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International Water Management Institute (IWMI)

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 V: Bibliography and appendixes

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Appendix I: LANDSCAPE WHICH CAN BE OBSERVED IN THE DIFFERENT ZONES WE HAVE DEFINED[1]

JORDAN VALLEY

Northern Valley or North Shunah

Picture 1: The extreme north of the valley

Picture 2: Citrus orchard in the extreme north of the valley

[1] All the picture have been taken by Venot between April and July 2003 unless otherwise stated

Picture 3 & 4: Zone of open fied in Kreymeh and Wadi Ryan Area Area (southern part of the North of the Jordan Valley)

Middle valley or Middle Shunah

Picture 5: The greenhouses area in the northern part of the Middle of the Valley (Deir Alla Area) February 2003, *Source*: J.Guillaud

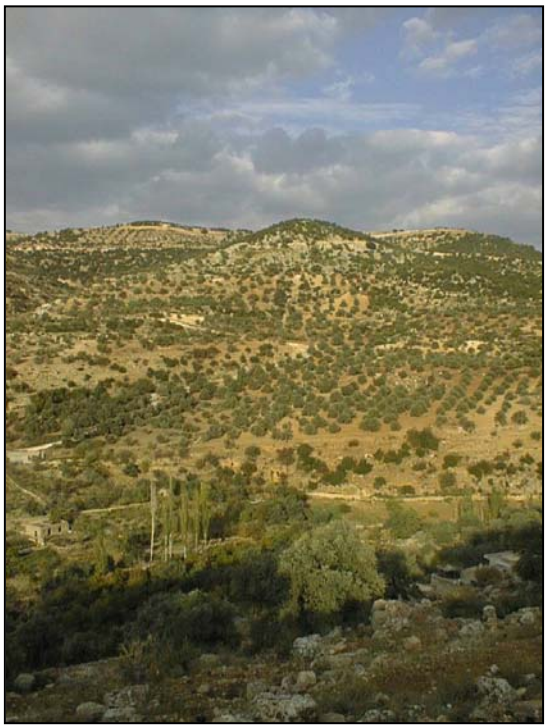
Picture 6: Dry area in the southern part of the Middle of the valley (Karamah Area)

Southern Valley or South Shunah

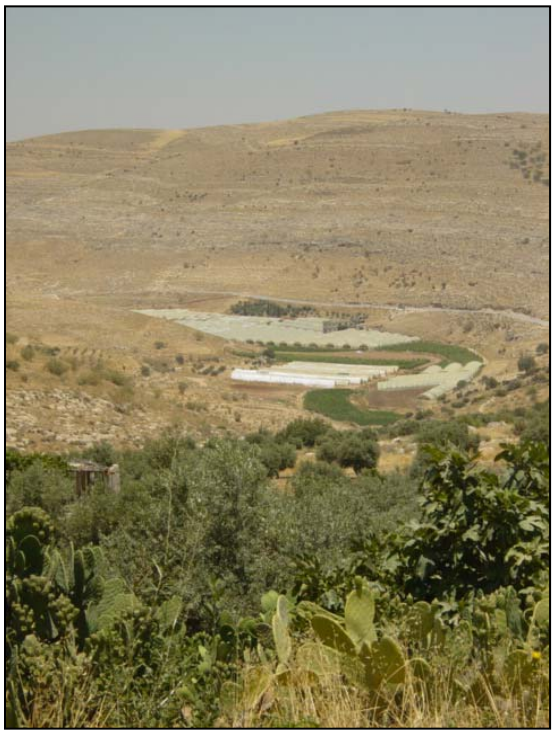
Picture 7: “banana line” in the South of the Jordan Valley

RAINFED UPLANDS

Picture 8: General landscape in the uplands



Picture 9: Hilly rain fed landscape in the Ajloun Neighbouring
Source: R.Courcier



Picture 10: Vegetable farm at the bottom of a small valley

Picture 11: Rain fed olive trees
Source: Remy Courcier

Picture 12: Rain fed vegetables in Salt's neighbouring

PERIURBAN AREA

Picture 13: greenhouses in Al Baqaa Area in the Amman area of Influence

Picture 14: Open field farm near Amman
Source: J.Guillaud

ZARQA AREA

Picture 15: vegetable farm on the Zarqa river Bank

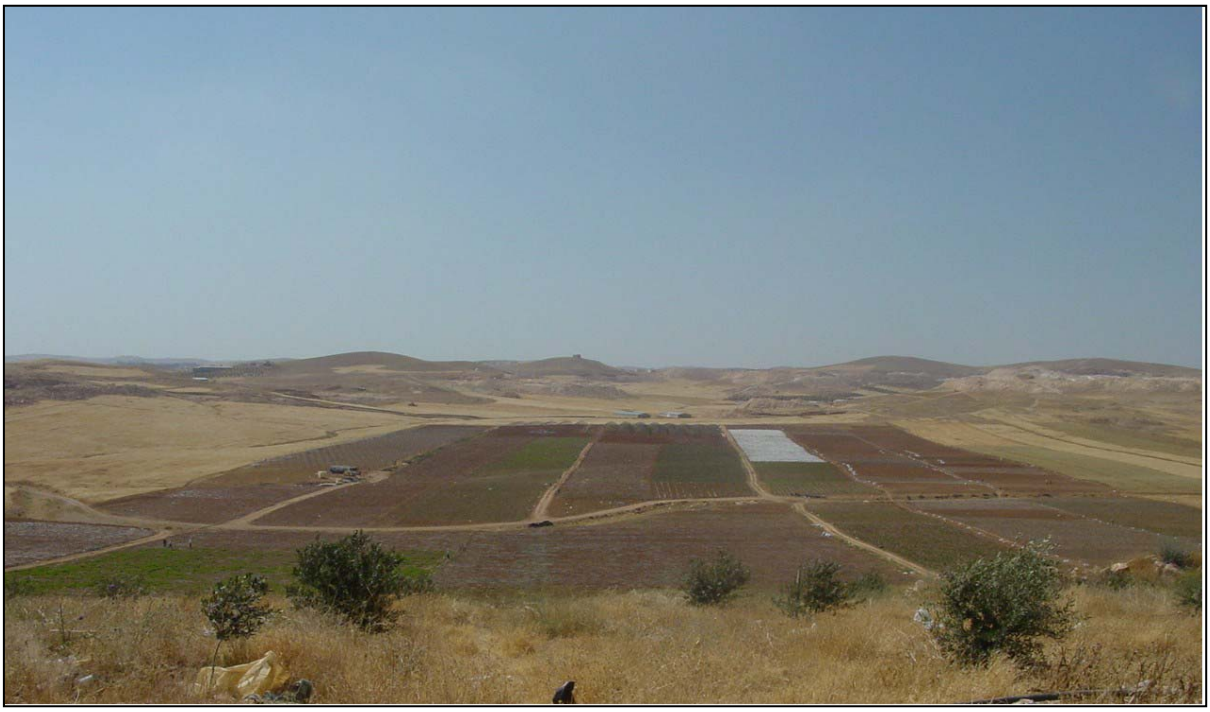
Picture 16: Olive trees along the Zarqa River

Picture 17: Fruit tree farm on the Zarqa River bank

Picture 18: General landscape of the Zarqa River, greenhouses, open field and fruit trees along the banks

TRANSITION AREA

Picture 19: rain fed olive trees in the hilly transition area



Picture 20: Installation of a vegetable farm in the transition Area

NORTHERN AREA

Picture 21: Irrigated vegetable farm in the north of Jordan

Picture 22 &23 : Rain fed cereals fields

EASTERN DESERT OR BADIA

Picture 24: The rain fed herding domain

Picture 25: Small plots of fruit trees in the desert

Picture 26: vegetables in open field in the middle of the desert

Picture 27: Green plot lost in the desert

Picture 28: greenhouses in the desert

Picture 29: Irrigated olive trees in the desert

Picture 30: Irrigated and cropped area in the desert

Appendix II: Vegetables cropped in open field or under greenhouses: operational sequence

Vegetables in open field

Operational sequence

For each crop, the operational sequence can be divided as follow

*Land preparation (2 ploughings and one passage of cultivator),
*Pipes installation,
*Manuring,
*Manure irrigation,
*Removal of the pipes,
*New use of the cultivator to incorporate the manure to the soil,
*New installation of the pipes, rows are generally 2 meters apart,
* Installation of the mulch, one line by pipes line,
*Seedling of one grain or of one small plant by hole. The choice of the holes used (and so of the sowing density) is function of the mulch and of the kind of crop,
*Irrigation and spreading through the irrigation water,
*Manual or mechanical weeding,
*Spreading of pesticides (in general insecticides)
*Manual harvest, and transport (in several times),
*Putting off the mulch and land clearing.

Land preparation

Autumn crops are preceded by a short fallow during which two ploughings are done. In September, manuring is done. Manure is irrigated before being mixed with the superficial soil horizon thanks to a cultivator. Spring crops are preceded by a more simple land preparation. Pipes then mulch are installed.

Fertilization

Market gardening needs important provision of manure to maintain the soil organic matter rate. One application is done before the autumn crop (in general with chicken's manure but sheep's manure can also be used). Spring crop isn't always preceded by a spreading.

Some chemical fertilizers are spread from the first weeks of cropping (ammonium sulphate). At the flowering, compound fertilizer are spread (20/20/20), all these fertilizer are spread thanks to the fertigation technique.

Transplanting and seedling

Purchase of seeds or small plants constitutes an important cost. Nurseries services are sometimes used by the farmers to avoid the handling of the seeds.

Weeding

In most of the cases, the manual weeding, added to the chemical one, is done by daily workers. Each crop is weeded two or three times.

Plant pest control

Every 7 to 10 days, plant pest control products are sprayed on the crops.

Irrigation

Irrigation period are regularly distributed along the year.

Harvest, conditioning, transport, selling

Vegetables are put in polystyrene boxes and sold generally in the central markets.

Common grazing

After harvest, farmers if they don't have any animals let the breeders grazed the plants for 25 to 30 JD/Ha before the next land preparation.

Vegetables under greenhouses

Greenhouses are constituted by metallic hoops on which a translucent plastic can be found from September to May. One greenhouse is 60 meters long; 8 meters large and 3.5 meters high. Between two greenhouses an empty space of one to two meters is let without any crops. Each greenhouse takes up 650 m².

Operational sequence

At the end of September, beginning of October, before the Tomato (or cucumber) crop, two deep ploughings are done. Between these two labours, one cultivator run is done.

*Manure (chicken or lamb's one)is spread once or twice a year before the beginning of each season of cropping (October and April), 9 pipes are installed in order to humidify the greenhouse,

* Pipes are removed to run the cultivator once more,
* The translucent plastic is newly installed,
* Pipes are again installed, one line every meter,
* Mulch is installed, along the pipes lines
* Seeds are transplanted in October/November;
* The irrigation is done 2 or 3 times each week then one time after each picking.
* Chemical fertilizers (ammoniac, compound fertilizers) are used through the irrigation water (fertigation technique) and the plant pest control products are sprayed in the greenhouses thanks to a tanker,
* There isn't a lot of work for weeding because of the soil sterilization,
* After each picking, the workers remove the dead leaves; vegetables are put in polystyrene boxes,

* Between April and May, the translucent plastic is removed,
*After the last harvest, plants are digging out, the mulch is burn and the pipes are salvage to be used during the next cropping season.
* Soil is ploughed ones,
* Soil is sterilized to allow a new cycle of cropping

About the harvest

This one can last several months, for example tomatoes are picked once or twice a week from December to May.

About the soil sterilization

From June/July, greenhouses are uncropped. In July/August the soil is sterilized thanks to gas or thanks to the solarization technique in order to get rid of the weeds and the soil parasites (for example nematods)

The first sterilization method consists in an injection of a toxic gas (methyl bromide). After one ploughing, pipes and small bottle of gas are installed under a thick plastic tarpaulin which covers the entire greenhouse surface. The soil is irrigated in order to saturate it with water, and then gas bottles are pierced in order to let the gas being spread. The tarpaulin is removed 5 to 7 days after and some farmers plough the soil another time to remove all the gas traces. Another technique consists in dissolving the gas in the irrigation water (at 90 to 100°C) and in distributing it through the emitters under the mulch lines.

The second sterilization technique is called the solarization one. After one ploughing, the soil is entirely covered with a plastic tarpaulin under which 15 to 20 pipes are installed. During one week, an important irrigation is done (one day every two days). Soil is saturated in water and is deprived of oxygen. This method can last between two weeks and one month and it is less efficient than the methyl bromide method.

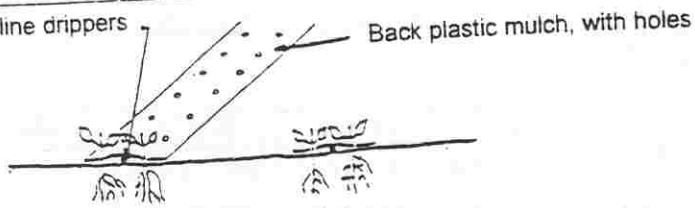
The soil sterilization permits to maintain high yields and a decrease in weeding and pest plant control costs. The Ministry of Agriculture, following international laws for the environment encourage since 5 years the solarization technique in order to avoid the use of the methyl bromide, a polluting gas[2].

Greenhouses displacement

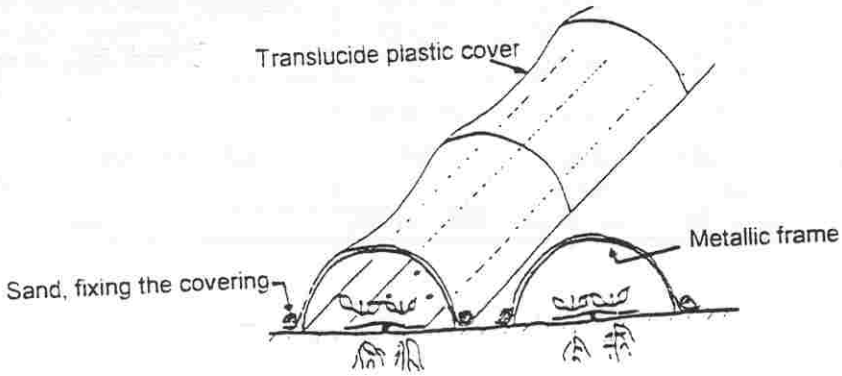
After 5 years of cropping, farmers observe a decrease in yields. The reasons of such decreases are not clear. It might be linked to a loss of efficiency of the soil sterilization; it might be linked to a soil salinization as well, linked to an over-fertilization…

Only the consequence is clear: farmers need to move their greenhouses every 5 or 8 years.

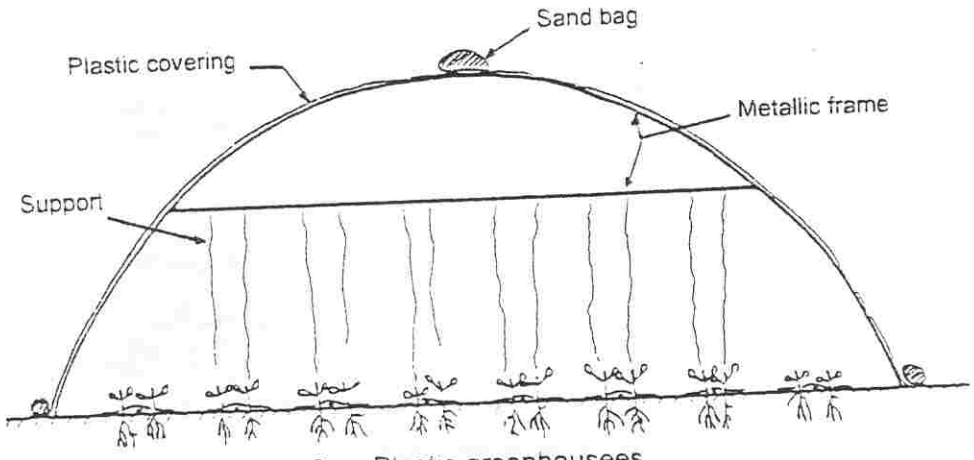
[2] An interdiction of such gas is planned for 2005.



9.a : Plastic mulch



9.b : Plastic mini-tunnels



9.c : Plastic greenhousees

Fig. 9 : The main techniques used in vegetable farming

Appendix III: Citrus farms: operational sequence

Pruning

The aim of pruning is to eliminate dead branches. It is generally done by Egyptian daily workers

Fertilization

In general lamb manure is spread at the bottom of each tree one year every two years at the first rain falls. In winter, nitrogen is brought. Compound fertilizer is spread at the flowering and potash is added in September to favour fruits formation.

Weeding

Weeding is done two or three times a year: two times in winter (at the beginning and at the end) and eventually one time in summer. This work is done by daily workers who mainly use a hoe.

Pest plant control

Lime with insecticides product is applied one year every 2 or 3 years to the tree trunks to avoid an invasion of aphids.

Sticky oil is applied to the leaves in summer if insects' attacks are recorded. The application takes generally places one year every two years.

In winter a friction is done to get rid of the lichen developed on the trunks because of the humidity.

Irrigation

Irrigation is done from April to the first rain fall (in September/October). Each plot of trees is generally irrigated every 15 days (more often on sandy soil)

Harvest, conditioning, transport and selling

Fruits are stocked in polystyrene boxes, transported to Amman or Irbid and sold in the central markets.

Appendix IV: Rough data concerning Olive trees surface and production

YEAR	production in thousands of tons
1968	12,6
1969	23,7
1970	3
1971	18,5
1972	35
1973	5,2
1974	40,5
1975	4,7
1976	22,5
1977	8,3
1978	37
1979	6,8
1980	44,5
1981	18,9
1982	40,4
1983	22,2
1984	50
1985	19,7
1986	31,8
1987	20,4
1988	70,8
1989	25,7
1990	63,7
1991	40,6
1992	81,8
1993	31,8
1994	96,5
1995	64,90
1996	128,9
1997	82
1998	177
1999	53,8

Table 1: Evolution of the Olive production in Jordan since 1968
Source: Ministry of statistics

Table 2: Repartition of Olive Trees surface and production inside Jordan in 1999.
Source: Ministry of Statistics

Surface of olive trees 1999 (dunums)

	Trees in Production		Trees with no production		total surface (dunum)	Oil (tons)	olive fruits (tons)	tons of fruits which have been transformed into oil	"total production (tons of fruits)"
	irrigated	Rain fed	irrigated	Rain fed					
Ajloun	5081	49967	345	9616	65009	3487	186	17435	17621
Jerash	11753	62561	4236	22224	100774	3559	890	17795	18685
Amman	60131	49080	8587	15308	133106	1078	447	1525	1972
Madaba	1135	17965	650	12720	32470	204	51	255	306
Zarka	56251	39020	5528	7340	108139	2314	772	3086	3858
Irbid	4270	206550	2522	45757	259099	1956	110	2066	2176
Mafraq	22830	27525	17100	21390	88845	2954	984	3938	4922
Al Baaqa	5000	147400	1400	23000	176800	2610	290	2900	3190
Jordan valley	4148	0	701	0	4849	76	77	153	230
Total basin	170599	600068	41069	157355	969091	18238	3807	49153	52960
Karak	8855	13419	3150	9438	34862	197	55	252	307
Attafeeleh	10150	19500	980	1370	32000	190	63	253	316
Ma'an	9527	2890	3726	1935	18078	165	45	210	255
Aqaba	1497	0	350	0	1847	25	12	37	49
Total Jordan	200628	635877	49275	170098	1055878	18815	3982	49905	53887

Tables 3 & 4: Import and export market for olive and oil production in Jordan from 1994 to 1999
Source: Ministry of statistics

Year	Total Production (tons of FRUITS)	olives - fruit (tons)					
		local production	imported	Imported from Palestine	Exported	Balance (Export-Import)	total consumption
1994	96500	14207	94	736,1	788	-42,1	14249,1
1995	64917	9929	42	259	856	555	9374
1996	128939	16656	70	199	518	249	16407
1997	82197	11002	125	232	436	79	10923
1998	176961	36258	283	0	1641	1358	34900
1999	42542	8138	114	0	409	295	7843

Year	olives - oil / ton								
	local production Olive pressed	Oil produced	Rapport Oil/fruit (%)	Imported oil	Imported from Palestine	exported Oil	Balance (Export-import)	Total consumption	Total consumption (in fruits)
1994	82293	15578	19	6996	1820	287	-8529	24107	127348,7
1995	54988	11409	21	0	524	326	-198	11607	55942,3
1996	112283	22945	20	192	987	213	-966	23911	117010,2
1997	71195	14100	20	2350	858	15	-3193	17293	87317,4
1998	140703	21413	15	3438	0	171	-3267	24680	162170,2
1999	34404	6597,3	19	173	0	918	745	5852,3	30518,9

Tables 5, 6 & 7: data on the olive trees market in Jordan.
Source: Ministry of Statistics

	Total local Production (Tons of fruit)	Total consumption of Oil (Kg)	Total consumption of fruit (Kg)	Total consumption of Olive fruits before transformation into oil (Kg)
1990	56000	42500	15000	57500
1991	33000	62500	9000	71500
1992	82500	85000	12000	97000
1993	70000	97500	11500	109000
1994	96500	24107	14249	141598
1995	64917	11607	9374	65316
1996	128939	23911	16407	133417
1997	82197	17293	10923	98240
1998	176961	24680	34900	197070
1999	42542	5852	7843	38362
2000	180000	150255	26000	176255
2001	87700	71840	12155	83995
2002	182500	145500	27500	173000

	production of local Oil (Kg)	Total consumption of Oil (Kg)	balance of Oil (imported -exported Oil) Kg
1990	8000	8500	500
1991	5000	12500	7500
1992	14000	17000	3000
1993	12500	19500	7000
1994	15578	24107	8529
1995	11409	11607	198
1996	22945	23911	966
1997	14100	17293	3193
1998	21413	24680	3267
1999	6597	5852	-745
2000	30600	30051	-549
2001	14909	14368	-541
2002	30 600	29 100	-1500

	production of local olive fruits (Kg)	Total consumption of olive fruits (Kg)	balance of fruits (imported -exported fruits) Kg
1990	16000	15000	-1000
1991	8000	9000	1000
1992	12500	12000	-500
1993	7500	11500	4000
1994	14207	14249	42,1
1995	9929	9374	-555
1996	16656	16407	-249
1997	11002	10923	-79
1998	36258	34900	-1358
1999	8138	7843	-295
2000	27000	26000	-1000
2001	13155	12155	-1000
2002	29500	27500	-2000

Appendix V: Deflator use in the different models for prices actualization

	1974 deflator	2001 <- year x year x deflator
1950	0,329	0,089
1951	0,361	0,098
1952	0,380	0,103
1953	0,388	0,105
1954	0,395	0,107
1955	0,410	0,111
1956	0,429	0,117
1957	0,442	0,120
1958	0,455	0,123
1959	0,459	0,125
1960	0,463	0,126
1961	0,476	0,129
1962	0,495	0,134
1963	0,503	0,136
1964	0,521	0,141
1965	0,546	0,148
1966	0,568	0,154
1967	0,686	0,186
1968	0,827	0,224
1969	0,866	0,235
1970	0,913	0,248
1971	0,961	0,261
1972	1,000	0,271
1973	1,000	0,271
1974	1,000	0,271
1975	1,000	0,271
1976	1,096	0,297
1977	1,237	0,336
1978	1,250	0,339
1979	1,266	0,344
1980	1,329	0,361
1981	1,420	0,386
1982	1,519	0,412
1983	1,683	0,457
1984	1,712	0,465
1985	1,824	0,495
1986	1,971	0,535
1987	1,971	0,535
1988	1,998	0,542
1989	2,332	0,633
1990	2,608	0,708
1991	2,752	0,747
1992	2,985	0,810
1993	3,070	0,833
1994	3,280	0,890
1995	3,343	0,907
1996	3,412	0,926
1997	3,454	0,938
1998	3,661	0,994
1999	3,651	0,991
2000	3,641	0,988
2001	3,684	1,000

SOURCES:

- ✓ http://www.uwsa.com/pipermail/money-ethics/1997/003834.html
- ✓ http://www.owlriver.com/pie.mhsc.org/DataPages/sd-079.htm
- ✓ http://memory.loc.gov/frd/cs/jordan/jo_glos.html
- ✓ http://www.parliament.uk/commons/lib/research/rp99/rp99-020.pdf
- ✓ From Department of Statistics, Omar Hakouz, head of National Account Division for data between 1976-2001
- ✓ Based on GDP at market prices

Appendix VI: Farms in the Highlands, A little work done on wells which determine the agriculture in the area

In this appendix we will present the way we use to build our models. First we have considered that in such farms an initial investment has been done (a well with the land irrigated around) during the late 70's, early 80's.

Concerning the prices of such an investment, we can present prices actualized in 2002. We established them thanks to surveys and thanks to prices observed at the moment of purchase in the last few years. The well considered can irrigate 250 dunums and is around 250 meters deep. An evaluation of the prices follows:

- ✓ Land➔ 50 000 JD (70 000 $) 300 JD/du

- ✓ Digging of the Hole and pumps➔ 150 000 JD (210 000 $)
- ✓ Electric System ➔ 12 500 JD (17 500 $)
- ✓ Divers (Wages/buildings…)➔ 25 000 JD (35 000 $)
- ✓ Big pipes ➔ 12 500 JD (17 500 $)
- ✓ **Total costs around 250 000 JD (350 000$) and 200 000 JD for the well[3].**

A well can be used during 25 years without any big investment on it. After this number of years, new investments are necessary (deepening of the well, replacement of the inner surface…). What is the residual value of the well?

We assume that the land has the same value: at 300 JD/du[4]. Concerning the well, new investments are needed: deepening and replacement of the inner surface for 10 000 JD, replacement of pipes and pumps (+ wages…) for 20 000 JD. We can also assume that the buildings are still usable.

To build our model we can consider that the residual value of the well corresponds to the initial investment minus this new necessary investment, so it means 170 000 JD. A well loose really slowly his value.

The value which has to be depreciate can be evaluated at 30 000 JD (the new investments needed) on 25 years.

After these economic considerations, we can focus on the financial aspect: in how many years a farmer can reimburse the initial investment he has done?

Year	1980	1981	1982	1983	1984	1985	1986	MEAN
Price (JD/Ton)	101	121	109	132	101	101	94	110

Table 1: Price of Tomato in the central market of Amman[5]

For this rapid evaluation, we will consider that the vegetables croppers crop only Tomatoes with the same way of cropping described in the report. Moreover, if we consider than the exploitations costs have been constant along the years, the differences observed in price directly show an effect on the net profit. The yields observed during the 1980-1986 period reached 20 to 25 tons/du.

[3] Such evaluations have been done thanks to historical surveys. For bigger plots (400 to 600 dunums), we consider that excepted the costs of hole digging & pumps which are one third higher, all the others costs are the same.

[4] We are not able to build the history of land prices since 1980, we only have punctual datas.

[5] In current money, datas from "The Jordan valley Dynamic Transformation: 1973-1986."

In the eighties the gross Output was at least reaching 220 JD/du/year in current money (1980) and the Net profit linked was around 50 JD/du/year in current money[6] (the actual total costs of 470 JD have a "1980 value" of 170 JD)

If we consider an exploitation of 250 dunums, the Net Profit brought out reaches 12 500 current JD. In these conditions, a family who bought a 250 dunums area and who invested in digging a well to crop this area earn her money back in 8 years (In 1980, the current price of the well considered was around 90 000 JD).

If we consider an actual average model, a farmer who wants to buy an area and dig a well to crop it with vegetables will need 12 years to recover the money due to the investment. We consider here that no bad-year happened and that the farmer can bring out an average profit of 85 JD/du/year on 250 dunums.

This is a theoretical calculation which can not take place because of the governmental interdiction of digging wells. But by purchasing a well (and the land around) some farmers can faced this situation.

In fact no true land-and-well market can be defined. There are some transactions, but that' done case by case and a no global dynamic on prices can be observed, that's why a definition of a well's residual value was not possible thanks to a commercial value.

Regarding to the people who purchase wells, they are big investor/engineer who implement a Big Intensive Fruit Trees Farm on a large surface (400 to 600 dunums).

To have an evaluation of the investment linked to such an implementation we only can based ourselves on the few surveys we have done on this subject. In that way we estimate that to buy a well and 500 dunums of land (which can be irrigated) you have to spend 300 000 JD.

Added to this amount you have to install the orchards at 400 JD/du. The total amount reach for 500 dunums: 500 000 JD (1000 Jd/du)[7]

When can you expect recover your money?

year	1	2	3	4	5	6 and more
% of production	0	15	25	50	75	100
Gross Output (JD/du)	0	270	450	900	1350	1800
Costs (JD/du)	330	370	390	470	520	690
Net Profit (JD/du)	-330	-100	60	430	830	1010
Net Profit (500 du)	-165 000	-50 000	30 000	215 000	415 000	505 000

Table 2: Evolution of mean costs and production during the first years of the production

During the two first years of cropping you don't earn any money and the total investments reaches 715 000 JD. From the 3rd year the orchards began to be profitable and after four years of production, you reimburse all your investment. To conclude it needs 6 years to have your money back after such an important investment.

[6] The actual total costs of 470 JD have a 1980 value of 170 current JD.

[7] Regarding to ARD work we have the same amount of investment per dunum (1000 JD) but the repartition of the investment in not the same, the price we used for digging well are much higher than the ones used by ARD and it is the contrary for orchards. We based ourselves on our surveys and actualized prices in 2001.

Annexe VII: a few word about the methodology used to build the economic models

The method used to identify the different farming systems is an economic one, based on a theory I learned at the INA P-G. According to this theory, it is possible to classify the farming systems in several "economic classes" which are linked to the technical and agronomical characteristics of the farms.

To characterize the farming systems on an economic point of view, we have chosen a graphic method: the representation of the Net Profit brought out[8] per familial worker and per year in function of the surface cropped per familial worker.

This simple graphic method permits us to have several information (economic and technical) on the farming systems:

- ✓ The slope of the line corresponds to the Net Profit brought out per dunum and per year: it is the **profitability** of the farm,
- ✓ The intercept correspond to the depreciation costs which are not proportional to the surface cropped. The intercept translates the **initial investment** which has been done by the farmer.
- ✓ Thanks to this graphic representation, and to the abscissa axe, we have information on the **intensification of the farming system** –in matter of labour-

The "farming systems line" can be compared to the poverty and the sustainability level. Teissier and Vallin have estimated the poverty level -which corresponds to the minimums needs of a family- at 1200 JD/worker/year (1700 $) and the sustainability level -which give an idea of the long term viability of one farm- at 1800 JD/worker/year (2535 $, it corresponds to the salary of one farm manager)

In conclusion such a graphic representation and the figures which are linked permits us to have a global vision of the farming systems present in the Jordan River Basin in Jordan and to evaluate what could be their evolution in a context where agricultural water will decrease.

[8] The Net Profit can be replaced by the Return on Capital if we identify the farming system as a kind of "capitalist or entrepreneur's agriculture"