probably decrease their water consumption mainly by decreasing the water allocation. If they pump between 120.000 and 125.000m³/year/well; that could allow them to crop between 81% and 100% (according to the water allocation per dunum) of their present surface and they could support the decrease of revenue reaching 6 to 9%.

245 In colour are presented the most probable scenarios of evolution

- If large intensive familial farmers decrease their consumption until 180.000m^3/year/well, that could allow them cropping between 80 and 100% of their actual surface (according to the water allocation per dunum), the expected decrease in yield reaching 12 to 14% (instead of the 18 % now expected).

31.500$/farm/year (while the future gain, after enforcement of the free trade agreement is evaluated at 165 800 $/farm).

If in the present conditions (customs protection on bananas), a shift to dates does not seem to be possible since it will not be interesting for the farmers, it becomes highly possible if these protections are raised up within the framework of the different free trade agreements to be enforced in Jordan. The investment to implement a palm trees orchard is appreciatively similar to the implementation costs of a bananas orchard so it could not raised any problem but as the production is highly delayed (6 years) it could prevent the farmer to shift to palm trees. However, these large bananas farmers develop a banana orchard only on one plot of their farm and the other surfaces are fallow or planted with vegetables. One of the possibilities would be to implement the palm trees orchard on the surfaces not planted with bananas, the farm will stay profitable thanks to the bananas production when, in the same time the palm trees orchard grow until become productive. Once the palm trees orchard productive, the banana activity could be stopped leading to important water savings. According to the water consumption of the palm trees, the farmer could have the possibility, if he has the financial means to do it, to increase the surface he crops in order to increase his revenue. One other advantage of the date palm tree is that the orchard can stay 30 years on a plot while a bananas orchard just stay 4 to 6 years in these farming systems: the investment is thus lower on the long term.

In the present situation and according to the 'potential water savings' that represents a shift to date palm trees, some incentives would be needed to encourage the bananas farmers to change their agricultural activity since a bananas production remains more profitable than a date one. On another hand, the sole enforcement of the free trade agreements, expected within the next few years, would be a sufficient incentive since the profitability of bananas farms will sharply decrease to become lower than the one of date palm trees plantation.

Note on vegetables in the south of the valley

Owners of large intensive farms have often a vegetables activity on the plots which are not planted with bananas. This secondary activity is done by employees or sharecroppers and will remain only if the added cost of water is lower than the revenue brought out by the vegetables. We have considered that the vegetables water allocation reached 510m^3/du/year (allocation in the north of the valley) and we consider the water used was charged according to the higher block-tariff since the farmer gives the priority to bananas. In familial farms, where the work is done by employees, added cost of water reaches 50 $/dunum/year. The average revenue brought out reaches, on average, 100$/dunum/year. The activity will thus remain.

In entrepreneur farms, the added cost of water reaches 7 to 15 JD/dunum/year according to the well category (legal, illegal, brackish). It does not influence the Net profit for the owner of the land (reaching 135 $/dunum). On another hand, the revenue of the sharecropper reaches 120$/dunum/year on average. If added costs are shared between owner and sharecropper, the revenue of the sharecropper will decrease of 3 to 6%, it is not important but as sharecroppers are already very poor, these new costs could lead them to quit the agricultural activity if they have this opportunity.

Finally, we can say that the principle of the By-Law No.(85) of 2002 aiming at controlling and limiting the agricultural water abstraction has been accepted by all the actors of the agricultural sector. It has opened the way to a taxation of volumes pumped in private wells. The recent evolutions and the lowering of the already low fees show however that its implementation is difficult and that it is a very sensitive question. Some influent social groups actually (mainly ancient Bedouins now settled in the eastern desert and who have developed an agricultural activity) try -and manage thanks to their support in the parliament- to limit its impact on their activity[246].

Therefore, the recent amendment which constitutes a step backwards (lowering of the already low fees) will result in a decrease of the potential water savings since an homogenisation of the quantity pumped in vegetables farms around 200.000 m^3/du/year can be expected (while a lower

[246] These farmers do not want that the water rights they obtained in the past change. They mainly consider that, because of the high investments they have done, they own the water they use and they do not have to pay any fees to pump it.

decrease both per farm and at the River Basin scale were highly probable for economic reasons[247] and possible on the agronomic point of view with the old rules of the By-Law), and in a diminution of the possible governmental income while no advantages for the water and agricultural sector have been identified.

In its present version (as in the former one) it is also worth noticing the By-Law do not constitute a tool to decrease the irrigated surfaces of olive trees which constitute one of the main aberrations of the agricultural sector in Jordan. These plots actually use one of the best quality water in Jordan while they are non profitable ‘social farms’ owned by influent absentee land investors.

On a general point of view, the different changes in water management we have described above will not lead to a global reorientation of the agricultural sector in Jordan. The already existing dynamics will be strengthen, the intensification of the farming systems both in the valley (greenhouses) and in the Highlands (fruit trees) will become more pronounced, a shift to less water-consuming trees allowing a high profit (palm trees) could occur in the valley and the extensive systems will become less and less profitable until they disappear. This disappearance which should appear only if the measures described are enforced and accentuated will not have very important impacts in terms of agricultural production since the most productive systems will remain. However, it will raise a lot of social problems the government will have to face. Some attendant measures and notably concerning agricultural advising will thus have to be developed by the Jordanian institutions.

[247] Farmers would actually have pumped a lower volume in order to preserve the already low profitability of their farms.

VI. SCALING UP TO THE RIVER BASIN SCALE

VI.1 INTRODUCTION: ITEMS CONSIDERED WITHIN THE ASSESSMENT

The last axis of research we would like to develop in this report is an extension of the observations and quantifications carried out at the farming system scale to the River Basin Scale[248]. This extension aims to quantify the consequences of the measures we have described, which are -or will be- taken at a national level and which essentially concern the *Lower Jordan River Basin in Jordan* because of the prominent role he plays within the country. Until now, we only have envisaged the impact assessment on a qualitative point of view and we will try here to quantify at the Basin level some of the scenarios we have discussed and for which we have enough information to extrapolate our conclusions.

The main problem we face is that, despite our fine knowledge of the structural characteristics of the farming systems we do not have a precise idea of the relative importance of each farming system within the Basin. The aggregation of data obtained at the farmer level will thus be difficult and should not allow having accurate information at the Basin level. Consequences of global measures could however be quantified at the Basin level and it is particularly interesting to develop an assessment on the following points:

- The **evolution of the Jordanian production** in term of volumes and cropping pattern,
- The **economic impact** of these evolutions in terms of value lost or added
- The **evolution of the irrigated surfaces** inside the River Basin;
- The **amount of fresh water saved in the agricultural sector** according to the different measures and policies implemented.
- The **economic costs** of the water measures and policies which will directly affect the Jordanian Agricultural Sector.

VI.2 THE NEW ECONOMICS RULES

Jordan gets into a process of market's liberalization. Within this framework several agreements have been signed and are -or will be- in force within the following years. We can cite for example the EU-Jordan agreement in force since the 1st of May, 2002; the GAFTA (Great Arab Free Trade Agreement) aiming to create a free trade zone between the Arab countries which will be completely enforced the 1st of January, 2005 and the WTO (World Trade Organization) Jordan is member since the 11th of April, 2000. All these agreements aim at decreasing the customs duty.

If for Jordan, the GAFTA is the central agreement to be considered since all customs duty on agricultural products should be lifted the 1st of May, 2005, the WTO will have important impacts for some crops and notably bananas, apples and grapes. The entry of Jordan in the WTO in 2000 has actually been accompanied by an obligation to reduce the customs duties to 30% of the value of the imported products. This rate is planning to decrease until 20% in 2010 according to a pre-established schedule. The other importation quotas (non proportional taxes) should also completely disappear by the year 2010.

For bananas, apples and grapes customs duties of 30% of the value imported and additional taxes of 250 JD/T imported are still in force. Mainly because of the economic importance of the banana production in the Jordan Valley[249], negotiations are still running since no schedule has been

[248] The River Basin has actually been presented here as the relevant scale to comprehend the water management mechanisms. See *Venot (2004)* for a more precise presentation of the River Basin concept

[249] We can also precise that it is a production with 'a social importance' since it is developed by members of a large influent family (Al-Adwan) having strong support in the parliament and acting in order to keep its privilege (here the development, for historical and social reasons of a very profitable water-consuming-crop)

presented for the disappearance of the taxes on these products. Based on our farming system's knowledge, we will try to quantify what could be the impact of the disappearance of these taxes on the Jordanian agriculture.

Apples and Grapes are often grown with other trees allowing the same economic return (in large intensive fruit trees farms in the *Highlands*) and are never central in the production systems since only one small share of the farm surface is planted with these crops. We can suppose that farmers will stop to grow apple or vineyard and will replace it by other trees as peaches, nectarines, apricots which already constitute the main share of the cropping pattern in the fruit trees farms existing within the Lower Jordan River Basin.

For bananas, the situation is not the same since some of the farming systems we have described are exclusively based on this production (north and south of the valley). We will try to quantify the economic impact of the suspension of the quotas at the farming system level and then at the Basin level.

Prices paid for the local production and for the imported production by the consumers are now quite similar. We can thus assume that if the quotas of 250 JD/T (350 $/T) are suspended, the price paid to the producer will fall by just as much; the economic impact can thus be easily quantified[250].

VI.2.1 Impact of the quotas' suspension on the River Basin Scale

The total production of Bananas in Jordan has been evaluated by the Department of Statistics at 42.000 Tons in 2003. If we consider this volume, and a decrease in prices of 305 $/T linked to the market liberalization, the net financial loss will reach 18,1 Millions of $ per year, that represents 8,1% of the value of the Jordanian agricultural production (estimated at US$ 222,6 Millions in 2000)[251].

Added to that, the liberalization of the market will certainly lead to a decrease in the irrigated surfaces planted with bananas. Bananas orchards in the north and the middle of the valley use now 1.320m^3/du/year i.e. 4,3 Mcm/year of the 'public water' managed by the JVA to irrigate 3.260 dunums. In the south, farmers irrigated their trees with 4.000 m^3/du/year and the total consumption reaches 41,6 Mcm/year for 10.400 dunums. In the table below, we present the impacts a disappearance of any surfaces of bananas now irrigated thanks to freshwater from Hisban and Kafrein Dam as well as from Wadi shueib will have. We have taken two parameters into consideration: the direct economic losses due to the decrease in production and the indirect economic gains due to savings in water exploitation costs.

[250] Quantifying the suspension of the proportional customs duties is much more difficult since it necessitates knowing what would be the volume imported when the taxes will not be applied anymore. We will not try to do it and will only focus on the impact of the quotas suspension what will be enough to determinate the future evolutions to affect the bananas production in Jordan.
[251] Estimation of the Central Bank of Jordan, in constant value (Basis 1994)

Box 12. ***Impact of the quotas' suspension on the bananas farms profitability***

	North of the valley		South of the valley			
	Surface irrigation	Drip irrigation	Small Familial farms		Large intensive farms	
			Owner of well	Purchase of water	entrepreneur farm	familial farm
Present price of production ($/T)	605	605	605	605	635	635
Future price of production ($/T)	300	300	300	300	330	330
Yield (T/dunum)	2,5	2,5	3,25	3,25	5,75	5,75
Expected Net economic Loss ($/du)	762,5	762,5	991,25	991,25	1753,75	1753,75
Present Average Net revenue ($/dunum/year)	700	1250	1673	933	2625	2530
Presumed Average Net revenue ($/dunum/year)	-62,5	487,5	681,75	-58,25	871,25	776,25
Presumed Net revenue (% of the present revenue)	0	39	40,75	0	33,2	30,7

Table 45. Impact of the quotas' suspension on the profitability of bananas farming systems in the Jordan Valley

The table above clearly shows the suspension of the quotas on bananas' importation will have strong impacts on bananas farming systems in the Jordan Valley. Two of them (surface irrigation in the north of the valley and familial farmer buying water in the south of the valley) will not be profitable anymore while the revenue of the others (which are also the most widespread) will decrease of 60 to 70% to *'only'* reach 490 to 870 $/du/year according to the farming system. This amount is still relatively high and corresponds to the revenue brought out in the most intensive vegetables farming systems in the middle of the valley (large entrepreneur's farm equipped with greenhouses)

We can however suppose that important changes will occur. Firstly will be recorded the complete disappearance of the two farming systems which will become non profitable (surface irrigation in the north of the valley and small familial farmer purchasing water). Secondly, there is a possibility that bananas farmers shift to date palm trees which have the advantage of both being less water-consuming than bananas and of allowing an important economic return since the revenue which could be brought out by date palm orchard is included between 2.100 and 2.800 $/dunum/year.

Because of the high investments required by the implementation of a palm tree orchard (about 850 $/dunum) only large absentee owners in the north of the valley (for them, the disappearance of the quota will be the triggering factor since we have seen there is no reasons for the shift to occur today) and large intensive familial or entrepreneur farmers in the south of the valley could bear this shift. Small familial farms do not have the necessary financial means to change their agricultural activity and we can suppose they will continue to crop bananas earning less money than before.

Due to the delayed production of a date palm trees orchard (5 to 6 years after planting) and because the custom duties are supposed to disappear in 2010, it is worth noticing that the farmers already have to implement this new kind of orchard if they want to keep a constant revenue after the year 2010. Through our surveys we do not have identified any vague attempt in this direction and farmers continue to crop as they were doing before ignoring or believing that this measure will be delayed and it may be very probable.

Lastly, it is worth noticing that, once the custom quotas lifted, the farm-gate value of bananas production will be lower than the farm-gate value of vegetables production (that is not the case now, cf. chapter IV.1). However, most of the bananas farming systems will remain more profitable than vegetables farming systems.

Prices we used are average farm gate prices assuming the quotas have been lifted[252]	**Scenario 1:** Disappearance of 50% of bananas Areas in the north and the middle of the Valley		**Scenario 2:** Disappearance of bananas surfaces planted in the south of the valley and irrigated thanks to freshwater from Hisban and Kafrein Dam & Wadi Shueib		**Scenario 3:** Shift from Bananas to date palm trees on surfaces planted in the south of the valley and irrigated thanks to freshwater from Hisban and Kafrein Dam & Wadi Shueib
Total Production in 2002 (Tons)	8 150		36 400		36 400
Direct Economic Loss (Thousands of $ per year) -Loss in Production-	-1 222,5		- 6971,1		-6971,1
Direct Economic Gain (Thousands of $ per year) - Production of Dates or vegetables [253]-		1 793,0 Shift to vegetables production in open field		7 067,5 Shift to vegetables production in open field	14 456,2
Net Agricultural Economic return (Thousands of $/ year)	**- 1 222,5**	**+ 570,5**	**- 6 971,1**	**+ 96,5**	**+ 14 449,3**
Decrease in Surface (dunums)	-1 630	0	- 6 425	0	0
Water Savings (Mcm/year)	2,2	0,81	25,7[254]	20,41	20,41
Indirect Economic Gain (savings of costs of water mobilization Comparison between a transfer from this water located in the valley with a Transfer from DISI)[255] Thousands of $ per year	Water used for drinking purposes in Amman		Water Used for drinking purposes in the south of the Jordan Valley and in Amman		
	+ 831,6	+ 306,2	+9 714,6	+ 7 715,0	+7 715,0

Table 46. Consequences of a global decrease of the surfaces planted with bananas in the Jordan Valley

By considering the sole economic agricultural balance at a macro-economic level, both in the north and in the south of the Jordan Valley, we can observe that the agricultural economic loss will be important if bananas are not replaced by another crop. However, this gross economic loss will be completely counterbalanced in case of replacement of the bananas areas by some vegetables areas (the net agricultural gains reaching respectively US$ 570 500 and US$ 96 500 in the north and the south of the valley). It is actually worth noticing that, with the new economic rules linked to the different free trade agreements, the value produced per dunum of bananas (maximum of 1085 $/dunum) is lower than the value produced per dunum of vegetables (1100 $/dunum)

Added to that, in the south of the valley, date palm trees seems to constitute a more interesting alternative than vegetables since the shift from bananas to palm trees will be financially favourable for the farmer[256] while it will also allow saving (and reallocating) some agricultural water.

On another hand, the diminution of the surfaces planted with banana trees would result in important water savings even if these surfaces are replaced by vegetables or date palm trees areas and

[252] According to our surveys, we used for the north, an average yield of 2,5 Tons per dunum, an average price of 300$/Ton (present price of 605 $/Ton minus 305 $ of quota). In the south the average yield considered is 3,5 Tons per dunum and the average price is about 310 $/Ton.

[253] For vegetables we used an average return of 1.100 $/dunum. For date production we used a Yield of 150Kg/Tree (10 trees per dunum) and a average farm gate price of 1,5 $/Kg. The Date palm tree consumption of water considered reaching 823 m^3/dunum/year (matching with the water requirement) as the one of vegetables in the south of the valley (the amount of 823 m^3/dunum/year corresponds to an homogenized water allocation for all crops)

[254] Amount supplied from Hisban Wadi and Shueib and Kafrein Reservoirs.

[255] Water costs we have considered: Transfer from the valley to Amman: 0,423 $/m^3$; water from DISI aquifer to Amman: 0,801 $/m^3$)

[256] The expected revenue for date palm trees plantation is very higher than the one expected in vegetables farming systems. Moreover, we have seen before than farmers developing bananas orchards are quite similar to the one having date palm trees plantation. A shift to date palm trees is thus more probable in the south of the valley since it will better fit with the strategies and objectives of the farmers.

reallocation to the domestic sector could thus be possible. These savings could allow meeting the needs of a growing population (both in the Jordan Valley and in Amman) at a lower cost (indirect savings linked to lower water mobilization costs are expected to be included between US$ 0,30 to 9,7 billions according to the scenario considered).

VI.3 THE SHIFT FROM FRESH TO TREATED WASTER WATER IN THE NORTH OF THE JORDAN VALLEY

VI.3.1 Agricultural losses in production and value

Knowing the total irrigated surfaces in the northern part of the Jordan Valley now supplied with freshwater[257], knowing the *crops yield responses* to an increase of the salinity of the water supplied to the crops (*FAO 29 (1985)* and *Grattan (2000)* -Cf. appendixes)[258] its is possible to assess the impacts the shift from fresh water to treated waste water would have in the northern parts of the Jordan Valley. Here, we will address the decrease in the volumes produced, then the agricultural economic loss (value of production)[259] to be expected and finally the potential freshwater savings linked to such measure.

The two table on the following page (table 48) present some conclusions for two scenarios: increase of the water salinity from ECw=1 to ECw=1,15 or 1,225 dS/m (cf. box above). We can see the total vegetables production will decrease of 1.770 to 2.940 Tons (i.e. less than 1% of the present production of the area). The little number of vegetables affected are high value crops (particularly pepper and bean, we could also cite strawberries, very sensible to salts, which do not appear in the statistics of the DoS). The economic impact of this decrease in yield is relatively high since an economic loss of 483.000 to 780.000 $/year is expected.

For fruits, a lot of species will be slightly affected by the shift (decrease in yield around 5% will be very common) and the total production will decrease of 4.990 to 6.950 Tons (i.e. 5% of the present production). The expected costs in terms of loss in agricultural value is expected to reach 1.469.000 to 2.076.000 $/year[260].

The **total financial** loss due to the decrease of the production's value to be recorded in the north of the Jordan Valley as a direct consequence of the shift to treated waste water will thus be included between 1.952.000 and 2.856.000 $/year. That represents 0,9 to 1,3 % of the value of the total agricultural production in Jordan (estimated at 222,6 millions of dollars in 2000) according to the chosen scenario. Added to these *'agricultural costs'*, have also to be considered the needed investments (reaching US$ 1,96 billions) to implement the waste water treatment plants as well as the Operation and Maintenance costs of the plants and networks to supply the irrigated schemes (evaluated at US$ 244 500 a year).

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[257] We based our evaluations on the figures presented by the DoS and we have considered that the entire northern directorate (i.e. 108.200 dunums) and the Development Areas (DA) 18 to 21 of the middle directorate (i.e. 13.000 dunums on 71.200) were supplied with freshwater. We thus have considered the total production of the northern directorate and the production of the middle directorate corresponding to the DA 18 to 21, assuming roughly that the average cropping pattern on these three DAs is the same than in the entire middle directorate.

[258] The water salinity increase is the most important consequence of the shift to treated waste water if we only consider the agricultural production

[259] To evaluate the value of the production, we used prices of production as registered in the central market of Amman in 2002 (Cf. appendix)

[260] In a first approximation, it is worth noticing we do not have considered the possible costs and benefits which would be linked to the development of trees less sensible to salts. This development could actually be observed as a direct consequence of the shift to treated waste water (Guava, figs, Almonds…). It is worth noticing that we do not have quantified the eventual shift to high value trees less sensible to salts which could occur in the north of the valley.

Production	% of actual production		Loss in production (Tons)		Loss in value ($)	
	EC= 1,15	EC= 1,225	EC= 1,15	EC= 1,225	EC= 1,15	EC= 1,225
Tomatoes	100	100	0,0	0,0	0	0
Squash	100	100	0,0	0,0	0	0
Eggplants	99	98	213,3	426,5	39703	79406
Cucumber	100	100	0,0	0,0	0	0
Potato	99	98	267,4	534,8	73161	146322
Cabbage	100	98	0,0	101,5	0	10019
Cauliflower	100	100	0,0	0,0	0	0
Hot pepper	97	95	192,7	321,1	52177	86962
Sweet pepper	97	95	201,0	335,0	66915	111526
Broad beans	95	92	99,3	139,0	55438	77613
String beans	95	92	156,3	218,9	89075	124706
Cow-peas	100	100	0,0	0,0	0	0
Jew's mallow	100	100	0,0	0,0	0	0
Okra	??	??	??	??	??	??
Lettuce	97	96	73,5	97,9	22274	29698
Sweet melon	100	100	0,0	0,0	0	0
Water melon	100	100	0,0	0,0	0	0
Spinach	100	100	0,0	0,0	0	0
Onion green	94	92	120,2	159,4	20010	26535
Onion dry	94	92	355,2	471,1	59120	78399
Turnip	97	96	17,4	24,6	??	??
Carrot	97	95	28,3	44,0	5436	8444
Parsley	??	??	??	??	??	??
Radish	97	96	45,6	68,5	??	??
Others	??	??	??	??	??	??
Total Loss (tons & thousands of $)			1770,2	2942,3	483	780

Table 47. Decrease in volume and in value to be expected with the shift to treated waste water in the north of the Jordan Valley

Figures for the areas irrigated thanks to freshwaterin the north of the Jordan Valley

Production	% of actual production		Loss in production (Tons)		Loss in value ($)	
	EC= 1,15	EC= 1,225	EC= 1,15	EC= 1,225	EC= 1,15	EC= 1,225
Lemons	96	94	1177,2	1715,0	353645	515229
Oranges local	97	96	85,1	128,9	34347	52023
Oranges navel	97	96	288,1	436,4	116253	176079
Oranges red	97	96	109,4	165,7	44134	66846
Oranges valencia	97	96	121,5	184,0	49013	74236
Oranges french	97	96	28,4	43,0	11448	17340
Oranges shamouti	97	96	137,1	207,6	55317	83785
Clementines	97	96	1035,9	1569,0	241070	365130
Mandarins	97	96	606,4	918,4	99206	150259
Grapefruits	93	92	127,9	155,3	27065	32864
Medn, mandarins	97	96	17,6	26,7	2887	4372
Pummelors	93	92	210,7	240,8	40421	46196
Sour oranges	97	96	0,0	0,0	0	0
Olives	100	100	0,0	0,0	0	0
Grapes			788,0	788,0	166711	166711
Figs	100	100	0,0	0,0	0	0
Peaches	96	94	7,3	11,3	4560	7074
Apples	96	93	41,7	62,5	24394	36591
Pomegrantes	??	??	??	??	??	??
Guava	100	100	0,0	0,0	0	0
Dates	100	100	0,0	0,0	0	0
Bananas	95	93	172,9	242,1	186329	260860
Others	??	??	??	??	??	??
Almonds	96	94	4,8	7,1	??	??
Plums prunes	95	93	2,5	3,8	1398	2126
Apricots	95	92	26,4	42,2	11153	17844
Pears	??	??	??	??	??	??
Total Loss (Tons and thousands of $)			4988,6	6947,7	1469	2076

VI.3.2 Freshwater mobilization and 'reallocation'

Now, appreciatively 75 Mcm of freshwater[261] are supplied to the irrigated perimeters located in the northern part of the Jordan Valley. 20 others Mcm/year of freshwater are mixed with blended waste water (coming from the King Talal Reservoir) and used in the middle of the valley. The total amount of freshwater used in the Jordan Valley thus reaches now 95 Mcm/year while 50Mcm/year are pumped from the Valley to supply Amman.

In 2025, we plan that no perimeters in the Jordan Valley will be anymore supplied with freshwater. It would be allowed by the increase of the capacity of the As-Samra treatment plant and by the treatment of 30 Mcm/year of waste water in northern Jordan. 25 Mcm/year of this retreated waste water will be supplied to the Jordan Valley perimeters for agricultural purposes. In the same time, 25 Mcm/year of freshwater will be newly mobilized thanks to dams along north *Side Wadis* and 10 Mcm/year will be supplied from Israel (desalinated water) as it is mentioned in the peace treaty of 1994.

Finally the irrigated perimeters of the northern Jordan Valley[262] will thus be supplied by 110Mcm/year of freshwater and 25 Mcm/year of treated waste water, it means blended water at a 1:4,5 ratio[263]. We assume that the shift to treated waste water in the north of the Jordan Valley will be accompanied by an increase of 33% of the quantity of water supplied to the farmers located in areas now receiving freshwater. Instead of receiving 75 Mcm/year of freshwater the 12.150 hectares of the northern part of the valley will receive 100 Mcm/year of blended water[264]. The remaining 35 Mcm/year will reach the perimeters located southwards the junction between the KAC and the Abu-Zighan Canal.

To conclude, the shift to treated waste water in the north of the valley and the new process of water mobilization within the same area will result in:

- The treatment of 30 Mcm/year of waste water in the northern cities of Jordan.
- The construction of new dams or an increase of the capacity of existing dams along the northern Side Wadis to mobilize 25 Mcm/year of extra freshwater.
- The development of a desalinization plant in Deir Allah (capacity of 10 Mcm/year, already functioning in 2004 to be pumped to Amman)
- The use of 15 Mcm of extra freshwater in the Jordan Valley
- The pumping of 30 Mcm/year of extra freshwater from the valley to Amman.

The total investments to do would reach US$ 39,4 millions[265] while the Operation and Maintenance costs of the needed waste water treatment plants have been evaluated at US$ 4,95/year millions. A cost to be added to the expected loss in agricultural value (average of US$ 1,92 millions).

Added to that, the mobilization of 40 Mcm/year of extra freshwater and its pumping from the Valley to Amman would allow a 'relative saving' of US$ 12,25 millions if we compare this peculiar cost of water mobilization (0,423 $\$/m^3$) to the cost linked to a transfer of freshwater from DISI (0,801$\$/m^3$). This 'relative saving' thus counterbalances the financial costs of the shift from freshwater to blended water in the north of the Jordan Valley. Therefore, and to conclude on this point, the supply of blended water in the northern part of the Jordan Valley will certainly cause a decrease of the volume and of the value of the agricultural production in the area. However, the freshwater used in this area being one of the less expensive water resources of the country, the potential savings in water

[261] 65 Mcm/year for the perimeters of the northern directorate (Department of water resources, JVA) and 10 Mcm/year for the perimeters of the middle directorate irrigated only with freshwater.
[262] Northwards of the junction between the KAC and the Abu-Zighan Canal (coming from the KTR)
[263] Ratio included in the range recommended in *WAJ, 2004*
[264] 85 Mcm/year in the northern directorate and 15 Mcm/year in the middle directorate. Moreover, at a ratio of 1:4,5, it means 20 Mcm/year of treated waste water and 80 Mcm.
[265] According to the *JVA 2003-2008 Strategic Plan*

exploitation costs are important and will counterbalance easily this loss, an annual surplus of US$ 3,13 millions would even be brought out[266].

VI.4 INCREASE OF WATER COST: A SOURCE OF REVENUE FOR THE GOVERNMENT

An increase in public agricultural water prices is one of the main evolutions now discussed within the institution in charge of water in the Jordan Valley (JVA, MWI) and its need is recognized by all (even farmers!). This awareness of farmers can mainly be explained by the fact that agricultural water prices are very low in the Jordan Valley (average of 0,02 $ per cubic meter) and only represent, for the majority of the farmers, a few percentage of their total costs (as it has been illustrated in the chapter IV.5) and thus of the revenue brought out in the farming systems

Based on the modelling of the economic and financial impacts of a water price increase on the farming system in the Jordan Valley, we will assume that the following evolutions will be recorded after the effective implementation of this measure aiming at recovering the O & M costs by multiplying the present prices by three:

- **No modifications of the agricultural areas**. Actually, because of the present land pressure and tenure in the Jordan Valley (cf. previous chapters), it is highly probable that even if some 'poor farmers' would stop their agricultural activities, it would not imply the abandonment of the concerned surfaces. Other farmers would actually rent or buy the plots to enlarge their own farms.

- **No savings in agricultural water use.** Neither the irrigated surfaces not the cropping pattern should be modified by an increase of public water prices

- **No modifications of the agricultural value produced.**

- **A new source of revenue for the government.** It is recognized that the actual price of agricultural water only reaches one third of the Operation and Maintenance Costs (O&M) of the supply system. The two other thirds are thus subsidized. In the perimeters now managed by the JVA (north and middle Ghors) an increase in the water prices to reach the level of the O&M costs recovery will bring additional revenue to the government of about JD 3,22 millions a year (US$ 4,542 millions a year)[267] which has be compared to the Jordanian water sector's global deficit.

Please Note we assume that there will be a unique public water fare in the entire Jordan Valley. That can be justified by the fact that we consider the entire Valley will be supply with blended water infive years from now

- The annual governmental subsidies to the water sector amount to about JD 64 millions a year (US$ 90 millions)[268] i.e 0,9% of the GDP. The accumulated deficit of the water sector should therefore reached US$ 1.156 millions in 2003[269] i.e. 12% of the GDP.

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[266] This annual surplus corresponds to 8% of the initial investments to be done in relation with this measure (shift to blended water in the north of the Valley and new facilities to be built in the northern Jordan Valley in order to increase the freshwater supply)

[267] This evaluation has been obtained by multiplying the average water costs ($/dunum) for each kind of crop by the irrigated surfaces planted with this kind of crop (according to the Department of Statistics). As there is still an 'on-demand' period for citrus and bananas plots, this total amount is underestimated. If we consider cereals are irrigated as vegetables this new amount reaches 4,892 Millions of Dollars. The total revenue from the water bills will thus reaches US$ 6,813 millions (US$ 7,738 millions if cereals are considered)

[268] Of which JD 15 millions are interest payments of external loans and JD 4 millions, indirect energy subsidies to farmers. This amount represented 29% of the governmental public deficit in 2002 and 85% in 2003 (*PEE, 2004* has actually estimated the public deficit -grants excluded- at 313 and 106,6 in 2002 and 2003)

An increase in public water prices to recover the O&M costs will thus allow decreasing by 5% the overall annual deficit of the Jordanian water sector.

This new source of revenue could be used by the JVA to implement some new irrigated schemes in the south of the valley along the 14,5 Km section of the King Abdallah Canal which is already equipped but not yet reclaimed. It is worth noticing, this extension of irrigated perimeters within the Jordan Valley would only be possible if the amount of water supplied to agriculture increases. An increase in the quantity of freshwater is not possible since it will go against the present water policies. However a supply with blended or treated waste water is seriously envisaged and will occur since it is planned that 240 Mcm/year of treated waste water will be used in Jordan in 2025. In conclusion by the year 2025, the entire Jordan Valley will be supplied by blended water. The possible impacts of such generalization of treated waste water use in agriculture (notably in the north of the Jordan Valley, now supplied with freshwater) will be studied in further details in a following section

VI.5 A SHIFT TO A HOMOGENIZED ALLOCATION OF WATER FOR ALL KIND OF CROPS

The present water supply in the Jordan Valley is based on water allocation rules which have been implemented following the recommendations of the first studies of large scale irrigation projects in Jordan during the 1950. These allocations lead to some disparities between the different crops planted since vegetables are supplied by 510 m^3/du/year, citrus with 840 m^3/du/year and bananas with 1320 m^3/du/year.

One of the possible evolutions in the Jordan Valley would be to homogenize the water supply to a common allocation for all the crops the farmers could use whenever they want all along the year[270]. We have seen above that the shift to treated waste water in the north of the valley would be probably accompanied by an increase of 33% of the total water supplied to the farmers. The 12.150 ha located in the north of the valley would thus be supplied with 100 Mcm. If the allocation is homogenized it means an allocation of 823 m^3/du/year. This homogenization would have several effects and notably would make easier the water supply management for the JVA[271] and would allow better fitting to the vegetables water requirements. In another hand, because the water requirements of bananas will not be met, this measure could allow decreasing the very-water-consuming surfaces planted with bananas. Concerning citrus few evolutions have to be expected but because of the interactions between the different evolutions to be recorded in the valley (decrease in water quality, increase of water prices…) it is possible than one share of the citrus plantation will disappear in the north of the valley.

Vegetables would be supplied by a new allocation amounting to 162% of the present allocation, while citrus would receive 98% of their present allocation and bananas only 62% of the present allocation. We assume that this measure will have the following consequences:

- Disappearance of any surfaces planted with bananas in the north of the valley and their replacement by vegetables (the shift to an homogenized amount of water will have a similar effect than the different free trade agreements which is expected to lead to the disappearance of half the surfaces planted with bananas in the north of the valley);
- Disappearance of the bananas surfaces planted in the south of the valley and irrigated thanks to Hisban and Kafrein dams and Wadi Shueib dam and replacement by date palm trees.

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[269] The *World Bank (1997)* has evaluated at US$ 476 millions the accumulated deficit of the Jordanian water sector in 1995 *(WB, Hashemite Kingdom of Jordan-Water Sector Review, 1997)*

[270] A fixed volume of water will be yearly allocated to farmers. These one would then use it how and whenever they want during the year according to their crop requirements (it is the principle of the *water-bank*, which will be allowed by the construction of the Wehdah Dam and a stronger control of the King Abdallah Canal.

[271] No control of cropping pattern would be actually needed since the water supply would not be dependant on the crops planted by the farmer.

- Decrease of the surfaces planted with Citrus fruits. We assume than one third of the citrus trees surfaces will be replaced by vegetables.
- An increase in the quantity of water used in irrigation in the northern and in the middle directorates. The northern directorate will be supplied by 85 Mcm/year of blended water instead of 65 Mcm/year of freshwater. The middle directorate will be supplied with 60 Mcm of blended water instead of 55 Mcm/year. The total amount of water used in irrigation in the northern and middle directorate will thus increase from 120 Mcm/year to 145 Mcm/year (i.e. an increase of 20%)[272].

It is worth noticing that the homogenization of water allocation in the valley would go in the same direction than the other measures we have considered in the valley: complete disappearance of bananas in the north of the valley, disappearance of bananas using 'public' fresh water from dams in the south of the valley as well as decrease of the surfaces planted with citrus trees and replacement of these surfaces by vegetables.

Development of irrigated areas and of JVA management enforcement in the south of the Jordan Valley

In the south of the Jordan Valley, we assume that there will be an enforcement of a public management through the JVA. The same rules of water allocation and water pricing which are now enforced in the middle and north directorates will be also implemented in the south of the valley. That will lead to the following evolutions:

- Fixed allocation of 823 m^3/du/year for all kind of crops[273]. It means for the present irrigated area a total amount of water supplied of about 50,9 Mcm/year i.e the same quantity than the one presently supplied by the public network.

- Payment of the water bills for the water supplied through the KAC (25 Mcm/year), from the Hisban Wadi (3,5 Mcm/year) , the Kafrein and the Wadi Shueib dams (respectively 7,8 and 14,6 Mcm/year) i.e. a total amount of 50,9 Mcm/year[274]. It will result in an added amount of US$ 2,6 millions for the Jordan Valley Authority[275] i.e. 2,8% of the overall annual deficit of the Jordanian Water sector. Increase in water prices in the entire Jordan Valley in order to reach the O&M recovery cost level will thus allow to decrease the annual overall deficit of the Jordanian Water sector of 7,8% (US$ 7,15 millions/year)

On another hand, it is planned that irrigated surfaces will increase in the south of the valley thanks to the rehabilitation of the last section of the King Abdallah Canal (known as the area of the 14,5-km-project which represents nearly 5100 hectares). This rehabilitation will be accompanied of:

- New investments[276]: Hisban Dam (US$ 4,23 millions); rehabilitation of the Hisban-Kafrein Area (US$ 7,05 millions) and of the 14,5-km-project perimeters (US$ 22,5 millions).

[272] In the same time, the total volume of freshwater used for irrigation purposes in the Jordan Valley will increase from 95 Mcm to 110 Mcm/year.

[273] This shift to a homogenized allocation of water will strengthen the evolution we are expecting from the different measures to be implemented in the Jordan Valley i.e. the decrease of the surfaces planted with bananas and their replacement with date palm trees. We can suppose that all the surfaces planted with bananas and irrigated thanks to Hisban wadi and Shueib and Kafrein dam will disappear (it means a total surface of 6 425 dunums on the 10 400 dunums planted with bananas in the south of the valley i.e. 62%). The other surfaces will remain since they are, in most of the cases, irrigated thanks to private wells and farmers will thus be able to conserve their present water allocation.

[274] The present amount of water supplied to the south of the Jordan Valley amounts to 70 Mcm/year (for a total irrigated surface of 6185 hectares on which about 20 Mcm/year are pumped from the Jordan Valley aquifer.

[275] Now, in the south of the valley 23,1 Mcm/year (on the 50 Millions supplied by the JVA) are effectively paid at an average cost of 0,02 $/m^3$ for a total amount of US$ 462000.

[276] Amount are from the JVA-Strategic Plan 2003-2008 (excepted for the 14,5-km-project area were we present our own rough evaluation)

- A new water supply of 42 Mcm/year (823 m^3/du/year) of blended water which will be charged at US$ 2,5 millions per year. It will be made possible thanks to the increase of waste water treatment plants both in the *Highlands* (and notably the increase of the capacity of As-Samra treatment plant) and in the Valley.

- We assumed that these perimeters will be cropped with vegetables (2/3 of the surface) and date palm trees (1/3 of the surface)

VI.6 Groundwater Control in the Jordan Valley Basin

Presently, 18 Mcm/year[277] are pumped in the Jordan Valley Basin for agricultural purposes, most of this amount thanks to private groundwater wells located in the south of the Valley. Conclusions of the lessons learnt at the farming system level (cf. appendix) show that the new Groundwater By-Law will only have slight impacts on effective groundwater exploitation in the banana farming systems in the south of the Jordan Valley. However, the interactions between the different measures which are expected to affect water management and agriculture in the Jordan Valley (and notably the enforcement of different free trade agreements), could lead to a low but effective decrease of the groundwater abstraction in the south of the Jordan valley.

We assume that 3975 dunums of bananas located in the south of the Jordan Valley are irrigated thanks to groundwater and are supplied with a total amount of 15,9 Mcm/year (allocation of 4000 m^3/dunum/year). To reach a sustainable level of water exploitation in the Jordan Valley Basin, it would imply than 3 quarters of the bananas surfaces (about 3000 dunums) would be replaced by date palm trees irrigated with 1000 m^3/dunum/year, the following consequences are thus expected:

- Increase of the Agricultural value from US$ 3,25 millions (bananas production without customs barriers) to US$ 6,75 millions (date protection) i.e. a gain of US$ 3,5 millions.

- A decrease of the groundwater abstraction by nearly 9 Mcm/year due to the decrease in the water allocation (from 4000 m^3/dunum/year for bananas to 1000 m^3/du/year for date palm trees) allowing to reach the sustainable rate of exploitation of the Jordan Valley aquifer (18Mcm/year)

VI.7 Evolution in Prospect in the Highlands

VI.7.1 A need for water quality conservation

Water quality conservation is of central importance in order to limit the always increasing water exploitation costs. A decrease of water quality in the aquifers located near the consumption centres (Yarmouk and Amman-Zarqa groundwater basins) will actually lead to do some necessary and costly investments to treat the water in order to continue using it for domestic purposes. Changes in water management and water use should thus be developed in order to limit this evolution. We have already presented (table 3), different water exploitation costs according to the different kind water supply existing (to be developed) in Jordan. It is thus possible to compare these costs and to know what would be the costs of a treatment of brackish groundwater.

ARD-USAID (2001) shows that, at the present over abstraction rate, the salinity in the Amman-Zarqa Basin is expected to gradually increase from current levels of 400-1000 ppm to a range of 1000-5000 ppm by the year 2020 due to a water table decline of 0,5 meter per year on average. *ARD-USAID (2001)* indicates that the average salinity of the Amman-Zarqa Basin will reach a range of 1500-2000 ppm.

[277] MWI-database figure, for the year 2003

First of all, following this increase of the water salinity, crops yield decreases should be register[278] and that will affect the total value of the agricultural production in the *Highlands*. In an average scenario, *Fitch (2001)* has evaluated at JD 23,5 millions (US$ 33,1 millions) the loss in agricultural value to be expected over the next twenty years from an increase of the water salinity.

Secondly and as we said it before, an increase in water salinity will not have impacts on the sole agricultural sector. Actually, water is pumped from the Amman-Zarqa and the Yarmouk Basins for industrial and domestic purposes[279] and any deterioration of the water quality will imply some extra investments to treat the water. Therefore the water exploitation costs will increase from the current price (average of 0,185 $\$/m^3$) to a higher amount evaluated at 0,565 $\$/m^3$ due to the needed investments to do to desalinate brackish groundwater (0, 380 $\$/m^3$).We assumed that the total volume of water abstracted for Municipal and Industrial purposes will remain constant at its level of 2001[280], costs will progressively increase with the successive implementation of the needed treatment plants and from 2015, the added cost of water treatment would reach US$ 36,48 millions per year (32,68 millions in the Amman-Zarqa Basin and 3,8 millions in the Yarmouk Basin)[281]. The total added costs linked to an extra treatment of the water is expected to reach US$ 259,2 millions over the next twenty years.

Finally, the decline of the water table level will also imply an increase in the pumping costs of water[282] while added costs of deepening or reconstructing wells will also be registered[283] as well as loss of wells within areas where over abstraction is maximum[284].

The table besides summarized the added costs to be expected if no measures are implemented in order to decrease the current over-abstraction and so to preserve the water quality of the aquifers of northern Jordan. These costs have been evaluated at a *present value* of US$ 381,5 millions over the next twenty years. To avoid, or at least soften, the expected water quality deterioration and the increasing costs which would be linked, some changes in water management in the *Highlands* are needed. We will present in the following chapters some of the measures we have identified and which seem to us to be heading in the direction of a more sustainable agricultural water management. Then we will compare the financial costs of these measures to the added costs to be done if no modifications in water management occur in Jordan during the next few years.

Table 48. Costs of a water quality decrease in the Highlands

Please Note: In red are indicated the present value of costs/investments to be paid over the next twenty years (using a discounting rate of 10%). Average on one year take into accounts this discounting rate.

[278] We present in appendixes the effect of a water salinity increase on the main crops planted in the *Highlands*

[279] According to the MWI database, 86 Mcm and 10 Mcm have been respectively pumped from the Amman-Zarqa and the Yarmouk basins in 2001

[280] The growing needs of the population will be met thanks to new water supply but not from an increase of groundwater abstraction what would be in contradiction to a more sustainable water management.

[281] Present value of investments to come

[282] *ARD-USAID, 2001* has evaluated at 0,0039 JD/m^3 (0,0055 $\$/m^3$) the increase of water pumping costs to be expected over the next 20 years in the Amman-Zarqa Basin

[283] *ARD-USAID, 2001* evaluated at 30 to 45% the number of wells which will have to be merely extended or rebuilt over the next twenty years (average cost of 26435 US$ -18750 JD-) while 5 to 10% of the wells located in the Amman-Zarqa Basin will need to be entirely rebuilt at an average cost of 86000 US$ -61000 JD.

[284] This 'loss' of agricultural wells will mainly occur in the Dulheil Area (one of the first areas where water has been pumped and exploited for multiple purposes). *ARD-USAID (2001)* has evaluated at 74 the total number of wells which will disappear during the next twenty years of exploitation.

Evolution recorded	Nature of the expected extra costs	Increase in agricultural pumping costs[285] -US$ Millions-	Increase in pumping costs (Municipal & Industrial)[286] -US$ Millions-	Rebuilding of wells Agricultural -US$ millions-	Rebuilding wells Municipal and Industrial	Loss in agricultural value -US$ millions-	Extra Water treatment for domestic and agricultural Uses -US$ millions-
'Physical' Water table decline	Amman-Zarqa Basin	0,416/year[287] i.e. 8,32 over the next 20 years	0,681/year i.e. 13,6 over the next 20 years	4,32[288] +2,8 = a total of 7,12 over the next 20 years	6,15 +4 = a total of 10,15 over the next 20 years	1,28/year[289] i.e. 25,6 over the next 20 years	∅
	Yarmouk Basin	0,237/year i.e. 4,75 over the next 20 years	0,079/year i.e. 1,58 over the next 20 years	0,71 +0,46 = a total of 1,17 over the next 20 years[290]	0,4 +0,2 = a total of 0,6 over the next 20 years	∅[291]	∅
'Increase of water salinity'	Amman-Zarqa Basin	∅	∅	∅	∅	1,655/year i.e. 33,1[292] over the next 20 years	11,61/year[293] i.e. 232,2 over the next 20 years
	Yarmouk Basin	∅	∅	∅	∅	0,81/year i.e. 16,28 over the next 20 years[294]	1,35/year[9] i.e. 27 over the next 20 years

[285] For information: pumping costs in the *Highlands* are included between 0,06 and 0,2 $/m^3$ (average of 0,185 $/m^3$

[286] We considered that the increase in water pumping costs ($/cubic meter) in domestic and industrial wells will be the same than in agricultural wells (0,0055 $/m^3$) over the next twenty years. All the wells will actually face the same dynamic of water table drop (even if this dynamic is variable in place and time all over the groundwater basin). Moreover, we considered that the annual added pumping cost is proportional to the annual volume of water pumped from the aquifer. In conclusion, thanks to the evaluation of the added pumping cost of agricultural water evaluated by *ARD-USAID (2001)* on the Amman-Zarqa Basin we thus have evaluated the added pumping costs of domestic & industrial water in the Amman-Zarqa Basin and the added pumping costs to be expected in all the wells of the Yarmouk Basin. It is worth noticing this way of calculation is a rough evaluation since the increase in pumping costs is directly linked to the water table dynamic (i.e. a drop) and thus to the over exploitation rate which is not the same in the two aquifers we have considered. We have considered

[287] It has to be related to an agricultural abstraction of 52,5 Mcm/year (figure of the MWI for the year 2001). The total cost is drawn from *ARD-USAID, 2001*

[288] There are 1088 wells in the Amman-Zarqa Basin (data from the MWI-GIS database) of which 668 are private agricultural wells (120 of these latters could be consider as shallow since they are located along the Zarqa River and other *Side Wadis*). Figure after ARD-USAID, 2001

[289] It is due to loss in operating agricultural wells. We assumed that there will not be any losses of Municipal and Industrial wells.

[290] For the Yarmouk Basin, we assumed that 20% of the wells will need to be partially deepened or rebuilt while 4% will need to be entirely reconstructed. For the calculation, we considered the costs presented by ARD-USAID on the Amman-Zarqa. There are 210 wells in the Yarmouk Basin (MWI-GIS database) of which 134 are agricultural wells

[291] We assumed that no loss of wells will be registered in the Yarmouk Basin

[292] Due to decrease in yields or disappearance of high value crops non tolerant to salts. Financial loss on 75.000 dunums i.e. an average loss of 22 $/du/year (average on the next 20 years)

[293] We consider that abstraction for Domestic and Industrial purposes from the Amman-Zarqa and the Yarmouk Basin remain constant at its level of 2001. Investment and treatment of groundwater is progressive: first treatments/investments are done in 2005 and all the projects are finalized in 2015. The rhythm of implementation is regular and linear (one tenth every year)

[294] We consider that ¾ of the irrigated surfaces will be affected by an increase in the water salinity leading, like in the Amman-Zarqa Basin, to an average financial loss of 22$/du/year (on the next 20 years)

VI.7.2 Digging up of irrigated olive trees

The table below evaluates the value produced by irrigated agriculture developed thanks to groundwater pumping[295] in the *Highlands*

	Irrigated Surfaces (dunum)[296]	Mean production value ($/du)	Total production value (Millions of $)
Vegetables	31 915	420	13,4
Stone fruits trees	34 265	1775	60,8
Olive trees	81 670	135	11,0
Total	147 850		**87,8**

Table 49. Total value produced by irrigated agriculture thanks to groundwater in the Highlands[297]

This table clearly illustrates that after 2015, the added cost of water treatment due to the water quality deterioration will represent nearly 40% of the present agricultural value produced in the *Highlands*[298].

The large surfaces of irrigated olive trees and the non profitability of these plots we have underlined before make us think that one of the most adapted mean to reduce the groundwater abstraction would be, in a first time, to limit the registered expansion of irrigated olive trees orchards[299] then to decrease the surface planted with olive trees.

Therefore, the total abandonment of the irrigated olive orchards in the *Highlands* could allow 'saving' 28,8 Mcm/year. 25,4 Mcm/year will be saved in the Amman-Zarqa Basin and the rate of over abstraction will be reduced by 29,6 %. The agricultural value lost will reach US$ 11 millions per year (i.e. 30% of the added costs to be expected if the water quality continues to decrease).

To save the same amount of water (28,8 Mcm/year), the complete disappearance of vegetables cropped in the Highlands will not be enough[300] while the disappearance of 82,6% of the fruit trees areas will be needed for a total economic value of US$ 50,2 millions per year (i.e. five times more than if olive trees orchards are abandoned).

In order to reach a better management of the groundwater resources and to conserve their quality, the suppression of the irrigated olive trees orchards seems to be one of the most adapted mean on an economical point of view since it allows minimizing the net financial loss due to a decrease in the agricultural production. Moreover, we have seen before that the irrigated olive plots were non profitable and essentially managed by owners having others activities (agricultural or non-agricultural) insuring their main revenue. Irrigated Olive plots are thus non central for the 'economic' livelihood of the 'farmers' in the *Highlands* of the *Lower Jordan River Basin in Jordan.* However these plots, like in all the Mediterranean countries, have an important cultural and social role, they constitute a true

[295] Evaluation of the volume produced and average farm gate prices have been used to present the evaluation of the value produced. For trees we have considered a production for mature orchards.

[296] Surfaces have been evaluated thanks to the GIS-landuse analysis and to the agricultural zoning previously presented in this report

[297] We have consider than olive trees are irrigated with 350 m^3/du/year; vegetables with 750 m^3/du/year and fruit trees with 1000 m^3/du/year

[298] A value which is expected to slightly decrease as describe in the precedent paragraph

[299] Until the end of the 1990s, the Jordanian government has highly facilitated the development of olive tree orchards through subsidies on olive trees. Actually, a one-year-tree only costs 1 JD when it was not simply granted to *farmers*. Subsidizing olive trees orchards could have important political implications since it can be seen, for the government, as a mean to insure the support of some influent social classes of the Jordanian society. Actually, some influent *farmers* who are more looking at the social recognition an agricultural activity can bring to them than at its economic profitability could actually been very interested/touched by the opportunities given by the government to develop an easy farming olive trees orchard (which match to their peculiar vision of agriculture) and would thus be obliged to the government for these opportunities. (cf. the *farmer's* characterization above)

[300] The complete disappearance of vegetables will allow saving 20,7 Mcm/year for a total value of US$ 13,4 millions

'social capital' and 'farmers' are attached to their orchard. On another hand, owners of such plots (large investor and/or ancient Bedouins settled) have often strong support in the parliament and it will be difficult to go against their interest (even if this one is not economic!).

The government should thus develop some measures aiming at decreasing the irrigated surfaces planted with olive trees. We can for example think to subsidies for digging up the orchards. These subsidies should not be too expensive since the income earned thanks to olive plots is very low (even null or negative since the orchards are often not mature) and the realized investment limited[301]. Governmental well's buy out could also possible but harder to implement since farmers often have other profitable plots planted with vegetables or stone fruits. These two possibilities will be studied in further details in a following chapter.

VI.7.3 Implementation of the groundwater By-Law No.85 of 2002

We have seen in the previous sections that the By-law will not imply any water savings in the fruit trees farms in the *Highlands*. The effective consumption of these farming systems could even increase since dynamics of agricultural development could be developed because of the peculiar relations existing between farmers, land and water in the area.

Therefore, the By-law will not imply any water savings in fruit trees farms in the *Highlands*. The effective consumption of these farming systems could even increase since dynamics of agricultural development could be developed because of the peculiar relations existing between farmers; land and water in the area.

However, some water savings seems to be possible in open field vegetables farms. The table besides presents the quantifications we have realized according to several scenarios. We focused on the farming systems developed thanks to groundwater and which will be affected by the implementation of the By-Law i.e. farms located within the *Eastern Desert and Transition Areas*. We have considered there were 24.750 of vegetables irrigated in open field in these two areas organized around 110 farms of 225 dunums in average. 2.200 dunums are located in the Yarmouk Basin and 22.550 in the Amman-Zarqa Basin. For the groundwater abstraction, official Figures presented for 2003 by the Ministry of Water and Irrigation have been used.

According to our analysis at the farming system level, we present in red the two most probable scenarios. We suppose that the By-Law will lead to a homogenization of the groundwater abstraction in vegetables farms to an amount of 200.000 m^3/year/farm. It means that farmers will pay the fees for the 50.000 first cubic meters above the limit (it corresponds to a bill of 250 JD -350$- per farm, i.e. 1,5$ per dunum).

According to the water allocation per unit of surface, it could allow 'saving' between 1,7 to 5,9 Mcm/year (90% of this amount in the Amman-Zarqa Basin which could lead to a decrease of 2 to 7 % of the actual water over abstraction within this basin) and between 0 and 7,5% of the surface cropped will disappear. (cf.table on the following page)

Governmental revenues obtained thanks to water bills (8700 to 38500 $/year) have strongly decreased because of the recent amendment. These revenues should be used to develop the means (material and human) in order to effectively and efficiently implement the By-law.

To conclude on this point, it is worth noticing very small water savings could be expected from the By-Law's implementation in the present conditions. An amplification of this measure would be needed if the aim pursued is a global decrease of the agricultural groundwater abstraction in order to protect the already decreasing water quality of the main aquifers of northern Jordan.

[301] A lot of farmers developed their orchard when the government supported the olive trees plantation by selling the trees at 1,4 $ (1 JD) per piece for a total amount of 85 $/dunum.

	Water Consumption	Amount of money perceived by the government ($/year)	decrease in the area cropped		Water savings			
			dunums	% of the actual surface cropped	Yarmouk Basin		Amman-Zarqa Basin	
					Mm^3/an	% of the actual water use	Mm^3/an	% of the actual water over abstraction
Scenario 1: Business as usual. Payment whatever are the water fees conservation of the surface cropped	Actual Consumption (960 m^3/du/year)	177100	0	0,0	0,0	0,0	0,0	0,0
	Average Consumption (750 m^3/du/year)	8662,5	0	0,0	0,5	1,4	5,4	7,1
	Net Water Requirements (615 m^3/du/year)	0	0	0,0	0,8	2,0	7,7	10,1
Scenario 2: Intermediate situation- Pumping until 200.000 m^3/farm	Actual Consumption (960 m^3/du/year)	38500	1833	7,4	0,2	0,4	1,5	2,0
	Average Consumption (750 m^3/du/year)	8662,5	0	0,0	0,5	1,4	5,4	7,1
	Net Water Requirements (615 m^3/du/year)	0	0	0,0	0,8	2,0	7,7	10,1
Scenario 3: Economic Weakness of the farmer Pumping of 150.000 m^3/farm. No water fees Payment	Actual Consumption (960 m^3/du/year)	0	7563	30,6	0,7	1,7	6,5	8,6
	Average Consumption (750 m^3/du/year)	0	2750	11,1	0,7	1,7	6,5	8,6
	Net Water Requirements (615 m^3/du/year)	0	0	0,0	0,8	2,0	7,7	10,1

Table 50. Global Impacts of the By-Law at the Groundwater Basin Level

NB: With a water consumption of 750 m^3/du/year, an average farm uses 161.250 m^3/year, while with a consumption of 615m^3/dunum/year, the total consumption only reaches 138.875 m^3/year

The net water requirements are drawn from *Fitch, 2001*

VI.7.4 Suppression of fruits and vegetables exports

In the present context of water scarcity, while it is needed to preserve the fruits and vegetables production oriented towards the local market, one of the evolutions which could be envisaged in the pursuit of a more sustainable water management is the suppression of any fruit and vegetable exportations coming from the *Highlands* and developed thanks to groundwater pumping.

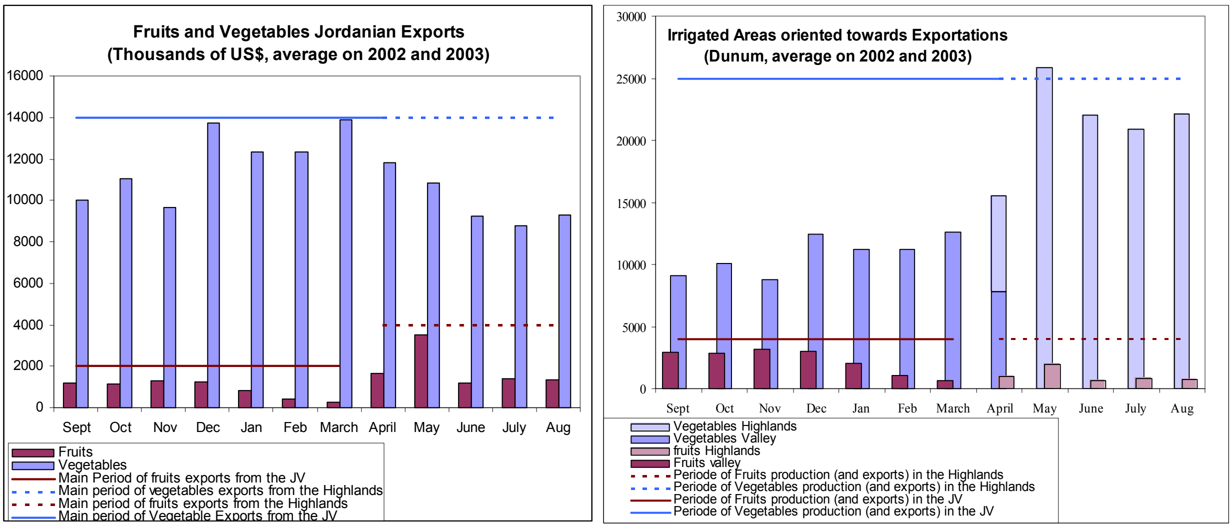

Figure 27. Period and Zoning of agricultural exports within Jordan (value and surface)

(Source: DoS database)[302]

The two charts besides illustrate the regions and the periods of fruits and vegetables exports in Jordan. In the *Highlands*, vegetables and fruits are exported from April to August, while from September to March; exports are originating from the Jordan Valley. We can observe on the chart located on the right panel than the vegetables production of the *Highlands* oriented towards foreign markets is developed on appreciatively 22.500 dunums i.e. 30% of the surfaces planted with vegetables in the *Highlands* (average surface between May and August) while the fruits production of the Highlands oriented towards export is developed on appreciatively 1000 dunums i.e. 1,5% of the entire fruit orchards areas of the *Highlands* (olives excluded)

By stopping any vegetables exports from the *Highlands,* the financial loss will reach appreciatively US$ 9,45 millions while the financial loss linked to the disappearance of fruits exports will reach US$ 1,77 millions. The total agricultural financial loss will thus reach US$ 11,2 millions i.e. 5% of the Agricultural Gross Domestic Product and it will allow to 'save' 15,625 Mcm/year.

Like it could be the case for the suppression of any surfaces of irrigated olive trees in the *Highlands*, a governmental well's buy out could be seen as one of the measures allowing to decrease and even to stop any exports of fruits and vegetables in the *Highlands.* The following chapter will study in further details what could be the cost of such measure.

VI.7.5 Buy Out of wells

This measure has been studied by ARD-USAID in 2001. We will present here their main results in terms of costs and of possible water savings. Actually "Aside from the strict enforcement of annual license abstraction limits [cf. the chapter on the By-Law No.85 of 2002] and levying water use

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302 Figures are from the DoS database as far as are concerned the export value. The corresponding surfaces have been evaluated by considering an average value of the production: (citrus: 410 $/dunum; vegetables in the valley: 1100 $/dunum, vegetables in the *Highlands*: 420 $/dunums; other fruits: 1775 $/dunum). Moreover, we assumed that fruits exports in the Jordan Valley are limited to citrus fruits while it is other fruits (peaches/nectarines) in the *Highlands.*

fees for any amounts exceeding these, another means of reducing water use in the Basin would be for the government to buy out well licenses. Sometimes this is referred to as "wells buy-out" or even "farm buy-out", but the license itself may be the important thing to buy because it is the license which gives the well owner the right to abstract water." *(Fitch, 2001)*.

Buying out the licenses can be seen as compensating the owners for their investment of their future income lost. Moreover, if paid over time, "the buy-out money could serve as a kind of pension to help the farmers retire, or to compensate them for the livelihood (income) which they forego when they give up the license" *(Fitch, 2001)*.

For the government, the aim is to purchase the greatest possible amount of water for the least possible expenditure. "On the other hand, it may be prudent to buy out farms in areas that are in danger of going dry, or where salinity problems are most severe. It may also be less expensive to buy wells in areas with saline water because the salinity is already affecting their incomes, and the valuation of their farms would thus be expected to be lower." (*Fitch, 2001*).

The table below summarizes the costs of wells' buy out per unit of surface if the government adopts an investment approach or an income approach.

Farm Value ($/dunum)[303]	Investment Approach[304]	Income Approach[305]	'10-years-income' Approach
Farms without orchards 100-300 dunums (seasonal crop)	705-1400	135 + 25%	1350
Farms with fruit trees orchards 100-300 dunums	1400-2800	1500 + 25%	15000
Farms with olive trees orchards[306] 100-300 dunums	980-1760	55 + 25%	550

Table 51. Costs of wells' buy out per unit of surface

We will assume that governmental well's buy out will take place in the *Lower Jordan River Basin in Jordan* in order to facilitate two of the evolutions which seem to us to be the most adapted in the present water scarce situation: disappearance of the irrigated olive tree orchard and suppression of the fruits and vegetables exports from the *Highlands.*

We will assume that the government will purchase the wells and the farms at a cost allowing the farmer to earn an amount equivalent to the one he would have perceived if he could have continue his agricultural activity during ten years. For olive trees and vegetables, this purchase will be progressive on ten years from 2005 to 2015 while, for the fruit trees, the purchase will be progressive on 5 years (2005 to 2010). In these conditions, the present value of the total cost of the wells' buy out measure will reach US$ 67,4 millions distributed as follow

- US$ 32,5 millions for the entire olive tree irrigated surfaces (81670 dunums) i.e. if we consider the volume of water 'saved' a cost of 1,13 $\$/m^3$.
- US$ 22 millions for the vegetables surfaces oriented towards the export market (22500 dunums) i.e. if we consider the volume of water 'saved' a cost of 1,3 $\$/m^3$.
- US$ 12,9 millions for the fruit surfaces oriented towards an export market (1000 dunums) i.e. if we consider the volume of water 'saved' a cost of 12,9 $\$/m^3$.

In a following chapter, we will compare this relative high cost (to which has to be added the costs linked to a decrease in the agricultural value produced in Jordan evaluated at US$ 152,72 millions over the next twenty years) to the costs which would be needed to preserve the water quality

303 If the water salinity reaches levels higher than 1500 ppm, *ARD-USAID (2001)* evaluates that the farm value decreases by 50% in comparison with the figures presented in the table valid for farms with water salinity lower than 1000 ppm.
304 After *Fitch (2001)*
305 To evaluate the farm value we used average Net revenue of the farmers to which we add a contingency of 25% to be sure that the price proposed to the farmer will be attractive for them.. For orchards, we used the expected net revenue when the trees are mature (even if most of the orchards are non yet mature)
306 Olive tree orchards or low quality fruit tree orchard

of the two main groundwater basins we consider here (Yarmouk Basin and Amman-Zarqa Basin) in order to continue to use these water resources for Municipal and Industrial uses.

VI.7.6 Use of treated waste water in the Highlands

Due to the wide-spread character of farms within the *Highlands,* the use of retreated waste water should remain relatively limited to areas located near the cities and near the treatment plants to be implemented in the *Highlands* or in areas where an important water table decline is registered since the cost of such supply. *ARD-USAID (2001),* for example, particularly mentioned the areas of Duleil and Hashemiya located near the large As-Samra treatment plant receiving fresh water from the Greater Municipality of Amman and which have been areas of historical development of irrigated agriculture thanks to groundwater.

The use of treated waste water in the *Highlands* should allow 'saving' some groundwater allowing a decrease of the groundwater abstraction in areas presently particularly depleted in which the groundwater quality is deteriorating (two phenomena with important economic impacts -cf. previously-).

- We assume that 5 Mcm/year of treated waste water will be used in the northern areas of the basin along *Side Wadis* or near the different treatment plants to be implemented.

- In the Amman-Zarqa Basin, treated waste water will be used to irrigated forages and trees, it is expected that 10 Mcm/year will be therefore used in irrigation while 5 extra Mcm/year could be also used for industrial purposes. It will allow decreasing the over abstraction of groundwater of about 7 Mcm/year if we assume that farmers will be supplied with 130% of their present water use.

- The costs of treated waste water supply to farmers in the Amman-Zarqa Basin will reaches 0,54 $\$/m^3$ to be compared to the water exploitation costs presently bear by the farmers and which reach an average of 0,185 $\$/m^3$. It represents an added cost of 0,355$\$/m^3$ [(307)] i.e. a total amount of US$ 3,55 millions per year. It is highly probable the farmers would not pay this amount which will thus have to be borne by the Ministry of Water and Irrigation and that will worsen its deficit.

VI.7.7 Irrigation Advisory Services (IAS) and On-Farm Management

According to *Hanson (2000),* Irrigation Advisory Services could result in water savings of about 15-20%. On the basis of the current groundwater abstraction in the two groundwater basins we have consider and of 15% IAS water savings, the potential reduction would reach 5,3 Mcm/year and 11,2 Mcm/year respectively in the Yarmouk and the Amman-Zarqa Basin (assuming nor wells Buy-Out neither no crop area reduction)[308].

If the other measures described above (wells buy out, digging up of irrigated olive trees, lifting of any exportation of vegetables and fruit trees from the *Highlands*) are effectively implemented, the water through IAS will remain limited to 4,15 and 3,1 Mcm/year in the Yarmouk and the Amman-Zarqa Basin[309] for a total cost of US$ 0,5 millions.

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[307] It is worth noticing this added cost is lower than the expected increase in water exploitation costs evaluated at 0,380 $\$/m^3$ (due to an increase in water pumping costs as well as in extra treatments of water linked to deterioration of the water quality -cf. above)

[308] These amounts decrease to 4,35 and 8,7 Mcm/year if we consider the official figures of groundwater abstraction for the year 2003 (i.e 29 and 58 Mcm/year respectively for the Yarmouk and the Amman-Zarqa Basin)

[309] The expected water savings of the other measures are actually expected to reach 7,75 and 53,6 Mcm/year respectively in the Yarmouk and the Amman-Zarqa Basin (according to our evaluation of the groundwater abstraction)

VI.8 SUMMARY: '*GAIN AND LOSSES*' *OF TWO SCENARIOS*[310]

VI.8.1 Two Scenarios

We will present here a rapid comparison of two scenarios. The first one can be qualified by the term ***'business as usual'***. In this scenario, except the water policies now under implementation or some large wide-scale measures not directly linked to the water sector no important changes concerning water management should be expected. The measures, policies or evolution which are common to the two scenarios we have considered are listed below:

- Process of freshwater mobilization (dams, desalinization plants) in the Jordan Valley and increase of the supply from the Valley to the urban centers (Amman-Zarqa);
- Increase of treated waste water use for agricultural purposes in the middle and the south of the Jordan Valley;
- Extension of irrigated areas in the south of the Jordan Valley;
- Enforcement of a JVA-management in the south of the Jordan Valley;
- Enforcement of different free trade agreements (GAFTA/WTO);
- Enforcement of the Groundwater By-Law No.85 of 2002;

Added to these first measures, the second scenario we can qualify of ***'virtuous evolution'*** is characterized by the implementation of several water and agriculture policies aiming at decreasing the agricultural freshwater use and aiming at reaching a more sustainable water exploitation notably as far as fresh groundwater resources located near the consumption centers are concerned. The following measures or policies have then been considered:

- Increase of public water prices in the entire Jordan Valley to reach the level of Operation and Maintenance Costs recovery;
- Shift to a homogenized and fixed water allocation for any kind of crops under the model of the water bank in the entire Jordan Valley;
- Shift from freshwater to treated waste water in the northern parts of the Jordan Valley;
- Use of treated waste water in the Highlands;
- Development of Irrigation Advisory Services (improvement of irrigation efficiency…) in the Highlands;
- Development of governmental well's Buy out;
- Reduction of Unaccounted for Water (this last measure is both oriented towards the agricultural and the Municipal and Industrial water uses);

VI.8.2 Expected impacts: costs and benefits analysis

The table X presented at the end of this chapter presents the main economic/financial and agricultural impacts of the implementation of the different measures we have presented previously (the implementation schedule of the measures is also presented). The main evolutions and conclusions are listed below:

(i) Scenario 'Virtuous evolution'

- In the Jordan Valley

  - **Progressive disappearance (2005-2010) of all the surfaces planted with bananas trees in the north of the valley** (3260 dunums) and replacement by vegetables. That is due both to

[310] Cf. appendixes to have a short presentation of the economic concept used in this chapter and notably the 'discounting technique' allowing evaluating the costs and benefits on a project on a period of time.

the enforcement of several free trade agreements and to the shift to a fixed allocation of 823m^3/dunum/year for all kinds of crops. It will lead to an increase of the agricultural value produced of about US$ 1,14 millions per year when the shift will be completed.

- **Progressive (2005-2010) and strong decrease of the surfaces planted with bananas in the south of the valley** (9400 dunums on the 10400 presently cropped) and their replacement by date palm trees (due to free trade agreements enforcement). It will lead to an increase of the agricultural value produced of about US$ 11 millions per year once the shift completed.

- Free trade agreements will lead to a decrease of the agricultural value produced in Jordan of about US$ 18,1 millions per year (loss in value of the bananas production).

- **Limited decrease of the surfaces planted with citrus trees in the northern parts of the valley** (24 400 dunums on the 73 100 dunums i.e. one third of the surfaces) and their replacement by vegetables (due to the shift to homogenized water allocation). It leads to an increase of the agricultural value produces of about US$ 18,5 millions per year.

- **Extension of the irrigated perimeters of about 51 000 dunums** (investment to be done between 2005 and 2010) in the south of the valley allowing an increase of the agricultural value produces of about US$ 62,8 millions per year one the entire irrigated scheme will be implemented.

- **Finally the agricultural value produced in the Jordan Valley is expected to increase of about US$ 73 millions per year once these changes completed (i.e. one third of the current Agricultural Gross Domestic Product)**

- **Development of several investments** (dams, desalinization and waste water treatment plants) for a total amount of **US$ 223 millions** (of which 150 millions are devoted to the As-Samra treatment plant modernization).

- These measures should allow:

  - **'Saving' 21,22 Mcm/year of freshwater** in the south of the Jordan Valley (Wadi Shueib; Hisban and Kafrein Dams) to be used for Municipal and Industrial uses within the Jordan valley or in Amman

  - **Restoring the Jordan Valley aquifer of 9 Mcm/year** of slightly brackish water and thus reaching the sustainable rate of exploitation of this aquifer

  - A new mobilization of **10 Mcm/year of desalinated water and 30 Mcm/year** of freshwater. These 40 Mcm/year are planned to be pumped from the Jordan Valley to the urban centers (Amman-Zarqa)

  - Finally it is **61,22 Mcm/year of extra freshwater which will be supplied to the consumption centres (mainly Amman-Zarqa)**. This process of water mobilization in the valley will allow a relative financial gain of US$ 19,2 millions per year once the measures implemented (i.e. 0,313 \$/m^3) if we compare this mobilization cost of water from the valley to the cost a water supply from DISI[311] will effectively reach.

- On another hand an extra water of 25 Mcm/year of water will be supply in the north of the Jordan Valley (15Mcm of freshwater and 10 Mcm of treated waste water) while the south of the Jordan Valley will also be supplied by an extra volume of 40 to 45 Mcm/year of blended

[311] Water mobilization costs from DISI : 0,801 \$/m^3

water (mainly coming from the King Talal Reservoir after the increase of the As-Samra treatment plant's capacity) for an added costs of US$ 4,05 millions[312].

- To conclude on the Jordan Valley, the implementation of all the measures we have considered within the ***virtuous evolution*** will lead to a financial gain (in present value) of US$ 487 millions over the next 20 years. That is mainly due to an increase in the value of the agricultural production which is expected to be registered as a consequence of the water and agriculture measures/policies presented above.

- In the Highlands

We have considered that the aim of the measures to be implemented in the *Highlands* is to limit and decrease the current groundwater abstraction in order to preserve the currently threaten quality of the water which is now used for Municipal and Industrial purposes.

Therefore, the measures we have presented aim at decreasing the agricultural groundwater abstraction while we assume that the municipal and industrial groundwater abstraction from the aquifers of northern Jordan will remain constant. It means that we will not assist to any kind of water reallocation from agricultural groundwater to domestic and industrial groundwater. Volumes saved will just recharge the aquifers in order to come up to the sustainable rate of exploitation of the groundwater basins and the growing needs of the population will be met thanks to the development of others measures (increase of water supply: Wehdah Dam, exploitation of the DISI aquifer; water demand management, reduction of unaccounted for water…).The main financial effects of the measures we have consider in our virtuous evolution are listed below.

- Evolutions linked to governmental well's buy out:

    - **Progressive disappearance (2005-2015) of any surfaces planted with olive trees** irrigated thanks to groundwater i.e. about 82 200 dunums located in the *Eastern Desert and the Transition Areas*.

    - **Progressive disappearance (2005-2015) of any production developed thanks to groundwater abstraction and oriented towards export market** (22 500 dunums of vegetables and 1000 dunums of fruit trees)

    - **A progressive loss (2005-2015) in terms of agricultural value** to reach US$ 22,2 millions per year (9,8% of the Agricultural gross domestic product) once the process of well's buy out would have been totally completed (shared as follow: US$ 11 millions for olive trees; US$ 1,8 millions for fruits and US$ 9,45 millions for vegetables)

    - **A total decrease of about 105 700 dunums** within the *Highlands* by the year 2015 (90 600 and 15 100 in the Amman-Zarqa and the Yarmouk Basins).

    - **A total cost for the government of about US$ 67,4 millions** corresponding to well's purchase.

- **Development of several measures (2005-2010) allowing a groundwater abstraction control** (irrigation advisory services, taxation of water for volumes pumped over a given limit) allowing some water savings (about 5,4 Mcm/year in the Amman-Zarqa Basin and 3,1 in the Yarmouk basin

- **Shift to treated waste water** allowing to decrease the agricultural groundwater abstraction of about 7 Mcm/year in the Amman-Zarqa Basin.

[312] By considering a water costs corresponding to the O&M costs recovery level.

- In relation to the different water savings, some financial saving concerning water exploitation costs (and mainly energetic costs) are expected to reach a total amount of US$ 8,7 millions (i.e. 0,135 $\$/m^3$) when all the measures will be implemented.

- Conclusions as far as water savings are concerned are summarized in the table below

[313]		Current Total Abstraction (Mcm/year)	Agricultural Abstraction (Mcm/year)	Safe Yield (Mcm/year)	To be saved in Amman-Zarqa Basin (Mcm/year)	To be saved in Yarmouk Basin (Mcm/year)
Amman-Zarqa Basin		155,6 (139,1)	74,5 (58)	67,5		
Yarmouk Basin		44,2 (37,6)	35,3 (28,7)	37,5		
Expected water savings (Mcm/year)					49	10,9
Buy Out of wells	Olive trees				25,4	3,4
	Exported Fruits and vegetables				11,2[314]	4,375
IAS and Groundwater By-Law					5,4	3,1
Shift to treated waste water					7	∅
Expected savings (% of present agricultural groundwater abstraction)					66 (84)	31 (38)
Expected exploitation rate (Mcm/year)					106,6 (90,1)	33,3 (26,7)
Expected exploitation rate (% of annual recharge)					158 (133)	89 (71)

*Table 52. Water 'savings' to be expected in the scenario **'virtuous evolution'***

If all the measures we have described are effectively implemented, we expect that the agricultural groundwater abstraction could decrease of about **49 and 10,9 Mcm/year** respectively in the Amman-Zarqa and the Yarmouk Basin. This will allow decreasing the current rate of abstraction from 230 to 158% of the annual recharge in the Amman-Zarqa Basin and from 118 to 89% of the annual recharge in the Yarmouk Basin[315].

- To conclude on the Highlands, the implementation of all the measures we have considered within the ***virtuous evolution*** will lead to a **financial loss** (in present value) of US$ 211 millions over the next 20 years. That is mainly due to well's buy out costs both in terms of financial investment for the government and in terms of loss of agricultural value.

(ii) Scenario 'Business as Usual'

- Jordan Valley

We have considered that, in the Jordan Valley, most of the evolutions we have described above for the ***'virtuous evolution'*** will also be registered in case of a ***'business as usual'*** management. Sole three measures will not be implemented: an increase in public water prices, a shift to homogenized water allocation for any kind of crops and the shift to treated waste water in the north of the valley. In conclusion:

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[313] In brackets we indicate the MWI-official figures of abstraction for the year 2003. All the calculation have been done according to our evaluation of agricultural groundwater abstraction

[314] 72% of the total surfaces we consider

[315] If we consider MWI-official figures for the year 2003 ; the over abstraction rate will decrease from 206 to 133% and from 100% to 89% of the annual recharge respectively in the Amman-Zarqa and in the Yarmouk Basin

- **The overall deficit of the Ministry of Water and irrigation will remain unchanged** since the amount linked to water bills will not increase of the US$ 7,15 millions a year which are expected from an increase in public water prices.

- **Bananas surfaces in the north of the valley will only decrease by one half** (1630 dunums) while **citrus trees surfaces will remain unchanged** (relative loss of US$ 18,5 millions if we compared to the ***virtuous evolution***)

- Water mobilization costs will be lower of about US$ 8,4 millions/year since there will not be added treatment of water or loss in agricultural value due to a shift to treated waste water in the north of the Jordan Valley

- In the Highlands

In the Highlands, we have considered that in the ***business as usual*** management only one of the measures presented above will be effectively implemented i.e. the groundwater abstraction control through the New Groundwater By-Law No.85 of 2002.

The other measures will not be developed while it is expected that Jordan will have to face:

- A deterioration of the groundwater quality which will imply added costs of water treatment in order to continue using these water resources for domestic and industrial purposes;

- An increase of the water exploitation costs (mainly energetic costs) due to the water table drop;

- A decrease of the agricultural value produced in Jordan due to the loss of agricultural wells;

- Finally the ***business as usual*** management will costs about US$ 381,5 millions over the next twenty years (at present value)

(iii)Balance sheet: Costs and benefits of the two scenarios

- Jordan Valley

In the Jordan Valley, and over the next twenty years, the ***virtuous evolution*** leads to a relative financial gain of about US$ 183 millions over the next twenty years (present value) in comparison with a ***business as usual*** management. That is mainly due to the increase of the agricultural value produced which is expected to be one of the impacts of a shift to homogenized water allocation in the entire valley.

- Highlands

In the *Highlands*, and over the next twenty years, the ***virtuous evolution*** leads to a relative financial gain of about US$ 155 millions over the next twenty years (present value) in comparison with a ***business as usual*** management. That is due to the fact that the measures (even if they are expensive) allow avoiding any extra treatment of water which are considered to be needed in case of a ***business as usual*** management.

- Conclusion

Finally, the ***virtuous evolution***, as we defined it leads to a relative financial gain of about US$ 338,5 millions over the next twenty years (present value) in comparison with a ***business as usual*** management.

Added to that, on a general point of view, it is worth noticing the different changes in water and agriculture management we have considered and which are supposed to be implemented in the case of our ***virtuous evolution*** will not lead to a global reorientation of the agricultural sector in Jordan. While some exportations from the *Highlands* will disappear, in the same time, the already existing dynamics will be strengthen: the intensification of the farming systems both in the Jordan Valley (greenhouses) and in the *Highlands* (stone fruit trees) should become more pronounced, a shift to less water-consuming trees allowing a high profit (palm trees) could occur in the valley and the extensive systems will become less and less profitable until they disappear (citrus and olive trees). The most productive farming systems will not be threatened by the modifications to come and Jordan would remain self sufficient as far as fruits and vegetables are considered.

The evolutions we have presented in the case of our ***virtuous scenario*** would only appear if the measures we described are enforced and accentuated. However the implementation of the measures already raises and will continue to raise a lot of social problems. The government will notably have to face a strong social opposition both from poor farmers who will see their activity becoming non-profitable because of the evolutions to be registered and from large absentee landowners who will see their former rights and privileges gradually disappear.

VII. CONCLUSION

Until now and above all during the last fifty years, because of the explosion of the demographic growth and of its global economic development, the *Lower Jordan River Basin in Jordan* has known a rapid and global process of mobilization and control of its rare water resources thanks to the implementation of diverse technical solutions: channels, dams, pumps, pressurized pipes and irrigation networks, wells, long-distance transfers, desalinization… Some perspectives of development still remain to avoid an increasing over exploitation of the already existing resources and to meet the growing demand of potable water mainly in the urban centre. However this increasing mobilization always requires investments as well as operation and maintenance costs higher and higher. The huge project of water transfer from the Dead Sea to the Red Sea known as the Red-Dead project is the example itself of this *headlong rush*. It should allow, in the medium term, to increase by half the available Jordanian water resources with good quality freshwater to be used for domestic purposes but the exploitation costs will also be twice higher than the actual costs because of the huge facilities to build (long distance transfer, turbine to produce electricity, desalinization, elevation of the water on 1.200 meters to Amman…). Because of the political regional situation, and as it has always been the case, the investment should be facilitated by the international aid. However, the operation and maintenance costs of these facilities should be borne by the entire Jordanian society and not only by the government already strongly subsidizing the sector.

The actual water situation gives cause for concern. Within the *Lower Jordan River Basin,* the surface waters are actually almost all controlled and used while the renewable groundwater are overexploited at 180% of their sustainable rate, registering important decline in their quality. In this context the market oriented irrigated agriculture developed from the 1960s, aiming at an economic profitability more than at feeding the population and consuming 70 % of the national water resources, raises some questions. Actually, since 1995 and the official recognition of the Jordanian *'Water Crisis',* the priority is to meet the domestic and industrial needs, the water-consuming agricultural sector thus compete with the other water users. This competition is both immediate -the water consumed by the agriculture is not used in other sectors- and postponed. The huge agricultural pumping of potable water from the deep aquifers causes a degradation of the water quality on the short term (direct pollution due to infiltration of pesticides and fertilizers) and on the long term (water salinization due to a decline in the water table) and jeopardizes their future uses at low costs for domestic purposes.

During the last fifty years, the Jordanian irrigated agriculture has been strongly developed in line with the more global economic development registered by the country during the same period. In a favourable economic context, agriculture was actually considered as -and effectively was- one of the means which could lead a young country to the modernity. By its importance within Jordan, the *Lower Jordan River Basin in Jordan* supplying 80% of the Jordanian water resources; gathering 83% of the population, 80% of the irrigated agriculture and having the most important potential of development played a central role in this national process. But today this general tendency has been reversed and some changes in water management driven by the water scarce context aim at reducing the agricultural freshwater use and thus the importance of the irrigated agriculture. We particularly have studied two water-measures (and their impacts on agriculture) to be implemented within the following year: a shift from freshwater to treated waste water in the north of the Jordan valley in order to supply the irrigated perimeters of this area and an increase in the effective water prices both public and private. An additional study of the impact of the agricultural market liberalization has also been developed.

In order to identify the possible evolutions of the irrigated agriculture in the *Lower Jordan River Basin*, we have chosen to apprehend the agricultural dynamic at the farming system scale. This approach allows us identifying two waves of agricultural development, based on different processes, and which explain the actual dichotomy we now observe within the *Basin.* In the 1960s and the 1970s, huge investments and projects of development have been developed by the government in the Jordan Valley what lead to the construction of a very intensive agricultural zone based on a fruits and vegetables production in winter irrigated thanks to a public supply network using the freshwater of the Yarmouk. During the 1980s and the 1990s, while some ancient Bedouins already settled began to develop an agricultural activity based on vegetables production in what we call the *Highlands*, private initiatives have been multiplied mostly by some Jordanian-Palestinian entrepreneurs who have realized huge private investments to develop a very profitable fruit trees activity which will been generalized afterwards. These huge investments have been made possible thanks to the evolution of the techniques and notably thanks to the apparition of the digging deep well's techniques which have constitute a true revolution. Associated to drip irrigation, the deep wells have actually allowed an unlimited access to and an efficient use of the good-quality-groundwater resources precisely raising some problems in the actual situation.

We conclude that a large diversity of farming systems could be described both in the Jordan Valley and in the *Highlands* according to six main agricultural areas we have identified and described: the Jordan Valley (which can be divided in three sub-areas from the north to the south), the Eastern Desert, the Uplands (with the Side Wadis and the Zarqa River), the Upper Yarmouk, the Suburban and the Transition Areas. The production systems are thus very diverse and it is possible to find different ways of cropping vegetables either in open field or under greenhouses as well as fruit trees in each of these zones. Farmer's incomes are thus also very variable essentially according to the level of investments and to the involvement of the 'farmer' in the farm. Despite this diversity of production systems, farmers can be classified in four main groups. We have thus identified large extensive land investors (or absentee owners), large intensive entrepreneurs farmers, familial farmers and very extensive poor farmers. Four classes, present in each of the area considered and which will be differently affected by the changes in water management.

Far from advocate a total cessation of any agricultural activity within the *Basin,* which, in addition, will not be the miracle cure to the water management problems in Jordan, and based on this farming systems knowledge we try to understand what could be the impacts of the water measures we have considered. This assessment put in prominent places diverse dynamics both now running and to happen in the near future. Despite some marketing conditions more difficult that in the past because of an increase in the regional production, the high-value fruits and vegetables production Jordan has developed both for the local consumption and for the exportation should remains unchanged (or very slightly) since it is the fact of the most intensive farming systems, developed by large entrepreneurs farmers, for whom the high profitability will not be affected by the changes in water management which even could accentuate the dynamics of intensification now running (development of the greenhouses and fruit trees orchards…). On another hand, the poor farmers developing extensive and low productive farming systems (mixed farms in the north and the south of the Jordan Valley, small vegetables farms in the middle-south of the valley) would be strongly affected by the measures and could disappear. That could lead to important social tensions and the government will have to develop some attendant measures notably in terms of agricultural supervision and advising in order to soften the impacts of the measures already -or to be- implemented. Familial farms will be differently affected by the measures (higher negative impacts are expected in the Highlands than in the Jordan Valley because farms are more extensive) but they could adapt their systems with a little governmental support in order to soften the economic impact the water policies will have on their revenue. The case of the absentee land investors is a little more complicated and reveals some aspects of the functioning of the Jordanian society.

History of the measures we have considered actually show us that there are a lot of socio-political obstacles to overcome to effectively implement them. Some farmers and mainly large absentee investor belonging to the high society or members of large influent Bedouins tribes having a strong support in the parliament actually prevent the implementation of the measures which could affect the rights (and notably the water rights) they have obtained in the past or at least 'dictate' the conditions of the mesures' implementation in order to soften the effective impact they could have on their farming systems. Within this framework it is worth noticing that what we consider as the two main aberrations of the agricultural situation in Jordan should remain unchanged if the water measures are implemented in their actual way. Very profitable and water consuming intensive bananas farms in the south of the Jordan Valley and non-profitable (but relatively low water-consuming) extensive irrigated olive trees plots in desert areas in the *Highlands* are actually developed by these 'influent farmers' and will not be affected by the increase in water prices to come (either by the public prices increase or by the implementation of the By law) while they are now jeopardizing the water resources of Jordan.

To conclude we can say that the measures now taken by the government will not imply big changes in the agricultural landscape of the Jordanian agriculture but could strengthen some of the dynamics already running mainly consisting in an intensification of the Jordanian agricultural landscape. Moreover, in order to effectively decrease the agricultural use of water, a strengthening of the measures will be needed and that will necessitate a strong governmental willingness and action in order to make the privileges of influent social groups disappear to the advantage of the entire society. The needed decisions to reach a more adapted water management to this water-scarce context could only be taken if we assist to the development of a general awareness of the water problem in Jordan in all its components and notably of these internal social blockings.

Aggregating the data we obtained at the farming system level, and considering the few water measures we have studied, our work put in a prominent place some conclusions at the River Basin scale. The enforcement of a public management of the water supply network in the south of the valley, the extension of irrigated perimeters still in the south of the valley and an increase in public water prices would only have beneficial consequences for the government since it would allow softening the present huge deficit of the highly subsidized Jordanian water sector. The replacement of freshwater by treated waste water in the north of the Jordan Valley seems to be a good eventuality since it will only cause slight decrease of the agricultural production and relatively easily bearable by the farmers while it could allow supplying Amman with low costs freshwater, the government realizing therefore important savings in term of water exploitation costs.

Bananas farms in the south of the valley will be affected neither by the increase of public water price nor by the implementation of the By-Law aiming at controlling the agricultural water abstraction. However, this crop is today highly protected and prices are thus artificially maintained at a high level. The lifting of these protections which could result from the market liberalization will lead to decrease the actual high profitability of the farms and some evolutions could then be possible. The replacement of bananas trees by date palm trees seems to be an interesting eventuality since it could both allow a high income for the farmers while water savings would also be realized.

Groundwater control in the *Highlands* (through the By-Law No.85 of 2002) would not have important impacts in terms of water savings. An effective decrease of agricultural groundwater abstraction would only be possible if the government develop some measures aiming at decreasing the irrigated surfaces in the *Highlands* and governmental well's buy out seems to be one of the most adapted solutions. Moreover, reducing the surfaces planted with irrigated olive trees as well as with fruits and vegetables oriented towards export should constitute a priority in order to decrease the present over abstraction already leading to groundwater quality deterioration and thus jeopardizing the future domestic use of these low costs water resources

Our impact assessment and our costs and benefits analysis underlined the fact that the implementation of different measures coming under a global willingness of *water resources sustainable management*, even if they are expensive, constitutes a virtuous evolution economically beneficially for the Jordanian society (and socially justified) since it allows preserving the water quality of aquifers located in northern Jordan and thus avoiding costly extra treatments of water to meet the increasing needs of a growing population.

Finally this report highlights two important gaps in the current assessment of the water and agricultural sector in Jordan. Since ten years, the agricultural groundwater abstraction is declining in most of the groundwater basins within the *Lower Jordan River Basin*. Despite several hypotheses to explain this observation, no real work has been done on the subject while it could allow a better knowledge of the processes now running and to happen in the future and thus to identify the most adapted measure to implement in order to reach a more sustainable water management. The other gap concerns the effective irrigated agricultural surfaces within the Basin. Despite the central character of this information, there is no 100% accurate data since several and different evaluations are available especially for the *Highlands. It is recommended* that special studies being lead on this point. That could therefore allow identifying with accuracy the most probable scenarios for the future of the irrigated agriculture in Jordan while in the same time it will lead to a better assessment of the effective agricultural water use.

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APPENDIXES