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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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Volume III: Modelling of the by law impacts' on the different farms and farmers.
Water considerations, evolutions and strategies envisaged

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MODELLING
OF THE
BY LAW IMPACTS' ON THE
DIFFERENT FARMS AND FARMERS

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THE NEW BY-LAW

We have seen (Vol. II) that agriculture, in the Highlands, is organized around private wells[1]. Most of the licenses (two thirds) of these wells define maximum quantities, and water meters are installed in almost all the wells but the half is out of use. We have seen before than, until now, while there has been growing concern about over abstraction, the Water Authority of Jordan (WAJ) has not really attempted to enforce license limits on abstraction and most of the wells actually pass the limits fixed by the licenses. The farmers feel not concern by these limits which have never been implemented.

The first real attempt to change this situation appeared very recently with the 85-2002 "by law" in which the government decided to charge fees for the volumes abstracted above 150.000 m3/year (100.000 m3/year in Azraq area). The fees are not very expensive even if higher tariffs have been decided for the unlicensed operative agricultural wells (which were not controlled until now) and most of the ancient licenses are limited to 50.000 and 75.000 m3. But, the Water Authority law of 2002 open the way to taxation on the water pumped beyond 150 000 m3. But anyway, until August 2003, these fees have not been collected. We can present the amount of taxes which are taken in consideration[2].

Water pumped	Water prices
Zero to 150 000 m3	Free
151 to 200 000 m3	25 Fils per m3 (0.035 $)
More than 200 000 m3	60 Fils per m3 (0.085 $)

Table 1: Fees on over-pumping water for licensed wells

Water pumped	Water prices
Zero to 100 000 m3	25 Fils per m3 (0.035 $)
101 000 to 150 000 m3	30 Fils per m3 (0.042 $)
151 to 200 000 m3	35 Fils per m3 (0.050 $)
More than 200 000 m3	70 Fils per m3 (0.098 $)

Table 2: Fees on over-pumping water for non-licensed wells[3]

Another problem we can underline, is the fact that many farmers understand from this new regulation that they now have the right to pump 150 000 M3/year (free of charge) whatever was the initial licensed (50 000 or 75 000 M3). The law maintains farmers in this way of thinking simply by the fact that it doesn't mention any measures concerning the enforcement of the initial limits (and the fees which will be used). As two thirds of the wells are officially licensed, an enforcement of such limits (50 and 75 000 m3) would have much more drastic consequences than the by law on the agriculture in the eastern desert.

[1] That is also the case for bananas farmers in the south of the Jordan Valley.
[2] Source of the tables: The Hashemite Kingdom of Jordan, Regulation No. 85 of 2002
[3] 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… hall be entitled to agree on water extraction from these wells for limited period and under specific conditions" In such cases the owner of such well will have to pay additional fees.

Admittedly the fees are not expensive (very low, compared to industrial fees at 0.250 JD/m3 and municipal fees around 0.800 JD/m3 for example) and the limit considered is high but, in case of field-implementation, and knowing that until now all the agricultural wells were operated free of charge, this decision may be an important first step in the right direction of a limitation of water abstraction for an agricultural use. This law has the merit to have introduced the idea of abstraction limitation which has always been unfamiliar to farmers and to the society in general.

As there isn't many unlicensed wells in the Highlands[1] (inside the JRBJ)[2], in our evaluations and calculations to evaluate the consequences of such policy on farmers/farm and water saving we will use the rules concerning the licensed wells.

This law which can have big consequences on farms' profitability must be implemented in a progressive way or supported by some adapted subsidies to allow the farmers to adapt themselves by eliminating low valued crops, learning how to grow higher value crops and becoming more productive. It is also possible that important entrepreneur farmers will stop their agricultural activity and will shift to another activity because of a decrease of the profitability of the agricultural sector.

We will see in the following paragraphs how the different kinds of farms and farmers will be concerned by the law and its implementation[3].

[1] The majority of unlicensed wells are located in Hisban/Kafrein area (south of the Jordan Valley) and in Azraq area (Out of the Basin)

[2] The unlicensed wells are mostly limited to some areas: shallow wells producing mostly brackish water in the south of the Jordan valley, some in Jafr desert and in Azraq Area.

[3] We choose to focus ourselves on the farms which could be concerned by the law and which could evolve after the implementation of the law, these farms function thanks to private wells. Are not presented the farming systems using "public water" -from JVA essentially- to irrigate their farms.

Water consideration, evolutions and strategies envisaged in Mafraq[1] Area

As we said it in the general presentation on the Highlands (cf. Vol. II), the New By-Law of 2002 will have, in case of implementation, some important consequences of the agriculture in Jordan. **Most of the evolutions will take place in the Eastern desert** where agriculture is closely linked to the groundwater over-abstraction. Due to an increase of urban water-needs (and an announced will of the government to favour municipal water use over an agricultural use) and to a decrease in profitability of certain farms, a complete restructuring of the agriculture in the eastern desert can be envisaged.

However, due to the important heterogeneity of the farms in this area, the evolutions and the strategies envisaged by the different farmers will not be equivalent and will be directly linked to their different farming systems

Vegetable farmers

In the open field vegetables farms, we have estimated the allocation of water at 1000 m3/du/year. It means a quantity of 4 mm/day/du during 8 months of cropping.

1. Large rented farms System I.1

Tenants of the farms are waiting and use this well known Scottish proverb "Wait and See". They are thinking about the law and the consequences it can have on their own business but are waiting for its implementation. They don't really know what to do but, as they heard speaking about limitation of pumping (never implemented!!) since almost 10 years and because of cultural reason they aren't persuaded that this new law will be really implemented.

In the eventuality the law will be implemented, farmers say they will pay the fees of water. If they keep their current use of water they will irrigate 150 dunums without any fees and will have to pay for the others 50 to 80 dunums. If we based us on an average surface of 225 dunums, they will have to pay for 75 000 cubic meters: it means an amount of 2750 JD (3875 $)

The total water costs (well/land renting and electricity costs+ water fees) will increase from 154 JD/du to 166 JD/du and from 0.154 to 0.166 JD/m3. This represents an increase of 22% of the water price and an increase of 2% of the total costs but this represents too 40% of the Net Profit such farmers can get out from its classic farm in bad year and 10% in good year. (30 and 7 % in bad and good year for farms cropping particular crops)

Tenants of vegetables farms will have two choices: pay the fees or decrease the amount of water they use (by decreasing the allocation per dunum or by decreasing the

[1] If we consider the total surface cropped in Mafraq directorate (and his repartition) and the evaluation of water consumption for each kind of farm we can estimate a mean consumption of water per dunum cropped: this one reaches 750 M3/dunums/year (For comparison, in the ASAL study they advance a average water consumption of 750 M3, in ARD study an average consumption of 715 m3/dunum).

surface cropped). If we use the new Net Profit to build an equivalent chart to the one presented in Vo.l II for the same farming system we obtain:

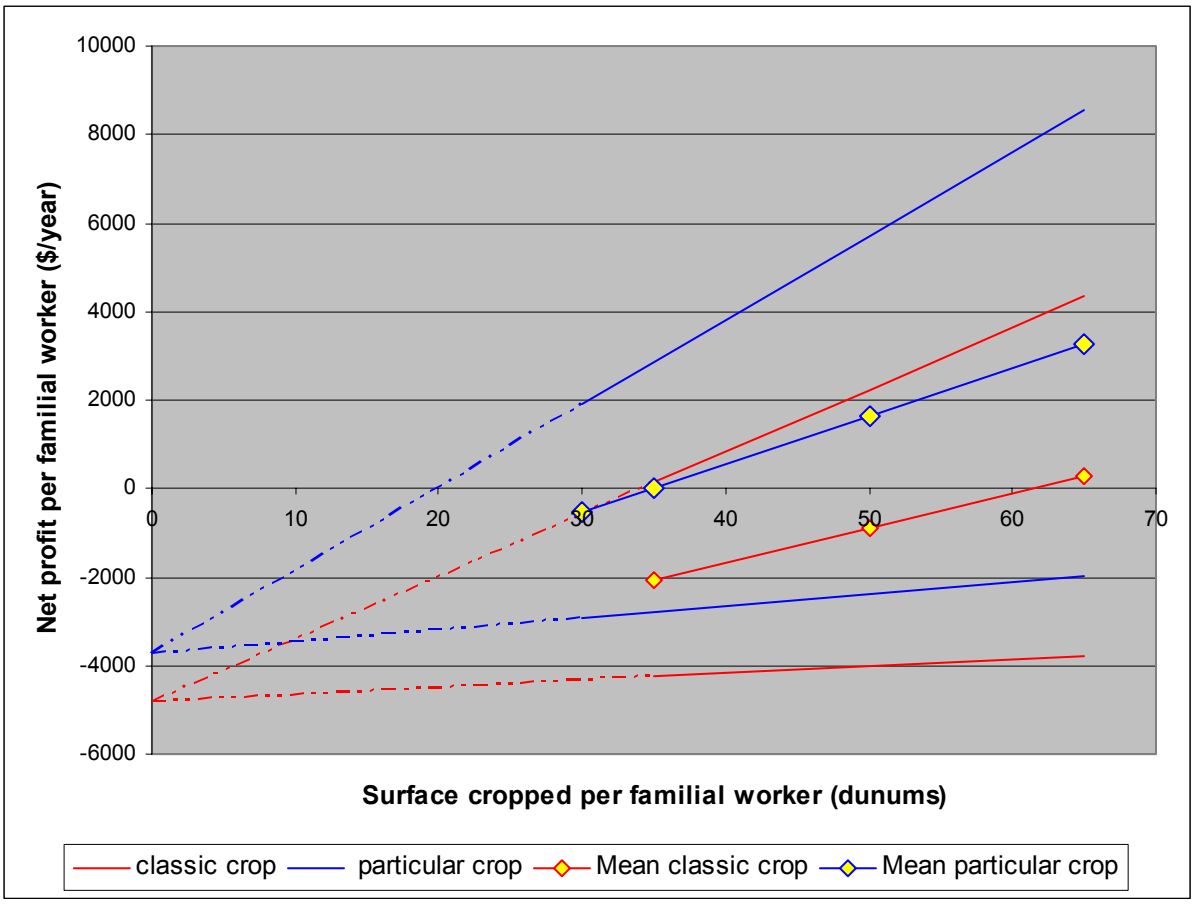

Figure 1: Net profit in function of surface cropped per familial worker after the implementation of water taxes.

Thanks to this chart, paying the fees seems to be impossible for farmers who crop a large area with classic crop (Tomato/watermelon), their farms will only be profitable for a surface cropped superior to 60 dunums per familial worker (the higher part of the range observed in the fields through the surveys). For smaller farms with particular crops, paying the fees seems to be possible even if the Net profit will decrease (farms are still profitable if a familial worker crop 35 dunums and more, such farmers could adapt themselves without changing their production system, they will have to save money on wages they pay to daily and permanent workers)

Farmers who crop a large farm will have to adapt themselves. Considering the agricultural knowledges and the capacity of investment (which is nearly nonexistent) they have and their vision of water, the evolution which can be envisaged is a decrease in surface cropped. Farmers will use the maximum of water they can afford to pay (150 000 M3) without taxes to irrigated the land they rent.

If we consider an average surface of 225 dunums for these farms (the classic farms will be the most involved in these evolution[1]), the quantity of water saved will reached 75 000 M3 per farm, one third of the water now used will be saved. If farmers keep the same way of

[1] The smaller farms with particular crops are enough rare to not to be taken into account in such scenario.

irrigation, the surface cropped will decrease by one third. If we consider that farmers will use 750 M3/du/year (mean consumption of water in Mafraq directorate) instead of 1000 m3 the surface cropped will only decrease by 11%.

2. Vegetable farm in ownership System I.2

Firstly we can give an idea of the water price for such farms, the prices of water is directly linked to the electricity/diesel used and to the maintenance and depreciation of the well. Farmers pay around 0.100 JD/m3 for the electricity, the depreciation of pump and well can be considered has a fee which reached 0.013 JD/m3. In conclusion, total costs reach 0.113 JD/m3, it is 25% lower than the fees paid by tenants.

In the eventuality the law will be implemented, farmers say they will pay the fees of water. If they keep their current use of water they will irrigate 150 dunums without any fees and will have to pay for the others 50 to 80 dunums. If we based us on an average surface or 225 dunums, they will have to pay for 75 000 cubic meters: it means an amount of 2750 JD (3875 $). The water price will increase from 0.113 JD/m3 to 0.125 JD/m3. This 10%-increase of the water price represents a 2%-increase of the total costs and:

Systems[1]	**classic**	**Classic absentee**	**alternative**	**Classic with particular crop**	**Alternative with particular crop**
On Net profit (bad year)	240	240	34	34	29
On Net profit (good year)	15	15	8	10	8
On Mean Net profit	29	29	13	15	12

Table 3: Water price increase in % of the net profit brought out per dunum in the different systems.

We can see on this table that the relative importance of the water price increase is more important for farms in ownership than for rented farms. New Net profit brought out per familial worker becomes:

[1] See Vol. 2 for a more complete description of the different systems presented here

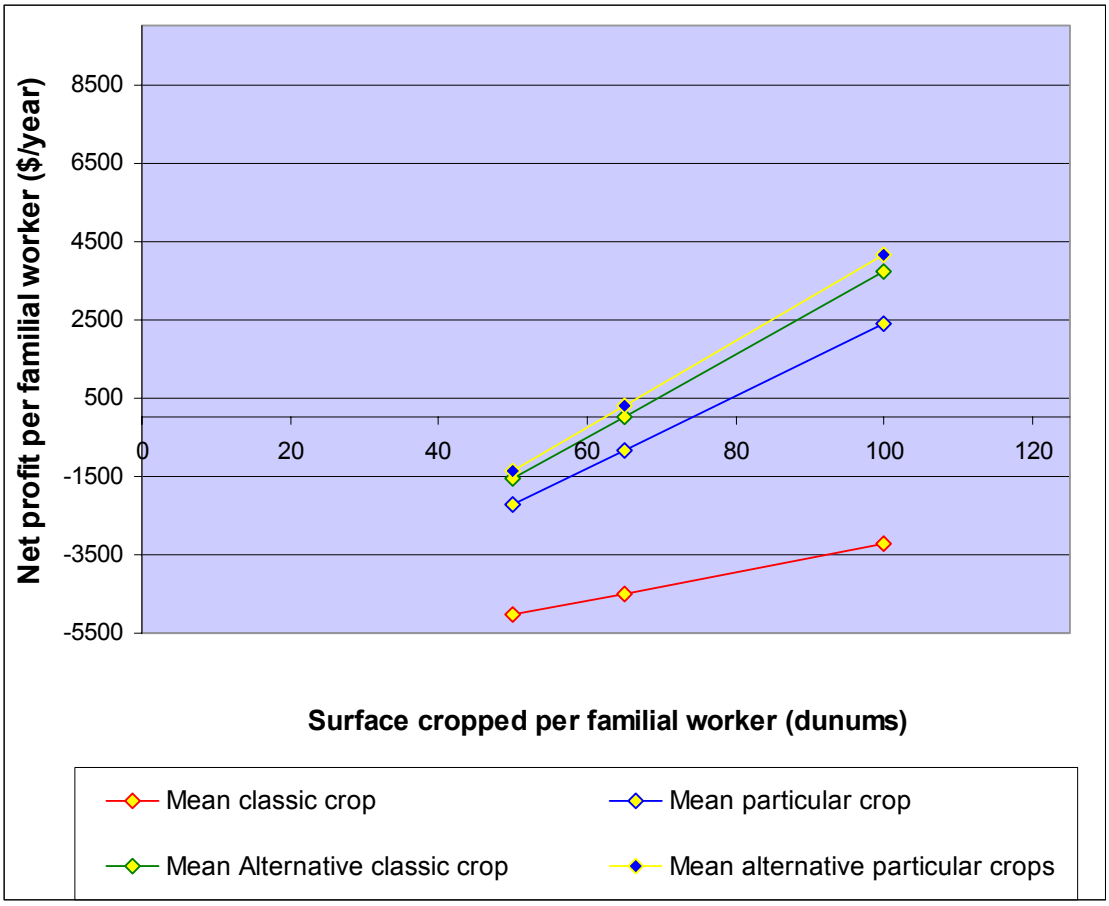

Figure 2: New profit bring out in different systems of farms in ownership after implementation of taxes on water over pumped.

We can observe two different groups of farms:

- ✓ The first one groups together the classic farms with particular crops and the alternative farms (one part of the farm is in ownership, an added plot is rented and cropped with vegetables). For this group, the Net Profit will decrease of 15% in average. These farms will be profitable if the surface cropped per familial worker is higher than 65 dunums (instead of 60 dunums with the actual water costs) this surface is still in the bottom of the range observed on the fields. In these conditions, we can suppose that owners will continue to use the same quantity of water. A possible evolution of these systems is an intensification of the farm: to counterbalance the loss of revenue linked to the water price increase, owners will save money on wages and permanent employees will work on a higher surface. Moreover, these farmers because they own the land and the well have more liberty than tenants; they can "play" on their investments and invest money during good years in order to have a profitable farm every year.

- ✓ Classic farms with classic crops constitute the second group. The Net profit will decrease of one third. Two sub classes can be identified and we will have two different kinds of behaviour.

➔Concerning the absentee owner, the way of management is very extensive (one permanent worker works on 9 to 18 dunums, and he should work on 30 dunums). We can suppose that to counterbalance the loss of revenue due to the water price increase, the owner will save money on wages that imply an intensification of the system.

➔ Concerning owners who are working on their farm the situation will be more difficult. The already precarious situation will become worse. Even if we consider a lower depreciation than in the chart presented above[1], the Net Profit will be positive only if the surface cropped per familial worker is higher than 65 dunums. Regarding to the importance of the Revenue loss, these farmers will not be able to pay the added water fees. A decrease in the quantity of water pumped and/or of the surface cropped under can be envisaged under the same conditions than the one presented for large rented farms. However, another possibility can be envisaged: these well's owners for which the agricultural activity will not be profitable anymore could rent out their wells to other farmers who will need water to ensure themselves an alternative revenue (we will see later that big fruit trees farmers will be interested in renting in a well to avoid payment of governmental fees)

Concerning the olive trees activity of owners of well and land in the area, we can note that the New Law could have some consequences. Indeed, through different surveys, we have evaluated the consumption of water of olive trees to 350 M3/du/year[2]. Such a consumption correspond to an amount of 52 500 cubic meter by year (with an average surface of 150 dunums of olives trees). If we consider this activity, the total quantity pumped from the well will reach 277 500 M3 (for 225 dunums of vegetables and 150 dunums of olive trees). The added fee corresponding will reach 5900 JD (8310 $) and 3150 JD (4440 $) will be due to the olive trees. Olive trees activity, already not profitable will become even less profitable: to the negative profit brought out (-23 $ in the better conditions), farmers will have to pay 21 JD/du of water fees[3].

3. Farms under sharecropping arrangement System I.3

The owner pays the water; the effective cost is around 0.090 JD/m3 (depreciation and energy costs). We can consider an average farm for this system; this one will be organized around 75 dunums of vegetables and 200 dunums of olive trees irrigated thanks to the same well. In this farm, the total consumption of water would be around 145 000 M3. There will be no evolution. Indeed only the larger farms will be concerned by the new law (100 dunums of vegetables and 300 dunums of olive trees), in this case, the owner will have to pay for 45 000 M3 of water, it means a total amount of 1300 JD/year.

We can think the owner will not pay for the fees. There are two different possibilities of evolution: to save water, the owner will not renew some of the sharecropping arrangments. In this case he will need to abandoned contracts on appreciatively 50 dunums. The other probable evolution is that the owner will increase his share to reimburse himself for the water fees he will pay. This situation will not be viable for the sharecropper who will see his profit declining until becoming nil (or negative). By consequence, the sharecropper will decrease his consumption of water to avoid paying the fees.

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[1] This lower depreciation corresponds to a lower level of investment and to a longer use of the material

[2] Most of the time, farmers irrigate their trees two times a week during the six months of summer between May and October : it means they put around 2 mm/day/du

[3] This idea will be developed in the following pages, in the paragraph devoted to olive trees. In that way we will compare the planned increases in production and in water prices to have an idea of the profitability of olive trees orchards during the year to come.

At Jordan scale this saving of water will be really negligible. The law will only have social impacts: this kind of system, already really rare, will disappear because it will be no more profitable.

4. Greenhouses farms System I.4

Concerning water consumption; and for an average farm of 150 dunums with 60 greenhouses, the total consumption of water reaches 180 000 M3. (It means 1250 m3/year/an) Concerning the effective water price, it reaches 0.119 JD/m3 (0.168 $) for the owner and 0.164 JD/m3 (0,231 $) for the tenant. For the tenant this decrease in price: from 0.400 JD in the neighbourhoods of Amman to 0.164 JD/m3 and from 290 JD/du to 164 JD/du (energy costs included) has been sufficient to counterbalance the loss of money due to a decrease in yield observed between the peri urban area and the eastern desert.[1]

Following the implementation of the law, farmers will have to pay an amount of 750 JD for their farm (5 JD/du; 0.004 JD/m3). Such an increase in the water price represents 3% of the Net Profit brought out in owned farms and 14% in rented farms. The most probable evolution is that farmers will pay the water fees and will continue to crop as before and they will probably save money in decrease the wages paid. The farm will become more intensive.

Concerning vegetables farms we have identified two different kinds of evolutions which can be possible in case of the new By-Law enforcement. The first one is a decrease in the water pumped and/or the surface cropped by the farmers, and second one is an intensification of the farming systems: saving on wages will counterbalance the loss of revenue do to the water price increase.

[1] This decrease in yield seems to be linked to an impoverishment of the yield due to a lower soil fertility.

Fruit trees farmers

1. Familial fruit trees farms System II.1

What is the price of water for such farmers?

Such exploitation uses 1400 m3 per dunum in average: it means around 6 mm/day/du (if we consider 240 days of irrigation). Water price corresponds to depreciation and maintenance price of the well and to energy costs. The energy costs[1] correspond to 0.057 JD/m3 and the depreciation costs correspond to 0.0010 JD/M3. The total cost is around 0.067 JD/m3.

With the new law, it means that such farmers will be able to irrigate 110 dunums without paying any tax on water pumped. If we consider an average surface of 200 dunums of fruit trees, the farm uses 280 000 cubic meter. It means that the farmers will have to pay 6050 JD (8486$) that is 30.25 JD per dunum (0.022 JD/m3). Due to the law, water price will increase of one third from 0.067 to 0.089 JD/m3 but such an increase only represents 4.5% of the Net Profit of such farmers in bad year. We can imagine that these farmers will continue without any change and will pay these fees.

On another hand, the water quality decline (and particularly the increase in salinity) can provoke some problems to certain sensible crops (for example apple). Now, in spite of the high salinity level, the consequences on trees like peach and nectarine trees seems to be limited and can be counterbalance by an adapted use of chemicals.

Concerning the farmers who are cropping vegetables as an added activity, they said us that in case of limitation of the water they will be allowed to pump, they will decrease the surface they cropped with vegetables (even stop any vegetables crop) and will pay the fees for the water they will use above the limit for their orchards.

2. Intensive fruit tree farms[2] System II.2 & II.3

In the same way that in the familial system describe above, water costs reach 0.067 JD/m3. The owner owns the well and uses 6 mm/day/du too. According to the new law and to this consumption of water, each well can irrigate 110 dunums of fruit trees. For a well which is now irrigating 300 dunums, the added cost of water will reach 16 650 JD (23 450 $) it means 55.5 JD/du/year (78 $, 0.040 JD/m3) related to a total consumption of 420 000 m3/year/farm. Price of water will increase of 2 thirds from 0.064 to 0.104 JD/m3. Such an increase represents 5 % of the net profit of such farmers. We can think that farmers will pay these fees and continue to crop as before. We will see in the following pages that the payment of these fees can take several forms.

[1] By energy, I mean electricity and diesel

[2] All prices are considered for licensed wells, these two amounts are the amounts faced by fruit trees farmers in our models.

Conclusion on Water Consideration

The new by-law of 2002 let envisaged some modifications in the agricultural landscape of the eastern desert. In case of implementation, the consequences will be diverse and will depend of the farming systems.

The most important modifications will concern vegetables farmers. Indeed we already have seen that tenant of wells will have to decrease the quantity of water they pump and the surface they cropped to keep their farms profitable. We will consider that vegetables farmers represents 44% of the surface cropped in the directorate of Mafraq[1] (it means 29 000 dunums) and that 70% of these farmers are tenants of the well they use (owners of wells who are cropping vegetables are rare[2]), the total surface considered reaches 20 000 dunums.

Considering explanations we gave (pages 6 & 7), the law will be manifested by a decrease:

- Of the surface cropped,
- Of the quantity of water pumped.

We have seen before that the quantity of water pumped in farms of this kind (large rented vegetable farms) will decrease by one third. If we consider that farmers will use the same amount of water per dunum they use now, the surface cropped will decrease by one third. If the decrease their water consumption by one quarter (to reach 750 m3/du/year, mean consumption in Mafraq area) the surface cropped will only decrease by 11%. The production of vegetables in the highlands will know the same decrease.

The surface concerned by saving water would be about 20 000 dunums and the quantity of water saved would reach 6.6 Mcm (each dunum consume now 1000 m3 of water per year and one third will be saved).

6600 dunums of vegetables will not be cropped anymore if the use of water is the same (1000 m3/du/year) and only 2000 dunums will disappear if the water consumption decrease to reach 750 m3/du/year.

For the other vegetables farmers who are owners of their land/well, we have seen that they can afford to pay the new water fees and continue to crop with the same system on the same area and with the same consumption of water. However, due to inter-relation between farmers of the area, we will see that this system can evolve in another way.

Lastly, the small water-sharecropper will probably disappear because their farming will not be profitable anymore. The farmer will only work to support one's family. Sharecropping farming seems to be really limited in the Eastern Desert to small plots located around small cities, in this way; the surface and the water considered by this evolution are really negligible.

[1] Data from James.B Fitch

[2] Owners of well mostly have invested high amounts in high value crops, more profitable than vegetables, as fruit trees plantation

Following the law (and his implementation), the relations which can be created between owners of their land/well who crop vegetables and the farmers who have fruit trees farms are very interesting. Indeed the last ones have an important consumption of water. As it is mentioned above, they won't probably change their way of cropping and will pay the water fees (no water saving will be done in fruit trees farms[1], that is due to the weak importance of this new water fees in comparison with the Net profit brought out in the big fruit trees farms). However, several way of payment can be envisaged.

- The first one is to pay the fees directly to the government.
- The second one is to rent an additional well to an owner who doesn't want to crop anymore. (a well's owner who crops vegetables could be in this situation as we will see it after)

Actually, according to some discussion with big fruit trees farmers, the pressure on wells will increase in the area. Actually, to avoid the payment of the added water fees, it is possible that these big farmers would try to rent new wells to decrease the quantity of water they pump from their well. In that way, some small farmers which are owner of well and who are cropping vegetables (see the system described above Vol. II) could stop their agricultural activity to rent their well to larger farmers.

Could we expect a generalization of this behaviour? We can see two main reasons to think the contrary.

✓ Firstly the prices of well renting are now really high (we have seen above that, renting a well corresponds to pay each cubing meter at 0.060 JD (0.085 $/m3). This price is higher than the fee envisaged by the government (See tables 1 & 2) which corresponds to 0.022 JD and 0.040 JD respectively for a consumption of 280 000 and 420 000 m3[2]. Big fruit trees farmers will not be interested in such fees.

✓ On another hand we have to point the revenue of farmers who could rent out a well instead of have an agricultural activity. Thanks to the farm model build we can compare the Net Profit such farmers have now and the profit they will do by renting out their well. The following figure is a representation of such comparison.

[1] The only water which will be saved, will be the water used to irrigate the vegetables considered as a secondary crop in the familial fruit trees farms. The amount of water and the surface considered are really negligible.

[2] Cases considered and described above for the two kind of fruit trees farms (familial and Non familial fruit trees farms)

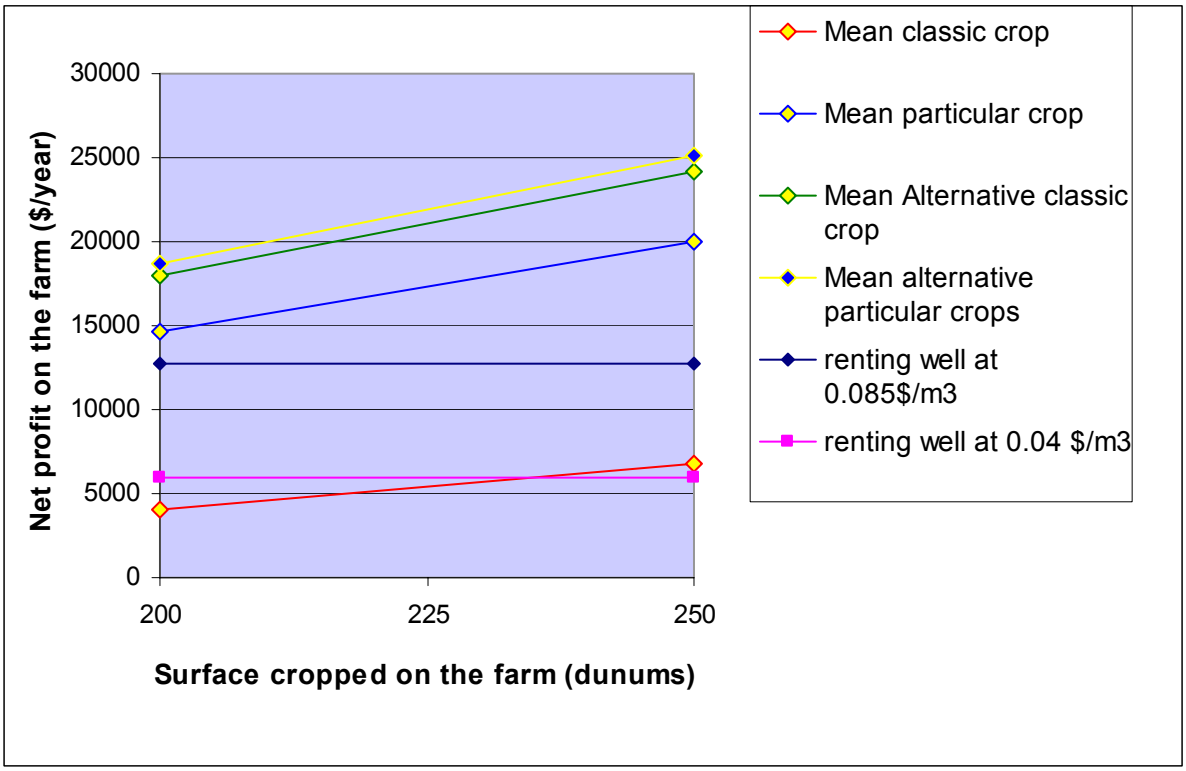


Figure 3: Net Profit for large farms in ownership and for renting out a well.

We can see on this chart that most of the farms permit to bring out a Net Profit higher (from 14150 to 25150 $/farm depending on the way of cropping) than the Net profit which could be brought out by renting a well at a fee which will correspond to 0.085 $/m3 (actual renting costs) and which only reach 12 750 $[1]. In these conditions owners of the vegetables farms will not be interested in renting out their wells instead of have an agricultural activity.

The only owner which could be interested is the owner of the classic farm which brought out a Net profit included between 4 050 and 6 800 $/year. But, as we have said that before, big trees farmers will not be interested in such fees (the governmental fees are cheaper). Indeed, regarding the fees implemented by the new "by law", the owner of a well can only rent a well for an amount which will correspond to a fee of 0.030 JD/m3 (0.04 $). This amount seems to be enough profitable (6 000$) for these owners who crop the same plot year after year.

In conclusion we can say that, the renting of new wells, now own by vegetables croppers will stay really limited. Only one group of owners (who earns little money with their agricultural activity) will find one interest to leave their activity and to become a well's renter-out.
The fruit trees farmers mostly interested in this scheme are owners of big intensive fruit trees farms.

[1] For a consumption of 150 000 m3

Thanks to this "by-law of 2002", the idea of a taxation of water (over)-pumped has been accepted by all the actors of the agricultural sector. Due to the traditional vision of water and to the fact that the government has to deal with private water-investors in the area, this first step open the way to deeper evolutions. We have seen that, in case of law implementation, most of the farmers could afford to pay the fees without changing their way of cropping. Only one group of farmers will be actually concerned by a decrease of the surface cropped and of the water pumped: saving of water will be realized inside this social group of farms (large rented vegetables farms). To amplify and generalize the consequences of the law as regards to the water saving (one of the most important concern if Jordan wants to reach a more sustainable water management) the water-fees have to be raised up and the upper limit of pumping has to be reduced to a lower amount. An enforcement of the old abstraction limit will also have deeper consequences on the agriculture in the eastern deserts.

The by law, if it is ratified by the parliament and enforced (installation of water meter, teams to read it, legal actions against people who infringe the law), let the way open to such modifications.

Vegetable Farms Systems III.1 &III.2

In the Area, (downstream of the Zarqa River) irrigation is done from April to November thanks to wells or spring located on the River banks.

➔ Tenant of wells (or springs) System III.2 use their source of water at its maximum of capacity. In most of the case the amount pumped is included between 50 000 and 100 000 cubic meters depending only on the capacity of the well[1] (the surface cropped and the quantity of water pumped aren't linked anyway)

If we consider an average farm of 18 dunums, the water allocation per dunum is included between 2500 and 5500 m3 each year (mean at 4000 m3/year/du)[2]. Such amount can be explained by two main facts:

- The water availability associated with low pumping costs[3].
- The low efficiency of surface irrigation, generally evaluated at 40 to 50%, while drip irrigation can have an efficiency of 80 to 90%. If we consider an efficiency of 50% the amount used by the plant is still high (around 2000 m3/year/du) and can partly explain the high yields observed in the Area.

Finally, regarding the quantity of water pumped, the new "by-law" won't have any consequences on the use of water of tenants of wells in the area (they pump less water than the limit mentioned in the by-law)

➔Concerning sharecroppers System III.1, the situation is quite different. Firstly, the water allocation is almost the same at 4000 m3/year/du in average but, as several sharecroppers use the same well, the quantity of water pumped per well is higher (25 to 50 dunums are irrigated thanks to one well) . It that way, we have estimated that the water pumped per well is included between 100 000 M3 and 200 000 m3/year.

The biggest owners will have to save water if they don't want to pay some water fees for an amount of 1250 JD/year (25 JD/du/year)[4].These 25 JD/du represent between 12 and 17% of the sharecropper Net Profit and between 10 and 14% of the owner Net Profit in function of years. Two possibilities can be envisaged:

[1] We don't have any precision on the legality of the wells

[2] This range is quite large but due to the little number of surveys we have done, we didn't manage to have a better evaluation. That's also due to the fact that for cultural reasons, the surface cropped doesn't play any role on the quantity of water pumped

[3] Wells aren't deep, electricity costs are around 40 JD/du , an amount which has to be compared with the 100 JD spent in Mafraq Area

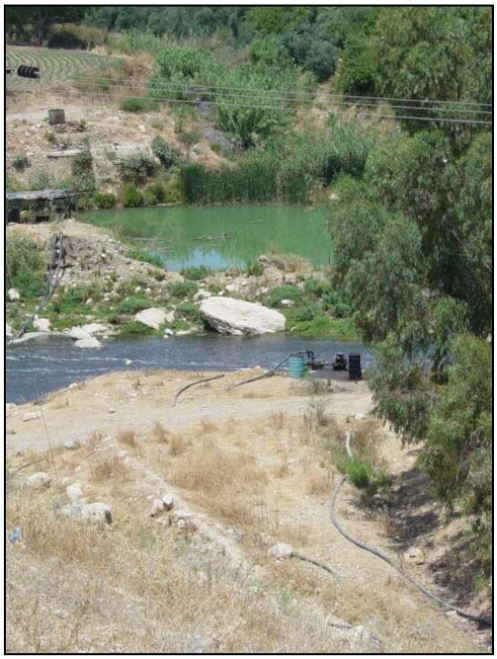
[4] Through our surveys, it seems that the situation in which a well (used by sharecroppers) permits to pump around 200 000 M3 is the more frequent

- The new cost will be paid and either shared between the owner and sharecropper (as all the other costs) or paid only by the sharecropper who is effectively using the water. One way or another, the revenue brought out by these farms will decrease and no water will be saved.

- The farmer will decrease his consumption of water to avoid the fees payment. Such behaviour will probably imply a fall in yields. One solution for farmers to avoid such fall could be to switch to drip irrigation (behaviour recently follows by some farmers in the area). Actually, use of drip irrigation will imply an improvement in irrigation efficiency (from 50% to 80% at least). In that way, to bring the same amount of water (2000 m3/year/du) to crops, only 2500 m3 will be needed (instead of 4000 m3). The quantity pumped will only reach 125 000 M3 and no fees will be paid.

The investment needed to realize such transformation has been evaluated at 150 JD per dunum (it means a yearly operational cost of around 34 JD/du/year)[1], this amount correspond to the Net Profit brought per dunum in bad year in the sharecropper system and has to be compared to the 25 JD/du/year of "new water fees". The switching to drip irrigation seems to be more expensive that the water fees payment but by using such a technique you increase the efficiency of fertilization thanks to the use of the fertigation system and you decrease the labour needed for irrigation. It implies some savings: for examples and according to some farmers fertilizers costs can be decreased by one third, it means a saving of 50 JD/du/year, considering wages savings are more difficult to evaluate because the work is done by familial workers in the system we describe here. But in conclusion and on long term switching to drip irrigation seems to be profitable[2].

➔ Concerning the absentee tenants who crop fodder upper stream of the River (System III.3), the water they use comes directly from the River and is mixed with treated waste water, so they won't be concerning by the restriction in water consumption.



Picture 1: Direct pumping upstream of the Zarqa river Basin

[1] 35 JD/du for small pipes (used during 3 years), 90 JD/du for big pipes and valves, 20 JD/du for filters, 5 JD/du for the mixer (all this material is used during 5 years).

[2] The problem can be the relative high amount to invest in first year (equivalent to the revenue of one dunum, it means between 10 and 15% of the revenue brought out per familial worker)

Fruit Tree Farms System III.4

Farms often use two shallows wells (or springs) located along the River banks. The amount bring by the farmers is around 6 mm/day/du, it means on 200 days of irrigation a global amount of 1200 M3/du/year. If we consider an average surface of 175 dunums, the total consumption of water will reach 210 000 m3. In case of the farmer use two wells (or springs) he will not be concerned by the limitation of abstraction. Indeed he pumps 105 000 m3 per well and the limit is at 150 000 M3.

If the farmer has only one spring/well, he will have to pay an amount of 1850 JD/year, it means an amount of 11 JD/du/year (15.5 $). The lowest revenue, such farms can bring out is around 1135 $/du/year, the added water taxes only represents 1% of this revenues. We can suppose farmers will pay these fees.

NB: Farmers using springs aren't concerned by the new by law of 2002. They can use the water they want without any regulation and will not change their way of cropping. Such farmers using springs are in most of the cases, small tenants cropping vegetables. Big farms of fruit trees are frequently irrigated thanks to shallow wells (appreciatively 30-35 meters deep).

Water consideration, evolutions and strategies envisaged in periurban area

Introduction

This area is an exception inside the Basin. That is the only area in the Highlands in which farmers buy water. In the other Areas, farmers rent a well. Admittedly, the fees correspond to a quantity of water pumped but only indirectly (the fees depends more on the well capacity than of the volume pumped). Near Amman, **the water is charged per cubic meter.** Fees for water are very variable and the cubic meter can be charge between 0.300 JD and 0.500 JD[1]. The amount of the fees depends on the owner wish and is directly linked to the Municipal price of water; this one is sale thanks to tanker at 0.500 JD/m3 but **this high price of "agricultural water" doesn't preclude yet the growing of Tomato, Zucchini, Cucumber**

Regarding to this water supply, farmers (in most of the case they are tenants) said us that they have some problems with their farm management because they depend on another person and they can not do what they want (and above all WHEN) in regard to their crop irrigation. That can have some bad consequences on the crop quality and on the revenue they can bring out from their farms. These difficult conditions of farming and the high price of water explain the migration movement we record in the JRBJ.

Due to a high water price, and in comparison to other regions of the highlands, the water allocation isn't high in Amman's area of influence. This one is close to 500 M3/du/year (it means 2mm/day/du for 8 month of irrigation, that is the same amount than in the valley, a low quantity compared to the other parts of the basin located in the Highlands)

In that way, and because the use a low quantity of water farmers will NOT BE DIRECTLY concerned by the new regulation. However due to the "water market" in the area, indirect consequences could be recorded. Most of the time, owners of wells have a double use of their wells: they sell half of the water pumped for an agricultural use and the other half for a municipal use. If they are above the 150 000 M3 limit, they will "transfer" the added water fees to users (municipal one or farmers…).

Agricultural sector

We can suppose that with the implementation of the new By-Law, water prices will increase but an evaluation of such increase and of its consequences is difficult to realize. Each owner manages his well as he wants, pump the quantity of water he wants and sells it to who he wants. In that way, defining a global evolution, or even an average scenario, seems difficult. Concerning the agricultural sector, we will consider two cases:

➔The owner increases the water price of 0.025 JD/m3. It means an increase of 6.25% of the water price.

➔ The owner increases the water price of 0.060 JD/m3[2]. It means an increase of 15 % of the water price.

[1] We will take an average of 0.4 JD/m3

[2] These two prices corresponds to the fees considered by the government in the New By law, for le gal wells and different levels of overpumping.

Tenant of land who buys water and sharecropper will be concerned by such an increase. For tenant such increase corresponds to 100 % of the Net Profit in bad year and 6 % in good year. For sharecroppers, this increase corresponds to 27% // 15% of the Net Profit brought out in bad //good year.

To conclude on agriculture, an increase of price will imply a decrease of the agricultural profitability in the Amman's Area of Influence. The phenomenon of migration already recorded will go faster and some farmers will lead to stop their activity because of a too bad profitability. We can suppose that the production of vegetables in the neighbourhoods of Amman will decrease a lot.

Links between different sectors

In the Amman's area of influence different water considerations are linked. We are in an area in which agricultural and municipal use of water are in competition. Due to these links an identification of the future evolutions is hard to do. However we can present some sketch of ideas.

- ✓ The urban pressure will continue to increase, due to this evolution and to the new by law, water prices will increase. The agricultural sector will be the first to suffer the consequences of this increase of prices. We can suppose that the agricultural water use will decline in the area: this will be due to farmers' migration or retirement linked to a farm profitability decline.

- ✓ Related to the urban pressure increase and to the raise of population's water needs, we can think that the municipal water use will rise. Owner of wells will sell water for a municipal use

- ✓ However, concerning municipal water use, two way of supply are in competition: the public one and the private one, trough wells located in the Amman's neighbourhoods. In the last few years, and thanks to taxes implementation, private supply has begun to be limited by the government to avoid a competition with the water supply public service of Amman. Thanks to these taxes, the "private-water price" and "the public-water price" are now comparable and there isn't a big advantage to be supply by private actors. In that way the importance of private supplying decreased in the last few years. A balance between private and public water supply will be found thanks to different policies and taxes implementation in function of aims follow by the government.

Water consideration, evolutions and strategies envisaged in the upper Yarmouk area

Open field farmers

These farmers pay for the use of a well. The fees are charged per cubic meter and the charge reaches 0.25 JD/m3 (0.35 $). In average and according to the farmers, the allocation of water reaches 600 M3/du/year (2.5 mm/day/du on 240 days of irrigation). As it is the case in some other regions in the basin, several farmers use the same well and they alternatively pump water. In that way, 4 to 6 farmers use the same well for a total surface cropped which is included between 300 to 500 dunums.

According to the actual allocation of water per dunum, the total quantity pumped is included between 180 000 and 300 000 M3. The farmers using the well will be concerned by the new law if the limits are truly implemented. The total amount which will have to be paid will be included between 750 to 7250 JD. It means an amount of 2.5 JD/du to 14.5 JD/du. This amount only represents between 3 and 6% of the Net Profit of such farmers. The most probable thing is that they will pay the fees and continue the way they crop without decreasing the water they use (which isn't so high if we compare it to the consumption in other parts of the Basin)

Greenhouses farmers

These farmers spend 400 JD per dunum and per year for the water they use, the average price of water is around 300 Fils/m3 in the area. In these conditions we can assume that the average consumption of water is around 1300 M3/dunum (4.5 mm/day/du for an irrigation period of 10 months). As these farms are developed around greenhouses it means 865 m3/greenhouses (5.8 mm/day/du effectively cropped). On average there are 4 to 5 farmers who are using the same well. However the surface cropped depends on the agreements existing between the farmer and the owner of the well.

➔If farmers are independent tenant, the surface irrigated by well is included between 150 and 200 dunums. The quantity pumped is included between 200 and 260 000 m3. The total amount of added water costs will reach 1250 to 4850 JD. Such amount represents between 8 and 24 JD/du/year. We can suppose that the owner of the well will increase the well rent (to pay these new taxes): the tenant will pay an added cost of water. This one represents between 4 and 11% of the Net profit of the farm in good year, but in bad year it represents 28 to 85% of the Net profit. Therefore, the tenant will decrease his total consumption of water. Two possibilities can be envisaged: a decrease in the surface cropped or a decrease of the water allocated per dunum.

➔If farmers are sharecroppers of an owner, the surface cropped thanks to one well is included between 80 and 120 dunums. According to the water allocation, and to the surface cropped, 105 000 to 155 000 m3 are pumped. This amount flirt with the limit of 150 000 M3 and the most probable evolution is a status quo: farmers will not change their way of cropping.

In the "transition area"

Through our surveys, we have estimated the consumption of water at 1000 m3/dunum/year it means on 8 months of cropping an allocation of 4 mm/day/du (twice more than the governmental allocation on the Jordan valley).

Concerning the surface irrigated thanks to a well, there are two different cases:

➔ The well is used by one farmer only; the surface cropped is around 150 to 200 dunums. Regarding the consumption of water and in the worse case, the farmer will have to pay 1250 JD/year (it means an amount of 6.25 JD/du). This amount represents 4% of the net Profit in good year and 33% in bad year.

➔The well is used by several farmers; the surface cropped is usually included between 200 (2 farms) and 300 dunums (3 farms): the farmers are in fact "tenant-partners".They will have to pay between 1250 JD/year and 7250 JD/year. It means for each farmer 6.25 JD/du if they are two on the same well and 24 JD/du if they are three pumping in the same well.

In comparison to the Net profit of such farms, this amount isn't negligible. We can suppose that farmers will decrease their consumption of water to avoid the payment of such fees. Like in the other cases, two way of water saving are possible: a decrease in the surface cropped and a decrease of the water allocation per dunum.

Water consideration, evolutions and strategies envisaged in the uplands

In the hilly region, farms are irrigated thanks to natural springs, therefore farmers aren't concerned by the new regulation which aimed to limit the water use in agriculture. The farmers will continue to crop as they always did.

Vegetable Farms

All the farms are irrigated thanks to natural springs. In most of the cases, several farmers use the same spring, they have their own pump and their own irrigation system. The delivery of water is regulated thanks to agreements between the farmers using the same spring. In that way, each farmer has the right to use his pumping system "X" day per week. This number of day depends essentially on the number of farmers. In most of the cases there are 4 to 6 farmers for an irrigated surface included between 150 and 250 dunums depending on the capacity of the spring used.

Concerning the water use of these farmers, we evaluated it at 1000 M3/du/year (it means 3 mm/day/du for 300 days of irrigation). With such consumption, the water quantity pumped per spring is included between 150 000 and 250 000 cubic meters a year.

Mixed Farms

We don't have any evaluation of the water consumption of such farms. However, as we said before and because the farm is irrigated thanks to a natural spring, the law won't have any consequences of the farmer's way of cropping and that will be true whatever the consumption of water is.

Water consideration, evolutions and strategies envisaged in the south of the Jordan Valley

Bananas farmers

1. Owner of wells

As we said it before, all the owners of large intensive banana farms and some small owners have their own well (legal or illegal, in general there are two wells on the farm) they use to irrigate their farm with brackish water.

According to our talks with farmers, the necessary investment to dig a well reaches appreciatively 10 000 JD per well[1]. Large investors farmers have also invested in a desalinization plant to clean their water (such investment costs around 60 000 JD for the volume of water they treat but prices are really variable in function of the capacity of the station[2] and of the water salinity)

Another point can be underlined: wells are often far from the farm. Indeed farms are located in the valley and wells are closer to the mountains because the saline rises from the highlands are higher in the valley than at the foot of the mountains. In that way, water from wells located near the mountains is more suitable for banana crops than water pumped from wells located in the plain. The location of the well used for irrigation is important because bananas are sensitive to the water quality and too saline water will imply decrease in the yield.

The use of water

Bananas farmers use all the water they receive[3] from Wadi and Dams according to their irrigated farm surface on one plot of bananas which generally correspond only to 1/10 to 1/5 of the farm surface. In that way, they put 10 to 20 mm/day/du on their bananas. It means for 9 months of irrigation a consumption of water of 2700 to 5400 M3/year/du of Bananas (in the following calculations, we will use an average of 4050 M3/du/year).

Capital intensive Banana farm

100 dunums planted with bananas and 225 with vegetables.

The total water use reaches 300 000 M3 for bananas (270 000 are pumped from wells, 30 000 are received from public facilities) and 170 000 M3 for vegetables.

- ✓ If wells are legal, the owner will have to pay an added amount corresponding to 140 000 m3. It means on two wells a total amount of 4900 JD. Regarding to the total amount pumped for bananas (below 150 000 M3/well), we can assimilate that the over pumping water is due to the vegetables. Thus, the added cost of water reaches 22 JD/du of vegetables, it represents 18 and 33% of the Net profit brought out by this activity. The farmer will certainly pay all the added taxes without changing his water use.

[1] A lot of wells have been dug in 1997 in the area. Farmers said us that the government allowed such practice that year and only that year. Statistics from the department of statistics didn't record any increase in the surface cropped with banana trees in the south of the valley: this surface stays constant appreciatively at 10 000 dunums.
[2] This one is defined as the volume of water the station can treat in one hour.
[3] Water supplied by the JVA.

- ✓ If wells are illegal, farmers will have to pay a total amount of 7100 JD for the water use by bananas and 7200 JD for the water use by vegetables. The total amount paid will reach 14 300 JD. This amount corresponds to 95 JD/du of bananas and to 32 JD/du of vegetables. A decrease of 4.5 to 6 % of the Net profit brought out by bananas (in good/bad year), and of 30 to 50 % brought out by vegetables (in good/bad year) is expected but the farmer will continue to crop this way without any saving of water.

Intensive familial banana farms

100 dunums planted with bananas and 50 dunums with vegetables.

The total water use reaches 600 000 M3 for bananas (540 000 are pumped from wells, 60 000 receive from public facilities) and 37 500 M3 for vegetables.

- ✓ If wells are legal, the farmer will have to pay 4900 JD (water use for bananas) and 2250 (water use for vegetables). For bananas only, this amount corresponds to 33 JD/du, it means only 1 to 2% of the Net profit brought out by this activity in good/bad year… the farmer will therefore pay this new tax. For vegetables it represent 45 JD/du, it represent 40 % of the Net profit brought out by the activity in good year and 100% in bad year. The farmer will also continue to crop without changing his water use.

- ✓ If wells are illegal, farmers will have to pay a total amount of 16 400 JD for the water use by bananas and 2 600 JD for the water use by vegetables. The total amount paid will reach 19 000 JD. For bananas it means an amount of 110 JD/du of bananas and 52 JD/du of vegetables. The Net profit of bananas is expected to decrease of 5 to 7 % in good/bad year. Concerning vegetables, the added costs of water represent 60% of the mean profit brought out.

In conclusion, we can say that, in all the cases, farmers who are owners of wells (legal or illegal), will pay the water taxes without changing in anyway their way of cropping and their water use. The profitability of the banana activity will decline of 7% maximum. For the vegetables activity, the decrease will be much higher (up to 65% of the mean Net Profit) but as it is a "secondary revenue" for the bananas farmers, this activity whatever the revenue is much profitable than letting the soil with no crop.

Small familial banana farm

The mean surface of the farm is close to 45 dunums with 37.5 dunums of irrigated banana trees. The quantity of water pumped reaches 150 000 cubic meter a year.

>>> If wells are legal, the farmer will not be concerned by the By Law,

>>> If wells are illegal, the farmer will have to pay 4000 JD (one well) or 3750 JD (two wells). It means 100 JD/du of bananas, an amount which corresponds to 7% of the Net profit in good year and 11% in bad year.

We can suppose that whatever the case, farmer will pay the taxes without changing his way of cropping and his water use.

2. Farmers who purchase water

Thanks to the few surveys we have done in the area, we evaluated that the water is charge between 150 and 200 Fils/m3 according to the user of the water and to the owner of the well. However most of the time the water isn't charge per cubic meter but per hour and the owner undertakes to assure a certain constant water flow (most frequently at 9l/s)

Farmers have the same consumption than above: JVA supplies the farmer with one tenth of the water he uses and the farmer buys the other 9 tenth. In these farms the total consumption of water is included (on average) between 100 000 m3 (for 25 dunums) and 200 000 m3 (for 50 dunums). Farmers buy between 90 000 and 180 000 m3 from a well. All the farms which have a surface cropped larger than 41 dunums buy more than 150 000 cubic meter (this amount correspond to the limit mentioned in the New By-Law). We can suppose that, the added fees of water which should be paid by the owner of the well will be directly transmitted to the users of the water. Farmers will be the one who will really pay the fees. In that way, the owner of the well will increase the water price to take into account these new taxes. We will describe here one financial evaluation of the consequences of the new law on the familial bananas farm:

Let present some initial hypothesis:

➔The quantity of the water pumped from the well and used by the farmer reach 200 000 cubic meters a year (50 dunums).

➔The increase of price implemented by the owner corresponds to the total amount he pays divided by the total quantity of water pumped from his well.

- ✓ If the well is legal, the price's increase will reach 6 Fils/m3 (0.09 $), the total price of water will reach 0.181 JD/m3, and 22 JD/du. This increase in prices corresponds to 3% of the actual water costs, 2% of the total costs[1] and 6% of the Net profit in bad year (2% in good year). We can suppose that the farmer will pay the fees. Indeed decreasing the quantity of water will imply a yield's decrease and the loss in Net Profit could be higher than the added costs of water.

- ✓ If the well is illegal, the price's increase will reach 30 Fils/m3 (0.4 $), the total price of water will reach 0.205 JD/m3 and 110 JD/du. This increase in prices correspond to 17% of the actual water costs, 9% of the total costs and 30% of the net profit in bad year (11% in good year). If the farmer wants to pay the same water costs, he will need to use only 3100 M3/year/du. A Big decrease in yield will happen and will also imply loss or earnings in the Net profit. This loss or earnings will maybe be higher than the added water costs[2].

[1] Water costs represent for these farmers 55% of the total costs

[2] For comparison, in a familial farm, Laurence Alias speaks about an average Yield of 3 Tons/du in the south of the valley for bananas trees under drip irrigation and which receive 3000 M3/year/du. If we Consider this yield, the Gross Output will only reach 2190 JD/du, in comparison to our models, that corresponds to a minimum loss or earnings of 215 JD/du (twice more than the added water costs, the farmer would have to pay) In these

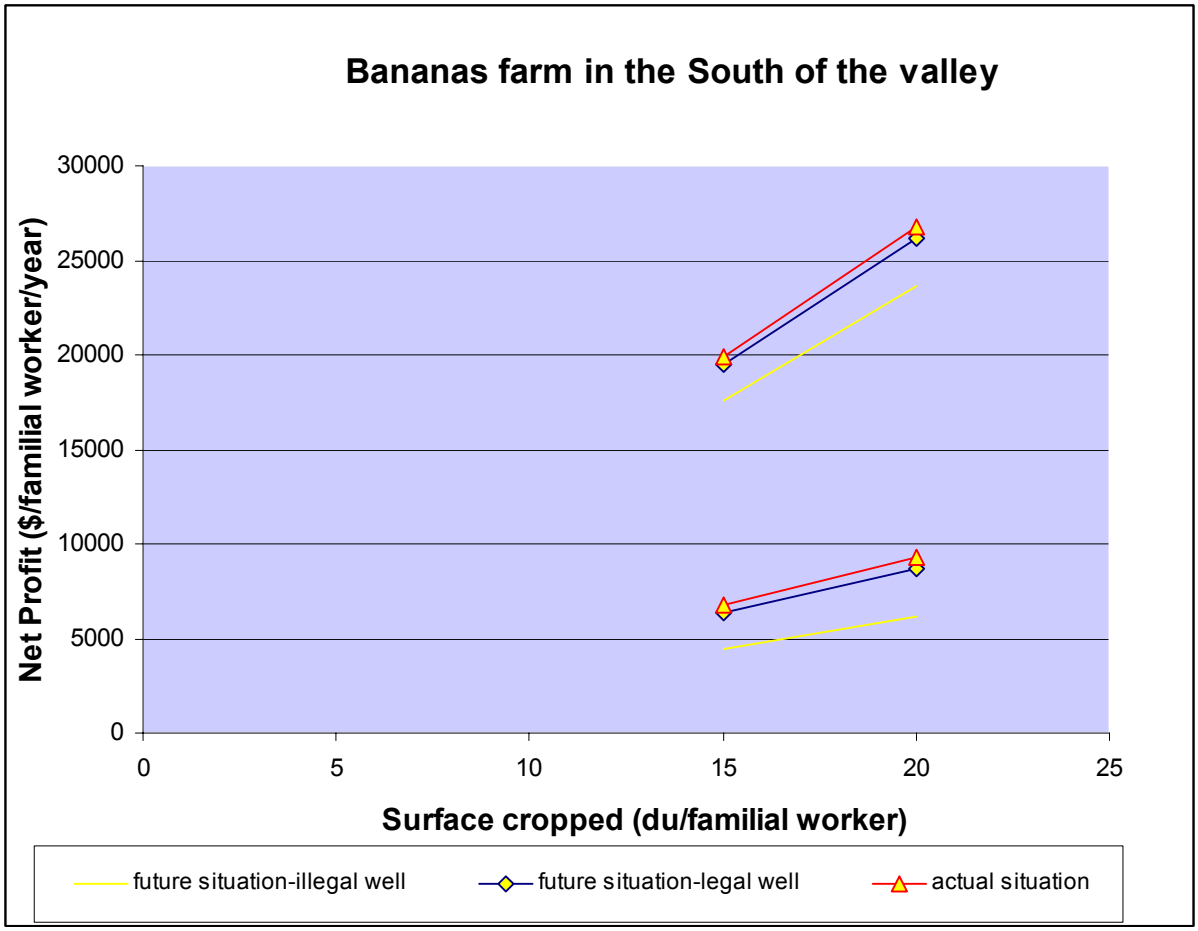


Figure 4: Evolution of the Net Profit for extensive farmers who purchase water in case of law implementation

3. Future of the Bananas production in Jordan

Banana is one of the crops which will be subjected to the new market conditions linked to the entry of Jordan in the WTO in 2005. In that way, bananas now protected by customs tariffs will be in competition with bananas product in Asia and in South America. According to *Salameh Alias,* the importation quota will have to disappear in 2005 (entry in the WTO) and actual taxes on importation (30% of the value imported and a fixed tariff of 200 JD/T) will have to be decrease of 25% on a ten years period from 2005.

The competitiveness of Jordanian Bananas will suffer from these new conditions and the farm gate price paid to the farmer is expected to decrease to be in line with the world market.

More information (what is the quota? comparison between the price of local and foreign production…) are needed to know with precision what will be the consequences of the Jordanian market opening on the bananas production, on the water use but we did not have the time to realize such a study…

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conditions we can suppose that the farmer will pay the added cost of water and continue to crop as he was doing before to maintain an important yield on his farm.

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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.