Reclamation's history of the Jordan River Basin in Jordan, a focus on agriculture: past trends, actual farming systems and future prospective.

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THE PECULIAR CASE
OF
THE OLIVE TREES
ORCHARDS[1]

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[1] For data concerning the 1994-1999 period, all the table are drawn from the "Annual report of Agricultural Statistics Department, 1999" and from the "Agricultural Data from 1994 to 1999", report, Hashemite Kingdom of Jordan, Ministry of Agriculture, Department of Development and planning. For data concerning the 1990-1994 and 1999-2002 period, all the tables and graphics comes from The International olive Oil Council.

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1. INTRODUCTION

In the directorate of Mafraq, irrigated olive trees are the most important crop in surface: such orchards represent 39% of the irrigated surface in the directorate. Due to the weak Profit, irrigated olive trees bring out and due to the existence of large area of rain fed olive trees in the Highlands (region of Ajloun/Jerash) more information have to be given to discuss about the validity and the future of such crop which is, now, poorly (even no) profitable and which, because of the large area concerned, use a big quantity of water.

We will first describe the olive sector in Jordan and then we will economically describe the different way of cropping olive trees. This economic study will be based on a comparison between rain fed olive trees and irrigated olive trees.

2. The olive sector in Jordan

Current situation

Data on Surface and production

First of all, we can say that a big increase in olive trees surface was observed during the early 90's following a government policy which has facilated the implantation of new orchards through low price of the trees. For example a 1-year-plant costs 1 JD (1,4 $) and moreover, some farmers said us that the government gave plants from its nursery in 1997 and 1998. This can explain the development of such crop which is considered like an "easy farming" which doesn't need an important care. Moreover, olive trees are really important in the culture of the Jordanians who like this tree and its production.
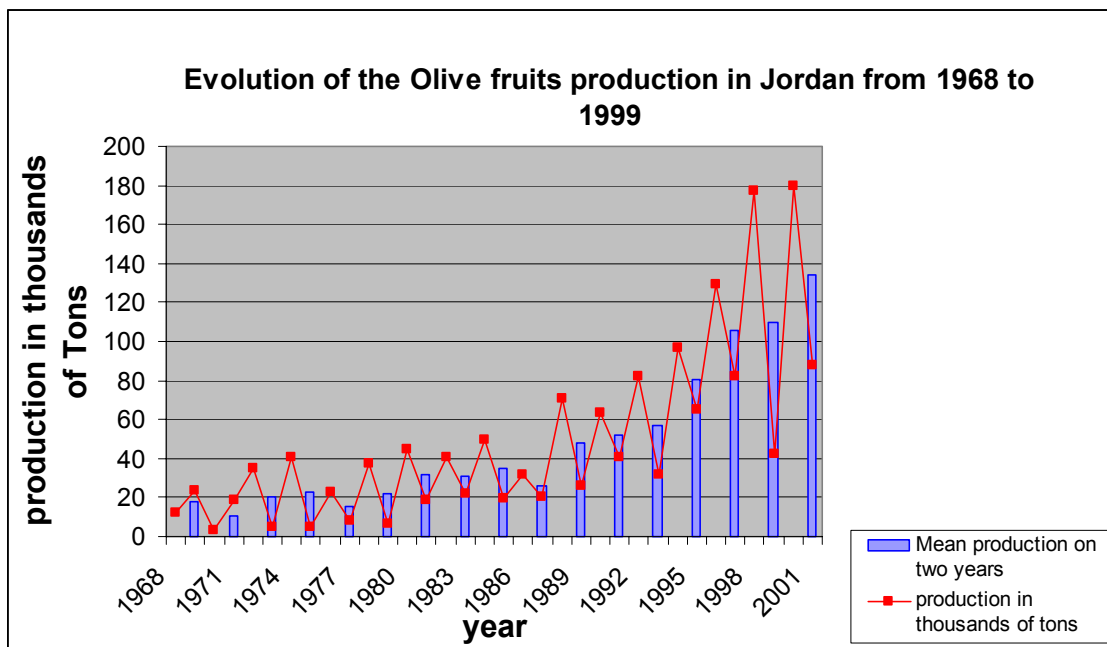

Figure 1: Evolution of Olive production in Jordan.
Source: Venot, 2003[2]

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[2] According to figures of the Ministry of agriculture, the ministry of Statistics and the international olive oil council

This chart permits us to visualize an increase in olive fruit production inside Jordan since the end of the sixties. We can see the alternation between good year and bad year of production which has ups and down. If we take into account a mean production on two years (one good and one bad year) this one increase from 18 150 tons in 1968/1969 to 133 800 tons in 2000/2001.

year	surface (dunums*1000)		surface totale	production totale (T*1000)
	oliviers irrigués	oliviers non irrigués		
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

Table 1: Evolution in olive trees surface and olive production in Jordan.

If we focus ourselves on the last decade, we can see how the surface cropped with olives trees increased. In that way and between 1994 and 1999[3] the irrigated surface has more than doubled from 99 600 dunums to 200 600 dunums. Regarding the rain fed surface, this one increase of 25% from 482 900 dunums to 635 900 dunums. Even if the share of irrigated olive trees has increased in the last few years, most of olives trees planted in Jordan are rain fed: 83 % in 1994 and 76% in 1999.

If we consider the surface of olive trees cropped in the basin we have such repartition:

Surface in dunum	Trees in Production	
	irrigated	non irrigated
Ajloun	5081	49967
Jerash	11753	62561
Amman	60131	49080
Madaba	1135	17965
Zarka	56251	39020
Irbid	4270	206550
Mafraq	22830	27525
Al Baaqa	5000	147400
Jordan valley	4148	0
Total basin	170 599	600 068

Table 2: Repartition of olive trees on the Jordanian Bank of the Jordan River basin

We can see that, in the basin, the total surface of olive trees is around 770 000 dunums (it represents 92% of all the olive trees cropped in Jordan) and that irrigated olive trees represent 22 % of the total surface. Irrigated olive trees are essentially cropped in the directorate of Amman, Zarqa and Mafraq (Amman Zarqa Basin) in which they respectively represent 55, 59 and 45 % of the total surface cropped with olive trees.

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[3] In 2000 and 2001 we don't have any evaluation of total surface cropped with olive trees. But we know that the surface of rain fed olive trees stayed constant since 1999.

Lastly, concerning an average yield of olive trees in Jordan we find 160 Kg/du[4].

Data on Olive consumption and trade

We will first considered total production and consumption of olive fruits before any transformation into olive oil.
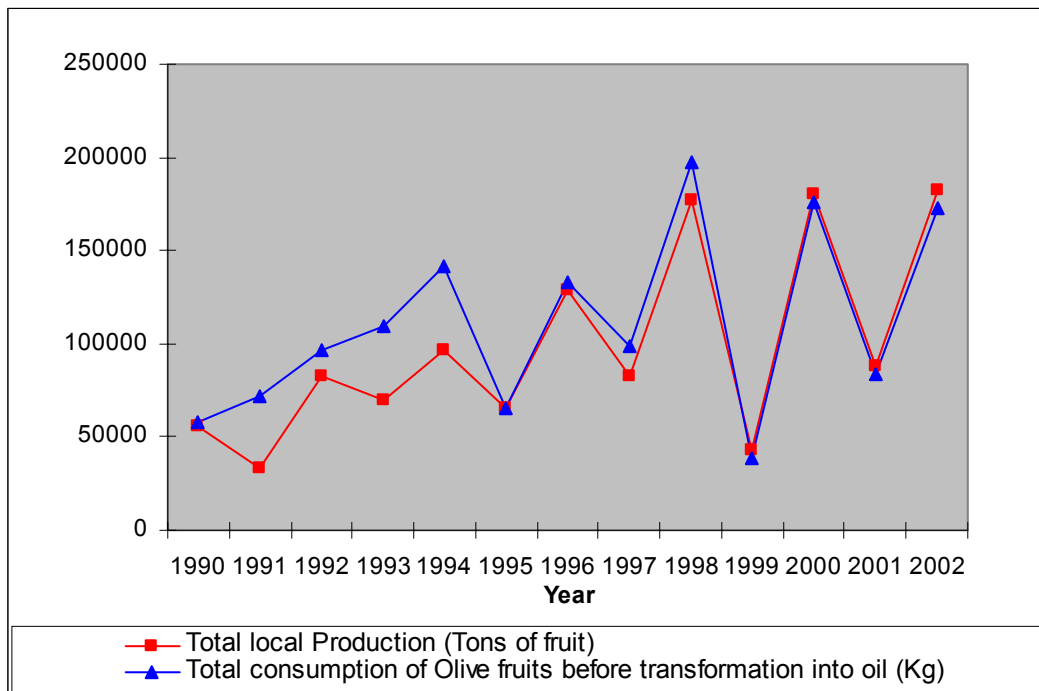
Figure 2: Jordanian production and consumption of Olive fruits.

In this chart we can see that consumption in Jordan seems to follow the production of olives. From 1990 to 1994, Jordan shows a deficit in olive fruit production ,important importations has been recorded but since this date, importations seem to be really limited and what is surprising is the fact that importations are higher when the local production is high than when it is low. Jordan seems to be able to absorb a high production of olive and to content itself with a low production without importing any foreign products. This is due to the fact that olive trees market is a "self sufficient" market in Jordan. Farmers firstly plant olive trees for their own use and after the demand and supply market is adapted to the production: the olive market is mostly a traditional one.

To be more rigorous and more precise, two different products have to be considered: the olives fruits (processed) and the olive oil. In average, we found that 85% of the olives produce in Jordan are transformed into oil (during the period 1994-1999[5]). We will analyse the market of the two products in Jordan.

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[4] This figure is simply obtained by dividing the total production by the surface cropped.
[5] We will assume that this proportion has been the same in 2000 and 2001.
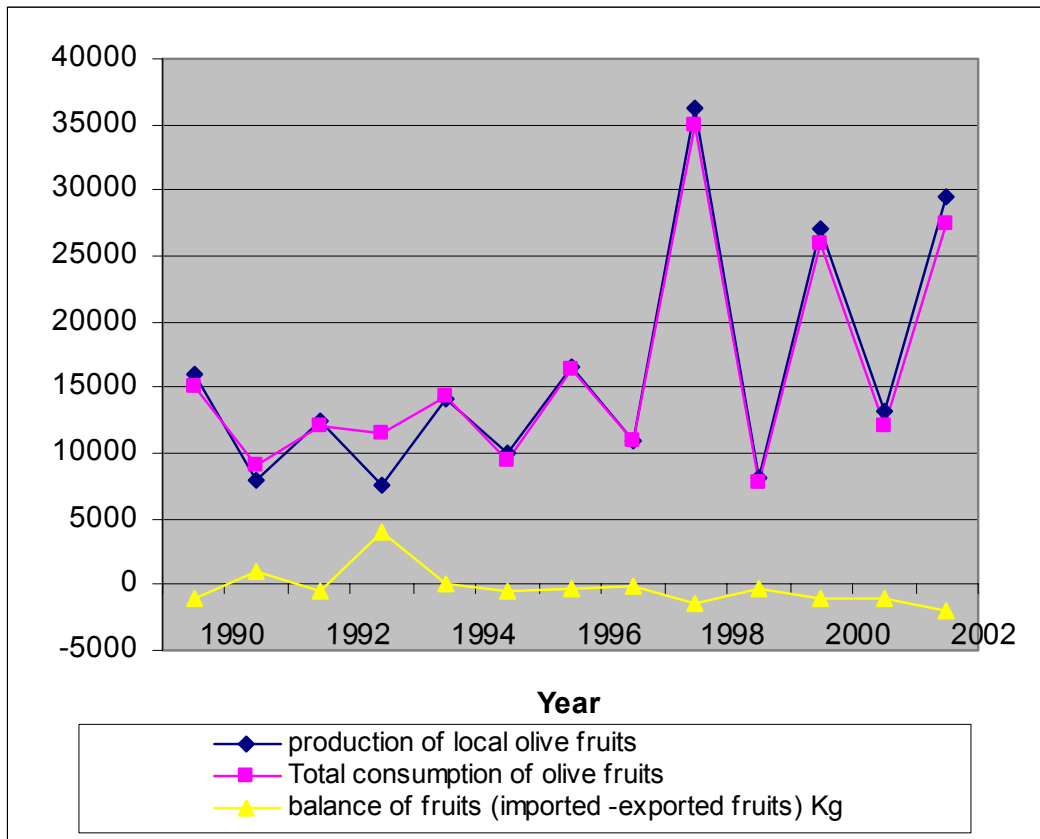
Figure 3: Local production and consumption (in tons) of olive fruits which don't go to be transformed into oil.

As it was shown in the previous chart, the olive fruit market in Jordan seems to be simple: Since 1994 the balance is nil, and the exportation are counterbalanced by the importation and the consumption follow the local production. Moreover the amount of the production concerned is very low (See appendix IV, Vol. V).
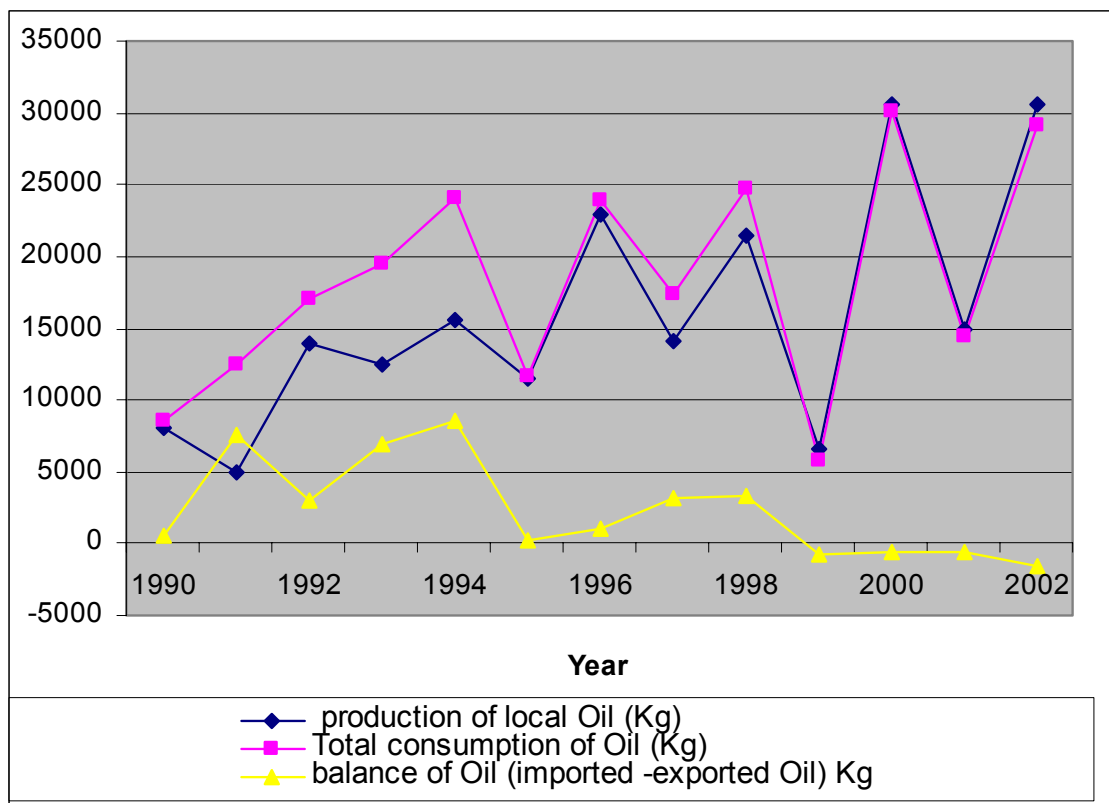
Figure 4: Local production and consumption (in tons) of olive oil.

Concerning olive oil which is the most important product, we can do the same observations than before: the Jordanian consumption of oil seems to follow the local production. An important importation has been recorded from 1990 to 1994 but since this date, the importations are really limited (existing in 1997 and 1998 but nil in 1995 and 1996).

Moreover since 1999 the olive oil balance is negative: exportations are higher than the importation.

In conclusion we can say that the Olive and the Olive Oil market in Jordan don't depend on the local production. The consumption follows the production year after year. During the early 90's, and due to the lowest productions importations were recorded but since 1994 olive oil (and fruits) trade stayed negligible in regard to the local production. However, 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. Data of the following years will be helpful to confirm or invalidate this tendency.

On another hand, and following an olive trees maturing (which began in early 90's), olive fruits and olive oil production are expected to increase during the next decade in Jordan. The consequence will be an increase in production. If the Jordanian market already reached its limit, this production will have to be exported. Some questions about the existence and the profitability of an olive (and olive oil) market directed to export have to be asked and deepened.

In the previous paragraph and in our statistics, we only have considered surface cropped which are actually in production. However, a lot of olive trees have been recently planted, these new orchards are not still productive but they will begin to produce in the next few years.

Surface in dunum	Trees in Production			Trees with no production			Total Sum
	irrigated	non irrigated	Sum	irrigated	non irrigated	Sum	
Ajloun	5081	49967	55048	345	9616	9961	65009
Jerash	11753	62561	74314	4236	22224	26460	100774
Amman	60131	49080	109211	8587	15308	23895	133106
Madaba	1135	17965	19100	650	12720	13370	32470
Zarka	56251	39020	95271	5528	7340	12868	108139
Irbid	4270	206550	210820	2522	45757	48279	259099
Mafraq	22830	27525	50355	17100	21390	38490	88845
Al Baaqa	5000	147400	152400	1400	23000	24400	176800
Jordan valley	4148		4148	701		701	4849
Total basin	170599	600068	770667	41069	157355	198424	969091
Karak	8855	13419	22274	3150	9438	12588	34862
Attafeeleh	10150	19500	29650	980	1370	2350	32000
Ma'an	9527	2890	12417	3726	1935	5661	18078
Aqaba	1497		1497	350		350	1847
Total Jordan	200628	635877	836505	49275	170098	219373	1055878

Table 3: Olive trees surface in Jordan in 1999

Regarding this table we can say that the total surface planted with olive trees reaches 1 056 000 dunums in Jordan and 969 000 dunums (92% of the total) in the basin we study. Three quarters of this surface are now in production and one other quarter will entry in production in the next few years. This observation is valid either in general or if we distinguish irrigated and rain fed surfaces. Non irrigated olive trees represent ¾ of all the surface planted with olive trees.

Let's do some rough hypothesis to predict the evolution of production in the next decade. We will consider that the trees which produce now, produce half of the quantity expected when the trees are mature. The other trees will become to produce this year (2003). What will be the consequences on Jordanian production of olives?
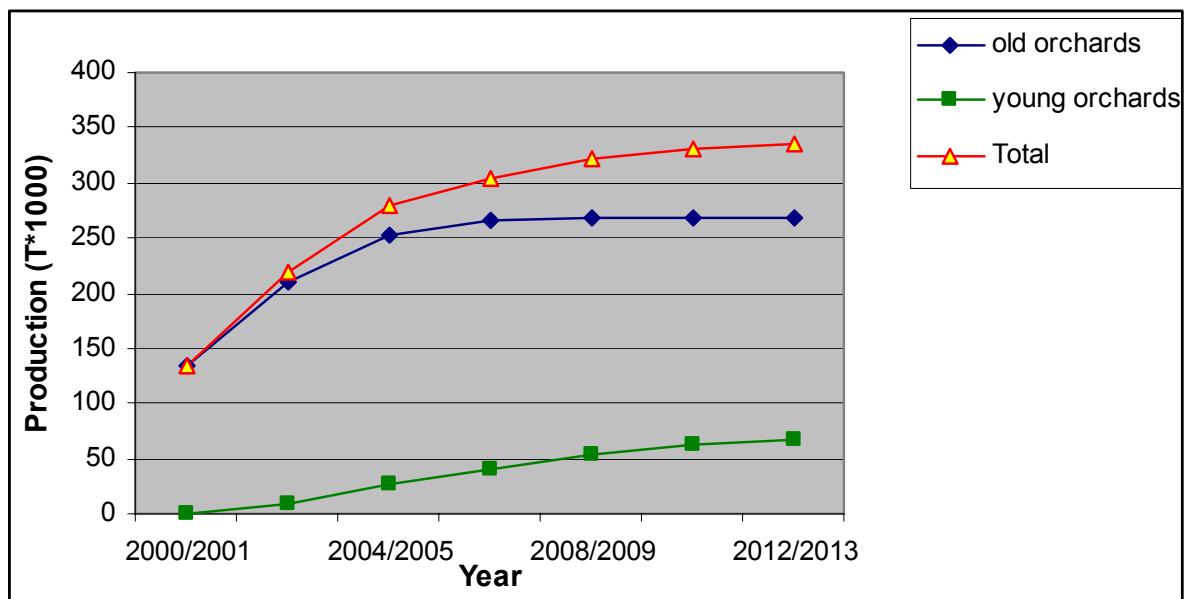
Figure 5: Expected evolutions of the olive trees production in Jordan during the next decade.
Source: Venot, 2003

More than a doubling of olive production is expected in Jordan during the next decade[6]. That will be due the maturing of orchards newly planted. The Jordanian market seems to have reached his maximum capacity of production until 2000/2001, if this tendency is confirmed; all this additional production would be exported. Does the olive trees activity be profitable any more or no? And regarding the profit brought out are there some differences between irrigated and rain fed olive trees?

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[6] If all the trees now planted stay in place.

3. Economic analysis on Olive trees production

General information on olive trees

According to the ASAL work and to our surveys, the production at maturity for rain fed olive trees is about 300 to 400 Kg/dunum/year (on average on two years), it means and 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 (small owner) the expected yield is about 450 Kg of Olives (90 Kg of Oil), for intensive farm (big owner) the expected yield is around 700 Kg (140 Kg of oil)/du/year

However, olive trees are known to be long to entry in production, indeed the full production isn't reach before the trees become mature (around 12 years old)

The evolution of production of an olive trees orchard can be summarizing 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 actual situation of production (young trees which produce half of their potential) and the future situation when the trees will be mature[7].

Irrigated olive trees

Picture 1: Irrigated Olive trees in association with watercress

As we have seen before, the largest irrigated surface cropped with olive trees are in the directorates of Amman, Zarqa and Mafraq. It corresponds to the regions we named Transition Area and Eastern Desert Area.

In our basin, 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 associated to another activity (vegetables or fruit trees cropping)

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[7] To predict the Net Profit in the next few years we considered that the oil price will not change. We took 27 JD for a box of oil of 17 Kg (price which has been paid during the two last years). We consider too that the price of oil which stays in Jordan is the same that the price of exported oil (same orchards, quality…)

<u>Different kind of olive trees farm</u>

Thanks to our surveys, we are able to identify different way of cropping irrigated vegetables. We can classify them from the more extensive to the more intensive.

✓ The more extensive way of cropping olives 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", 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 (actual situation, the owner is losing money): - 31 \$/du/year and it will only reach 4 \$/du/year when the trees will be mature. This kind of plots is mainly found in the Eastern desert.

✓ The second kind of farming is an intermediate way of cropping. Two kinds of farms can be found with the same kind of olive trees plot.
    * The first one in the eastern desert: It is vegetables and fruit trees farm owns by a man involved in the management and the work of his farm. The owner and his family are working on the field helped by permanent and daily employee. Olive trees planted on a 100 to 200 dunums-plot are under drip irrigation (cf. picture), the harvest is done by the family and some daily employee, the yield expected is the same than in the system described above. The net profit brought out is still negative when the trees are young (actual situation): - 23 \$/du/year and will reach 41 \$/du/year when the trees will be mature. The rare "only-olive trees farms" we saw in the eastern desert

have this way of management. The plot cropped has a surface included between 200 and 300 dunums and the owner often is an absentee one.

Picture 2: Classic plot of Olive trees under drip irrigation in the Eastern desert

    * As we said it before, along the Zarqa River we can find two different kinds of plots. The first ones have a surface included between 100 and 200 dunums and are owned by a local land lord who either rents out some other plots to small vegetables farmers or have a fruit trees farm[8]. The family takes care of the orchards and participate in the harvest with daily workers. The other plots are larger (around 200 to 300 dunums) and are owned by an absentee owner who very rarely comes to his farm.

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[8] See the description done for the Zarqa area

✓ The last way of cultivating olive trees is a more intensive one. Only really big intensive fruit trees farms are concerning (essentially in the Eastern desert and on the hilly side of the Zarqa River). The plot planted with olive trees is large (200 to 400 dunums), it is "added" to another plot (nearly of the same surface) planted with other fruit trees (peaches, nectarines, apple trees….). The owner of the farm is only involved in the management of the farm, he comes on the farm to control the work of his employees. The Yield expected at maturity is around 700 Kg of fruits/dunum in an average year (Mean done on one good and one bad year). The Net profit brought out this system is negative when the trees are young (actual situation) :
-8 $/du/year and will reach a highest amount at maturity: 71 $/du/year.

✓ About the importance of each system we can say that the third one is really limited (in surface and in number of farmers considered). Most of the irrigated olive trees are cropped in the two first ways presented.

In conclusion on irrigated olive trees, we can say that an olive trees orchards is a long term investment which cost money during the first years (even until 7 years, the Net Profit brought out is negative). More intensive the way of cropping is, highest the expected profit is. In comparison we can study the Net profit brought out by rain fed olive trees farms.

Rain fed olive trees

Picture 3: Harvest on Rain fed Olive trees

To define the system we based our selves on the ASAL work and on a little number of surveys we have done. Such farms are located in the Highlands Area (Jerash/Ajloun…)The average surface of the farms is included between 30 and 50 dunums and 2 familial workers work on the farm during the year. For the harvest, one part of the work is done by the family, and another part is realized by daily employee.

The actual Net profit brought out by this system is around 18 $/du/year and the Net profit expected when the trees will be mature is close to 62 $/du/year.

We highlight that the rain fed olives trees are more profitable and will be more profitable when the trees will reach their maturity than the majority of the irrigated olives trees planted in Jordan.

4. Conclusion and problematic regarding water

To summarize the situation of olive trees in Jordan we can present these two following Charts:
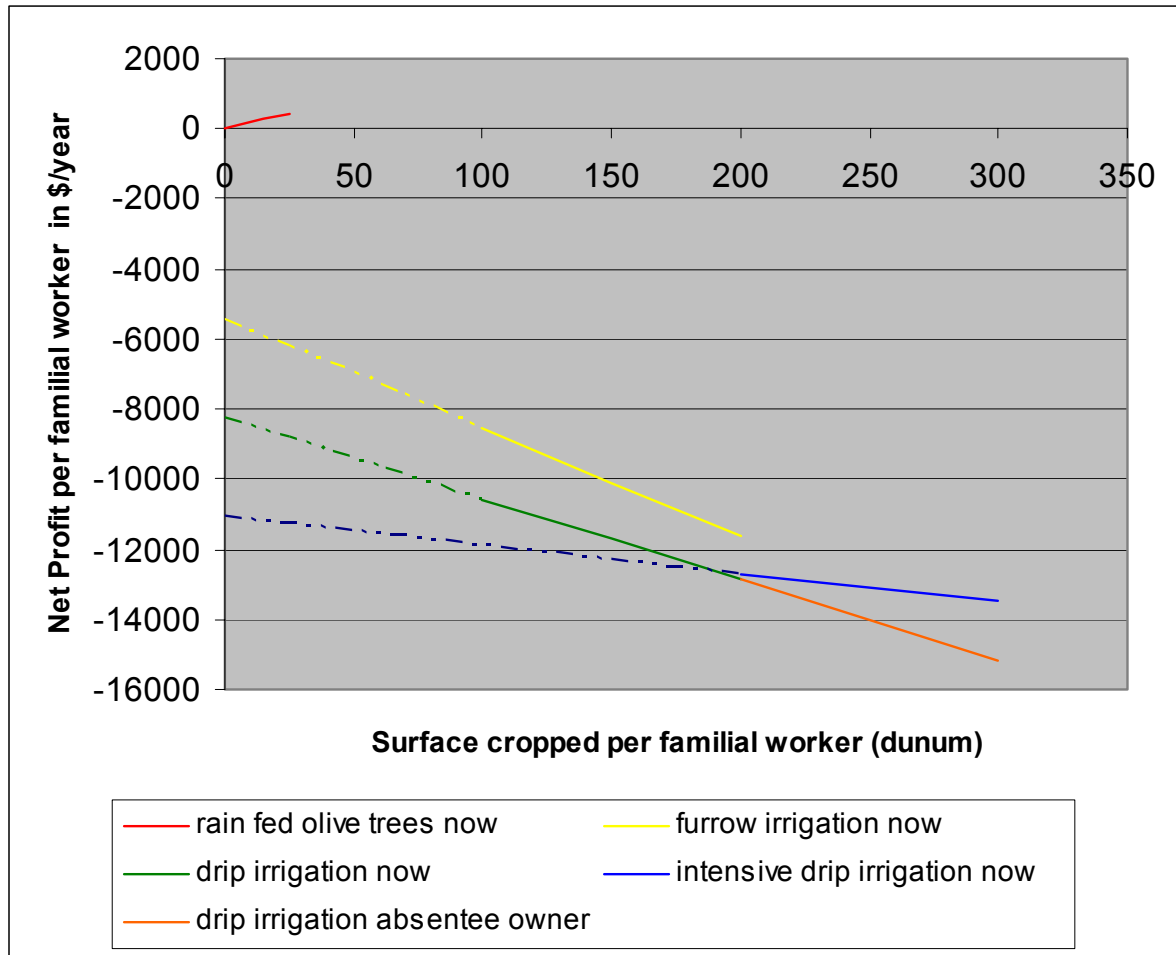
Figure 6: Comparison of the actual Net profit per familial worker for the different kind of olive trees farms.

This figure shows that only rain fed fruit trees are now profitable: the slope of the straight line is positive. For the other systems which are all irrigated systems, the profit is negative (the slope is negative).
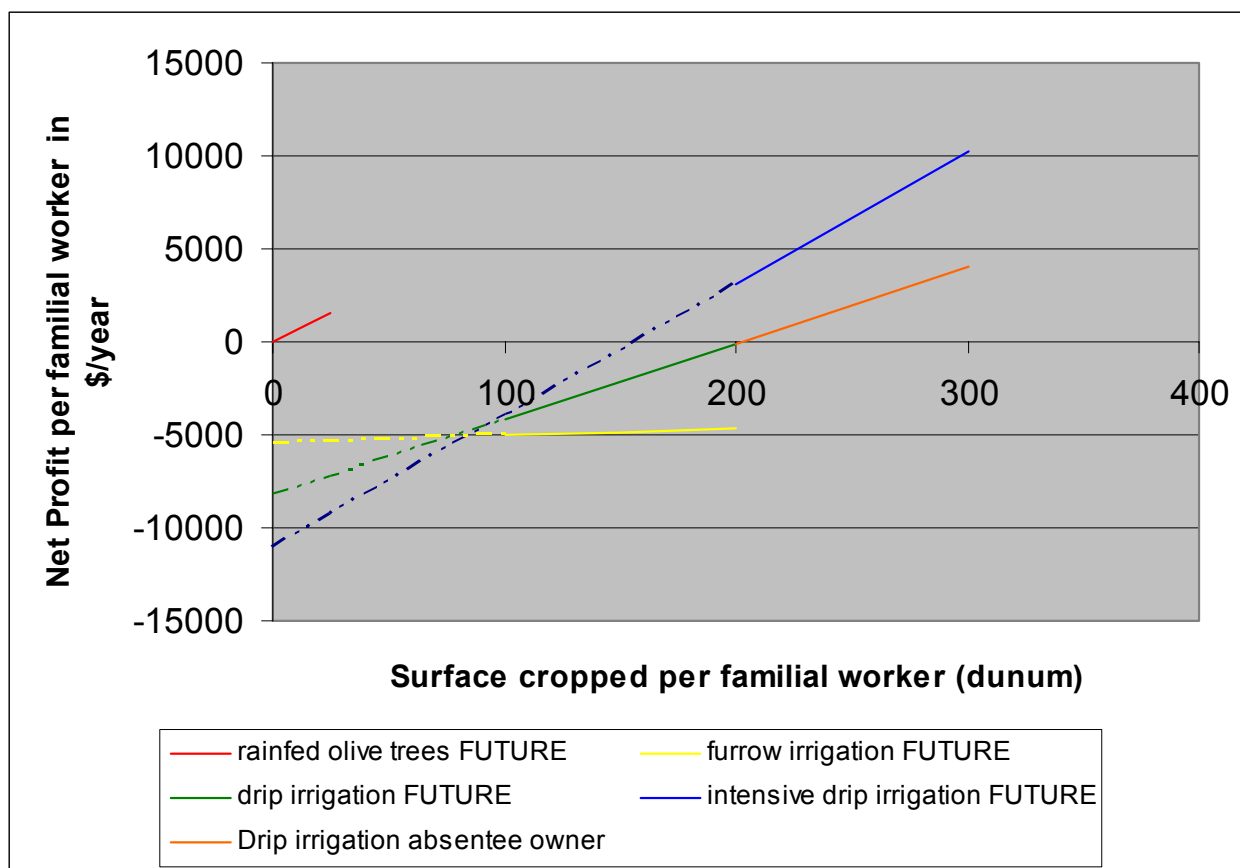
Figure 7: Comparison of the expected Net profit per familial worker for the different kind of olive trees farms.

On this chart, until the water prices or costs raise, we can see that all systems become profitable at maturity: all slopes are positive. Rain fed agriculture and Intensive drip irrigation systems have comparable slope, higher than the two other systems. Moreover we can say that even if slopes are positive,

✓ The "olive trees under furrow irrigation-system" isn't profitable alone (the investment has to be used on other crops like vegetables or fruit trees).

✓ The "olive trees under drip irrigation-system" is profitable alone only if the surface planted is larger than 200 dunums. This explains we haven't seen a lot of olive trees farm and that olive trees are always associated to another activity.

Concerning the water, and the "by law of 2002" what will be the consequences of its implementation.

Farmers irrigate olive trees with 350 M3/du/year. For big farms only planted with olives trees, the total consumption of water will be around 105 000 M3 (300 dunums). The law will not have any consequences on them: they will continue to crop like before.

However, as olive trees are always associated with other crops, the quantity of water use on the farm has to be considered.

✓ For vegetables farmers who have a plot of olive trees the total consumption of water of their well will reach 277 500 m3/year (225 dunums of vegetables, 150 dunums of olive trees). Such farmer will have to pay 5900 JD it means 16 JD/du/year (22.5 $).

➔ Under furrow irrigation the Net Profit brought out thanks to the olive trees will be negative at maturity: -18.5$/du/year, the farmer will loose money.

➔ Under drip irrigation the Net profit brought out thanks to the olive trees will reach 38 $/du/year at maturity.

✓ For a fruit trees farmer who have a plot of olive trees, the total consumption of water will reach 262 500 m3/year (150 dunums of fruit trees, 150 dunums of olive trees). Such farmer will pay 5000 JD it means 17 JD/du/year (24 $).

➔ Under furrow irrigation the Net Profit brought out thanks to the olive trees will be negative at maturity : -19.5 $/du/year, the farmer will loose money.

➔ Under drip irrigation the Net profit brought out thanks to the olive trees will reach 36 $/du/year at maturity.

✓ For a big fruit trees farmer who have a plot of olive trees, the total consumption of water will reach 525 000 m3 (300 dunums of fruit trees and 300 dunums of olive trees) Such farmer will have to pay 32 000 JD if he has one well and 10 000 JD if he has two wells it means 53 JD/du/year (75 $) or 17 JD/du/year (24$) (one or two wells)

➔ If the farmer has one well, the Net Profit brought out thanks to the olive trees will be negative: -4 $/du/year

➔ If the farmer has two wells, the Net Profit brought out thanks to the olive trees will only reach: 47 $/du/year

If the by law is implemented, the olives trees orchards under furrow irrigation characterized by a really extensive way of cropping will be no more profitable. Considering the other way of cropping, irrigated olive trees will be profitable but less than rain fed olive trees even for the farmers who manage intensively their orchards.

> An over production of olive fruits and oil will happened in the next few years: the production is actually expected to double in 3 years from now, and the local market seems to have reach its maximum of absorption since the last 5 years (exportation are slowly increasing). 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 behave in such way (only the biggest farmers who already have their export channel will be able to adapt themselves to these new market conditions).

Because of these new market conditions, AND while the government of Jordan wants the country to reach a more sustainable water management, planting and cultivating irrigated olive trees seems to be silly.

✓ For the farmers, irrigated olive trees aren't more profitable than rain fed olive trees (even less) and the situation will become worse with the new taxation on ground water abstraction.

✓ For the country:

- Rain fed olive trees surface will be sufficient[9] to assure the olive trees production market of Jordan in the future years.
- Concerning the water, irrigated olive trees use ground water with a really weak economic return : a maximum of 0.070 \$/m3 against 0.105 \$/m3 for vegetables and 0.770 \$/M3 for fruit trees[10]; if we assume than irrigated olive trees represent 39% of the surface cropped in the Amman Zarqa Basin, olive trees consume 14.4 Mcm of groundwater (19% of the agricultural use)

> *It is recommended* that the Jordanian government take some measures about irrigated olive trees, stop to support these plantations. The increase in the surface cropped should be stopped and no more new surfaces should be planted. Within the framework of a more sustainable water management in Jordan, other drastic measures as subsidy to farmers for digging up the irrigated olive trees could be studied.

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[9] In 3 years, when the new orchards will produce half of their mature production, the actual production will be reached thanks to the rain fed orchards only. All the production of irrigated orchards could be seen as an additional production.

[10] The two last figures are averages done on the different economic systems presented.

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5. Economic models of different kinds of olive trees plantation

Rain fed Olive trees farm- Actual situation with a young orchard

It is a familial farm in ownership, 2 familial workers during the year and daily employees for the harvest. One worker can work on 80 dunums Surface included between 30 and 50 dunums.						Model built on a two years-average (one good and one bad year) Yield at maturity of 350 Kg fruit/dunum			
revenue for a young orchard **(7 years, half of the production expected)**						Proportional value to the surface (JD/du/year)	Proportional value to the surface ($/du/year)	Non Proportional value to the surface (JD/du/year)	Non Proportional value to the surface ($/du/year)
		Qty	Unity	Qty	Unity				
Gross Output	**Olive trees**	35	Kg oil/du			55	78		
Variables Costs	**Olives trees**					20	28		
Product costs	Olive Trees					15	11		
	Water								
	Manure					10	14		
	Chemical fertilizer					2,50	4		
	Pesticides					2,5	4		
	Total Input					**15**	**21**		
	Electricity/Petrol								
	Pump maintenance								
	Others								
Service Costs	Olive Trees					5	7		
	Equipment location					5	7		
	transport								
Gross Margin	**Olive Trees**					35	49	0	0
Exploitation	**Costs**					2	3	0	0
Depreciation Non proportional costs	Small material (clippers...)								
	Truck								
	Pump and motor								

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	Pool (irrigation system)				
	Big material well				
Proportional costs	Irrigation system (pipe...)				
	Plantation greenhouses/tunnel	60 JD/du 30 years	2	3	
Land rent					
Well rent					
Interest on loans					
	Olives Trees		**33**	**47**	
Wages Costs	**Olives Trees**		**20**	**28**	
Permanent Employees Olive trees					
Daily Employees Olive trees			20	28	
Handling of equipment (greenhouses, tunnel, plastic)					
harvesting			20	28	
Others					
	Olives Trees		**13**	**18**	
SUMMARY	**TABLE**				
Gross output			**55**	**78**	**0**	**0**
Variables costs			**20**	**28**	
Gross margin			**35**	**49**	
Exploitation Costs			**2**	**3**	
Net margin			**33**	**47**	**0**	**0**
Wages Costs			**20**	**28**	
Net profit			**13,00**	**18**	**0**	**0**
Net profit/Total Costs (%)			**31**	**31**	

Rain fed Olive trees farm- Future* situation with a mature orchard

* water costs have been supposed constant in the calculation

It is a familial farm in ownership. 2 familial workers during the year and daily employees for the harvest.One worker can work on 80 dunums. Surface included between 30 and 50 dunums.						Model built on a two years average (one good and one bad year) Yield of 350 Kg fruit/dunum			
revenue for a old orchard **(12 years, mature trees, the maximum of production is reached)**						Proportional value to the surface (JD/du/year)	Proportional value to the surface ($/du/year)	Non Proportional value to the surface (JD/du/year	Non Proportional value to the surface ($/du/year)
		Qty	Unity	Qty	Unity				
Gross Output	**Olive trees**	70	Kg oil/du			**110**	**155**		
Variables Costs	**Olives trees**					**25**	**35**		
Product costs	Olive Trees					20	14		
	Water								
	Manure					12,5	18		
	Chemical fertilizer					5	7		
	Pesticides					2,5	4		
	Total Input					**20**	**28**		
	Electricity/Petrol								
	Pump maintenance								
	Others								
Service Costs	Olive Trees					5	7		
	Equipment location transport					5	7		
Gross Margin	**Olive Trees**					**85**	**120**	**0**	**0**
Exploitation	**Costs**					**2**	**3**	**0**	**0**
Depreciation Non proportional costs	Small material (clippers...)								
	Truck								
	Pump and motor								

	Pool (irrigation system)					
	Big material well					
Proportional costs	Irrigation system (pipe...)					
	Plantation greenhouses/tunnel	60 JD/du 30 years	2	3		
Land rent						
Well rent						
Interest on loans						
	Olives Trees		**83**	**117**		
Wages Costs	**Olives Trees**		**40**	**56**		
	Permanent Employees Olive trees					
	dailyEmployees Olive trees		40	56		
	Handling of equipment (greenhouses, tunnel, plastic)					
	harvesting		40	56		
	Others					
	Olives Trees		**43**	**61**		
SUMMARY	**TABLE**					
Gross output			**110**	**155**	**0**	**0**
Variables costs			**25**	**35**		
Gross margin			**85**	**120**		
Exploitation Costs			**2**	**3**		
Net margin			**83**	**117**	**0**	**0**
Wages Costs			**40**	**56**		
Net profit			**43,00**	**61**	**0**	**0**
Net profit/Total Costs (%)			**64**	**64**		

Irrigated Olive trees farm-Furrow Irrigation-Actual situation with a young orchard

Plot of 100 to 200 dunums of olive trees. This is not a farm model but a crop model. This olive trees activity had to be added to another activity (See the model described) Cropping vegetable is the main activity of the farmer				The owner is an absentee land investor. Yield at maturity: 450 Kg fruits/dunum.			
The production is sale before harvest	**Olive trees are under furrow irrigation**	**Situation at 7 years**		Proportional value to the surface (JD/du/year)	Proportional value to the surface ($/du/year)	Non Proportional value to the surface (JD/du/year	Non Proportional value to the surface ($/du/year)
		Qty Unity Qty Unity					
Gross Output	**Olive trees**			**30**	**42**		
Variables Costs	**Olives trees**			**35**	**49**		
Product costs	Olive Trees			30	21		
	Water						
	Manure			10	14		
	Chemical fertilizer			2,50	4		
	Pesticides			2,5	4		
	Total Input			**15**	**21**		
	Electricity/Petrol			15	21		
	Pump maintenance						
	Others						
Service Costs	Olive Trees			5	7		
	Equipment location			5	7		
	transport						
Gross Margin	**Olive Trees**			**-5**	**-7**	**0**	**0**
Exploitation	**Costs**			**2**	**3**	**-3860**	**-5444**
Depreciation Non proportional costs	Small material (clippers...)						
	Truck					2000	2821
	Pump and motor					500	705

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Proportional costs	Pool (irrigation system)					160	226
	Big material well	30 000 JD	25 years			1200	1693
	Irrigation system (pipe...)						
	Plantation greenhouses/tunnel	60 JD/du	30 years	2	3		
Land rent							
Well rent							
Interest on loans							
	Olives Trees			**-7**	**-10**	**-3860**	**-5444**
Wages Costs	**Olives Trees**			**15**	**21**	**-3860**	**-5444**
	Permanent Employees Olive trees	120 JD/month		15	21		
	dailyEmployees Olive trees						
	Handling of equipment (greenhouses, tunnel, plastic)						
	harvesting						
	Others						
	Olives Trees			**-22**	**-31**		
SUMMARY	**TABLE**						
Gross output				**30**	**42**	**0**	**0**
Variables costs				**35**	**49**		
Gross margin				**-5**	**-7**		
Exploitation Costs				**2**	**3**		
Net margin				**-7**	**-10**	**-3860**	**-5444**
Wages Costs				**15**	**21**		
Net profit				**-22,00**	**-31**	**-3860**	**-5444**
Net profit/Total Costs (%)				**-42**	**-42**		

Irrigated Olive trees farm-Furrow Irrigation-Future* situation with a mature orchard

* water costs have been supposed constant in the calculation

Plot of 100 to 200 dunums of olive trees. This is not a farm model but a crop model. This olive trees activity had to be added to another activity (See the model described)						The owner is an absentee land investor. Yield at maturity: 450 Kg fruits/dunum.			
Cropping vegetable is the main activity of the farmer									
The production is sale before harvest	Olive trees are under furrow irrigation	Situation at 12 years (maturity)				Proportional value to the surface (JD/du/year)	Proportional value to the surface ($/du/year)	Non Proportional value to the surface (JD/du/year)	Non Proportional value to the surface ($/du/year)
		Qty	Unity	Qty	Unity				
Gross Output	**Olive trees**					60	85		
Variables Costs	**Olives trees**					40	56		
Product costs	Olive Trees					35	25		
	Water								
	Manure					12,5	18		
	Chemical fertilizer					5	7		
	Pesticides					2,5	4		
	Total Input					**20**	**28**		
	Electricity/Petrol					15	21		
	Pump maintenance								
	Others								
Service Costs	Olive Trees					5	7		
	Equipment location transport					5	7		
Gross Margin	**Olive Trees**					**20**	**28**	**0**	**0**
Exploitation	**Costs**					**2**	**3**	**-3860**	**-5444**
Depreciation Non proportional costs	Small material (clippers...)								
	Truck							2000	2821

	Pump and motor					500	705
	Pool (irrigation system)					160	226
Proportional costs	Big material well	30 000 JD	25 years			1200	1693
	Irrigation system (pipe...)						
	Plantation greenhouses/tunnel	60 JD/du	30 years	2	3		
Land rent							
Well rent							
Interest on loans							
	Olives Trees			18	25	-3860	-5444
Wages Costs	Olives Trees			15	21	-3860	-5444
Permanent Employees Olive trees				15	21		
daily Employees Olive trees							
Handling of equipment (greenhouses, tunnel, plastic)							
harvesting							
Others							
	Olives Trees			3	4		
SUMMARY	TABLE						
Gross output				60	85	0	0
Variables costs				40	56		
Gross margin				20	28		
Exploitation Costs				2	3		
Net margin				18	25	-3860	-5444
Wages Costs				15	21		
Net profit				3,00	4	-3860	-5444
Net profit/Total Costs (%)				5	5		

Irrigated Olive trees farm-Drip Irrigation-Actual situation with a young orchard

Plot of 100 to 200 dunums of olive trees. This is not a farm model but a crop model. This olive trees activity had to be added to another activity (See the models described in VOL6)					The owner and his family are working on the farm. Yield expected at maturity : 450 Kg fruits/du			
Cropping vegetables is the main activity of the farmer	**Olive trees are under drip irrigation**	**Situation at 7 years**			Proportional value to the surface (JD/du/year)	Proportional value to the surface ($/du/year)	Non Proportional value to the surface (JD/du/year)	Non Proportional value to the surface ($/du/year)
		Qty	Unity	Qty	Unity				
Gross Output	**Olive trees**					70	99		
Variables Costs	**Olives trees**					35	49		
Product costs	Olive Trees					35	25		
	Water								
	Manure					10	14		
	Chemical fertilizer					2,50	4		
	Pesticides					2,5	4		
	Total Input					**15**	**21**		
	Electricity/Petrol					20	28		
	Pump maintenance								
	Others								
Service Costs	Olive Trees					0	0		
	Equipment location								
	transport								
Gross Margin	**Olive Trees**					35	49	0	0
Exploitation	**Costs**					11	16	-5860	-8265
Depreciation Non proportional costs	Small material (clippers...)								
	Truck							2000	2821
	Pump and motor							1500	2116
	Pool (irrigation system)							160	226

Proportional costs	Big material					1000	1410
	well	30 000 JD	25 years			1200	1693
	Irrigation system (pipe...)			9	13		
	Plantation	60 JD/du	30 years	2	3		
	greenhouses/tunnel						
Land rent							
Well rent							
Interest on loans							
	Olives Trees			**33**	**47**	**-5860**	**-8265**

Wages Costs	**Olives Trees**			**40**	**56**	**-5860**	**-8265**
Permanent Employees Olive trees		120 JD/month		15	21		
dailyEmployees Olive trees				25	35		
Handling of equipment (greenhouses, tunnel, plastic)							
harvesting							
Others							
	Olives Trees			**-7**	**-10**		
SUMMARY	**TABLE**						
Gross output				**70**	**99**	**0**	**0**
Variables costs				**35**	**49**		
Gross margin				**35**	**49**		
Exploitation Costs				**2**	**3**		
Net margin				**33**	**47**	**-5860**	**-8265**
Wages Costs				**40**	**56**		
Net profit				**-7,00**	**-10**	**-5860**	**-8265**
Net profit/Total Costs (%)				**0**	**0**		

Irrigated Olive trees farm-Drip Irrigation-Future* situation with a mature orchard

* water costs have been supposed constant in the calculation

		Situation at 12 years (maturity)				Proportional value to the surface (JD/du/year)	Proportional value to the surface ($/du/year)	Non Proportional value to the surface (JD/du/year)	Non Proportional value to the surface ($/du/year)
Plot of 100 to 200 dunums of olive trees. This is not a farm model but a crop model. This olive trees activity had to be added to another activity (See the models described in VOL6) **Cropping vegetable is the main activity of the farmer**								**The owner and his family are working on the farm.** **Yield expected at maturity : 450 Kg fruits/du**	
The production is sale before harvest	**Olive trees are under furrow irrigation**								
		Qty	Unity	Qty	Unity				
Gross Output	**Olive trees**	90	Kg oil/du			**145**	**205**		
Variables Costs	**Olives trees**					**40**	**56**		
Product costs	Olive Trees					40	28		
	Water								
	Manure					12,5	18		
	Chemical fertilizer					5	7		
	Pesticides					2,5	4		
	Total Input					**20**	**28**		
	Electricity/Petrol					20	28		
	Pump maintenance								
	Others								
Service Costs	Olive Trees					0	0		
	Equipment location								
	transport								
Gross Margin	**Olive Trees**					**105**	**148**	**0**	**0**
Exploitation	**Costs**					**11**	**16**	**-5860**	**-8265**
Depreciation Non proportional costs	Small material (clippers...)								
	Truck							2000	2821

	Pump and motor					1500	2116
	Pool (irrigation system)					160	226
	Big material					1000	1410
	well	30 000 JD	25 years			1200	1693
Proportional costs	Irrigation system (pipe...)			9	13		
	Plantation greenhouses/tunnel	60 JD/du	30 years	2	3		
Land rent							
Well rent							
Interest on loans							
	Olives Trees			**103**	**145**	**-5860**	**-8265**

Wages Costs	**Olives Trees**		**65**	**92**	**-5860**	**-8265**
Permanent Employees Olive trees			15	21		
daily Employees Olive trees			50	71		
Handling of equipment (greenhouses, tunnel, plastic)						
harvesting						
Others						
	Olives Trees		**38**	**54**		
SUMMARY	**TABLE**					
Gross output			**145**	**205**	**0**	**0**
Variables costs			**40**	**56**		
Gross margin			**105**	**148**		
Exploitation Costs			**2**	**3**		
Net margin			**103**	**145**	**-5860**	**-8265**
Wages Costs			**65**	**92**		
Net profit			**38,00**	**54**	**-5860**	**-8265**
Net profit/Total Costs (%)			**36**	**36**		

Irrigated Olive trees farm-Drip Irrigation-Actual situation with a young orchard
Intensive farming

Plot of 200 to 400 dunums of olive trees. This is not a farm model but a crop model. This olive trees activity had to be added to another activity (See the models described)						The way of cropping is more intensive than the farmers who are cropping vegetables as their main activity. The owner is an absentee land investor. Yield expected at maturity 700 Kg fruit/du.			
Cropping trees is the main activity of the farmer	**Olive trees are under drip irrigation**	**Situation at 7 years**				Proportional value to the surface (JD/du/year)	Proportional value to the surface ($/du/year)	Non Proportional value to the surface (JD/du/year	Non Proportional value to the surface ($/du/year)
		Qty	Unity	Qty	Unity				
Gross Output	**Olive trees**					**111**	**157**		
Variables Costs	**Olives trees**					**50**	**71**		
Product costs	Olive Trees					50	35		
	Water								
	Manure					10	14		
	Chemical fertilizer					10	14		
	Pesticides					10	14		
	Total Input					**30**	**42**		
	Electricity/Petrol					20	28		
	Pump maintenance								
	Others								
Service Costs	Olive Trees					0	0		
	Equipment location								
	transport								
Gross Margin	**Olive Trees**					**61**	**86**	**0**	**0**
Exploitation	**Costs**					**12**	**17**	**-7860**	**-11086**
Depreciation Non proportional costs	Small material (clippers...)								
	Truck							4000	5641,75
	Pump and motor							1500	2115,66

	Pool (irrigation system)				160	225,67
	Big material				1000	1410,44
	well	30 000 JD	25 years		1 200	1692,52
Proportional costs	Irrigation system (pipe...)			10	14	
	Plantation	60 JD/du	30 years	2	3	
	greenhouses/tunnel					
Land rent						
Well rent						
Interest on loans						
	Olives Trees			**49**	**69**	**-7860**	**-5573**

Wages Costs	**Olives Trees**			**55**	**78**	**-7860**	**-5573**
	Permanent Employees Olive trees	120 JD/month		20	28	
	dailyEmployees Olive trees			35	49	
Handling of equipment (greenhouses, tunnel, plastic)						
	harvesting					
	Others					
	Olives Trees			**-6**	**-8**		
SUMMARY	**TABLE**					
Gross output				**111**	**157**	**0**	**0**
Variables costs				**50**	**71**		
Gross margin				**61**	**86**		
Exploitation Costs				**2**	**3**		
Net margin				**59**	**83**	**-7860**	**-5573**
Wages Costs				**55**	**78**		
Net profit				**4,00**	**6**	**-7860**	**-5573**
Net profit/Total Costs (%)				**4**	**4**		

Irrigated Olive trees farm-Drip Irrigation-Future* situation with a mature orchard

Intensive farming   * water costs have been supposed constant in the calculation

<table>
<tr><td colspan="2">Plot of 200 to 400 dunums of olive trees. This is not a farm model but a crop model. This olive trees activity had to be added to another activity (See the model described)</td><td colspan="2"></td><td colspan="4">The way of cropping is more intensive than the farmers who are cropping vegetables as their main activity. The owner is an absentee land investor. Yield expected at maturity 700 Kg fruit/du.</td></tr>
<tr><td>Cropping trees is the main activity of the farmer</td><td>Olive trees are under drip irrigation</td><td colspan="4">Situation at 12 years (maturity)</td><td>Proportional value to the surface (JD/du/year)</td><td>Proportional value to the surface ($/du/year)</td><td>Non Proportional value to the surface (JD/du/year</td><td>Non Proportional value to the surface ($/du/year)</td></tr>
<tr><td></td><td></td><td>Qty</td><td>Unity</td><td>Qty</td><td>Unity</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Gross Output</td><td>Olive trees</td><td>140</td><td>Kg oil/du</td><td></td><td></td><td>222</td><td>313</td><td></td><td></td></tr>
<tr><td>Variables Costs</td><td>Olives trees</td><td></td><td></td><td></td><td></td><td>60</td><td>85</td><td></td><td></td></tr>
<tr><td>*Product costs*</td><td>Olive Trees</td><td></td><td></td><td></td><td></td><td>60</td><td>43</td><td></td><td></td></tr>
<tr><td></td><td>Water</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Manure</td><td></td><td></td><td></td><td></td><td>15</td><td>21</td><td></td><td></td></tr>
<tr><td></td><td>Chemical fertilizer</td><td></td><td></td><td></td><td></td><td>15</td><td>21</td><td></td><td></td></tr>
<tr><td></td><td>Pesticides</td><td></td><td></td><td></td><td></td><td>10</td><td>14</td><td></td><td></td></tr>
<tr><td></td><td>Total Input</td><td></td><td></td><td></td><td></td><td>20</td><td>28</td><td></td><td></td></tr>
<tr><td></td><td>Electricity/Petrol</td><td></td><td></td><td></td><td></td><td>20</td><td>28</td><td></td><td></td></tr>
<tr><td></td><td>Pump maintenance</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Others</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>*Service Costs*</td><td>Olive Trees</td><td></td><td></td><td></td><td></td><td>0</td><td>0</td><td></td><td></td></tr>
<tr><td></td><td>Equipment location</td><td></td><td></td><td></td><td></td><td></td><td>0</td><td></td><td></td></tr>
<tr><td></td><td>transport</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Gross Margin</td><td>Olive Trees</td><td></td><td></td><td></td><td></td><td>162</td><td>228</td><td>0</td><td>0</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Exploitation</td><td>Costs</td><td></td><td></td><td></td><td></td><td>12</td><td>17</td><td>-7860</td><td>-11086</td></tr>
<tr><td>*Depreciation* Non proportional costs</td><td>Small material (clippers...)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Truck</td><td></td><td></td><td></td><td></td><td></td><td></td><td>4000</td><td>5642</td></tr>
<tr><td></td><td>Pump and motor</td><td></td><td></td><td></td><td></td><td></td><td></td><td>1500</td><td>2116</td></tr>
</table>

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Proportional costs	Pool (irrigation system)					160	226
	Big material					1000	1410
	well	30 000 JD	25 years			1 200	1693
	Irrigation system (pipe...)			10	14		
	Plantation	60 JD/du	30 years	2	3		
Land rent	greenhouses/tunnel						
Well rent							
Interest on loans							
	Olives Trees			**150**	**212**	**-7860**	**-11086**

Wages Costs	**Olives Trees**		**100**	**141**	**-7860**	**-11086**
Permanent Employees Olive trees			30	42		
daily Employees Olive trees			70	99		
Handling of equipment (greenhouses, tunnel, plastic)						
harvesting						
Others						
	Olives Trees		**50**	**71**		
SUMMARY	**TABLE**					
Gross output			**222**	**313**	**0**	**0**
Variables costs			**60**	**85**		
Gross margin			**162**	**228**		
Exploitation Costs			**2**	**3**		
Net margin			**160**	**226**	**-7860**	**-11086**
Wages Costs			**100**	**141**		
Net profit			**60,00**	**85**	**-7860**	**-11086**
Net profit/Total Costs (%)			**37**	**37**		

6. Abstract and Key words

Jordan faces today a critical situation of water shortage, which, following a strong demographic growth and an increase of the everyday needs of the population will get worse. The development and the exploitation of new water resources have met the increasing demand. However, today only a few new exploitable water resources exist and it would require very high investments and operational costs to exploit them. Continuing, irrigated agriculture has been developed in Jordan for reasons of technical feasibility and economic profitability since the sixties. This consumes today nearly 70% of Jordan's water and contributes only 3% to its Gross National Product. Thus the socioeconomic return of the agricultural use is lower than the one linked to an industrial or municipal one.

In Jordan River Basin in Jordan, two different kinds of agriculture can be identified. First is an intensive irrigated agriculture developed since the sixties in the valley of the river thanks to a channel harvesting the surface waters coming from the Yarmouk River and other secondary rivers called "Side Wadis". The Second kind of agriculture has been developed during the last two decades in the mountains and in the Eastern Desert thanks to private groundwater exploitation.

Due to water shortage and because of social imperatives, the government decided to provide water to urban centers. This policy, accepted by all, will reduce the quantity of water used in agriculture. Thus, the study of irrigated farming systems, their past history and their technical-economic characteristics, achieved in this study permit us to identify various social groups of farmers and different kinds of agriculture. These groups and practices, according to their characteristics and to their location in the watershed, will differently respond to the constraints imposed by the water shortage context and to the related political orientations.

Projects studied and in progress (pressurized irrigation, replacing fresh water with retreated waste water…) as well as recent and not yet enforced measures (taxing private ground water abstraction in the Highlands) reveal the government will to decrease the quantity of water used in agriculture in Jordan. In case of implementation, these measures may slightly reshape Jordanian agriculture but they already provide a framework for deeper changes.

Key words: Jordan, Watershed, Jordan River, Irrigation, Irrigated Agriculture, Water shortage, Agricultural Water Use, Irrigated farming systems, Geographical Zoning, Technical and economic modelling.