Socioeconomic and Policy Research Program (SERPR)
International Center for Agricultural Research in the Dry Areas - ICARDA

The Limits of Groundwater Mining in Dry Areas

Agriculture Water Management Journal (September 2012)

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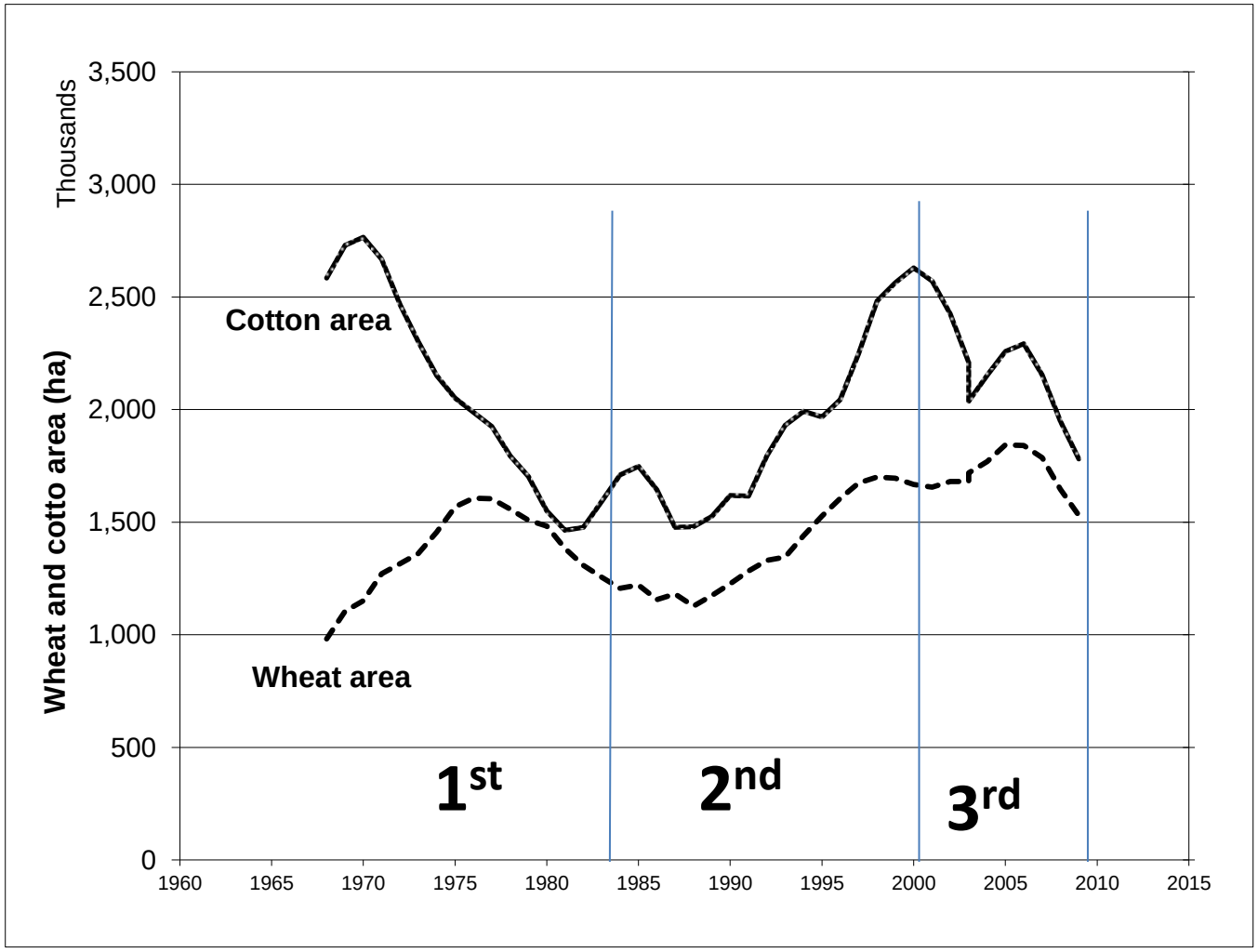
Cotton and wheat production areas in Syria, 1960-2009



Source: MAAR, Statistical Yearbook, 1980-2010

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Table 1: Major production input subsidy based on 1999 exchange rate in Syria

Commodity	Local Prices (SYP)	World Market Prices (US$)	Border Prices (SYP)	Input Price Subsidy (SYP)
Diesel fuel (L)	6.1	0.23	11.54	5.44 (47%)
N fertilizer (kg)	8.3	0.18	9.00	0.70 (8%)
P fertilizer (kg)	8.3	0.23	10.72	2.42 (23%)

Note: Border prices = Exchange rate x World market prices (Int. FOB Prices + Transport). Exchange rate has been almost fixed in Syria since 2000 to 2011, at 50 SYP per dollar.
Source: Authors' estimation using FAOSTAT international market prices.

Second phase → intensive subsidy program

Third phase:

- Stabilization of income → subsidies
- More rural employment → more agricultural production
- Foreign exchange rate earnings → agricultural exports
- Food security → self-sufficiency
- 70% of total agricultural budget to subsidies.

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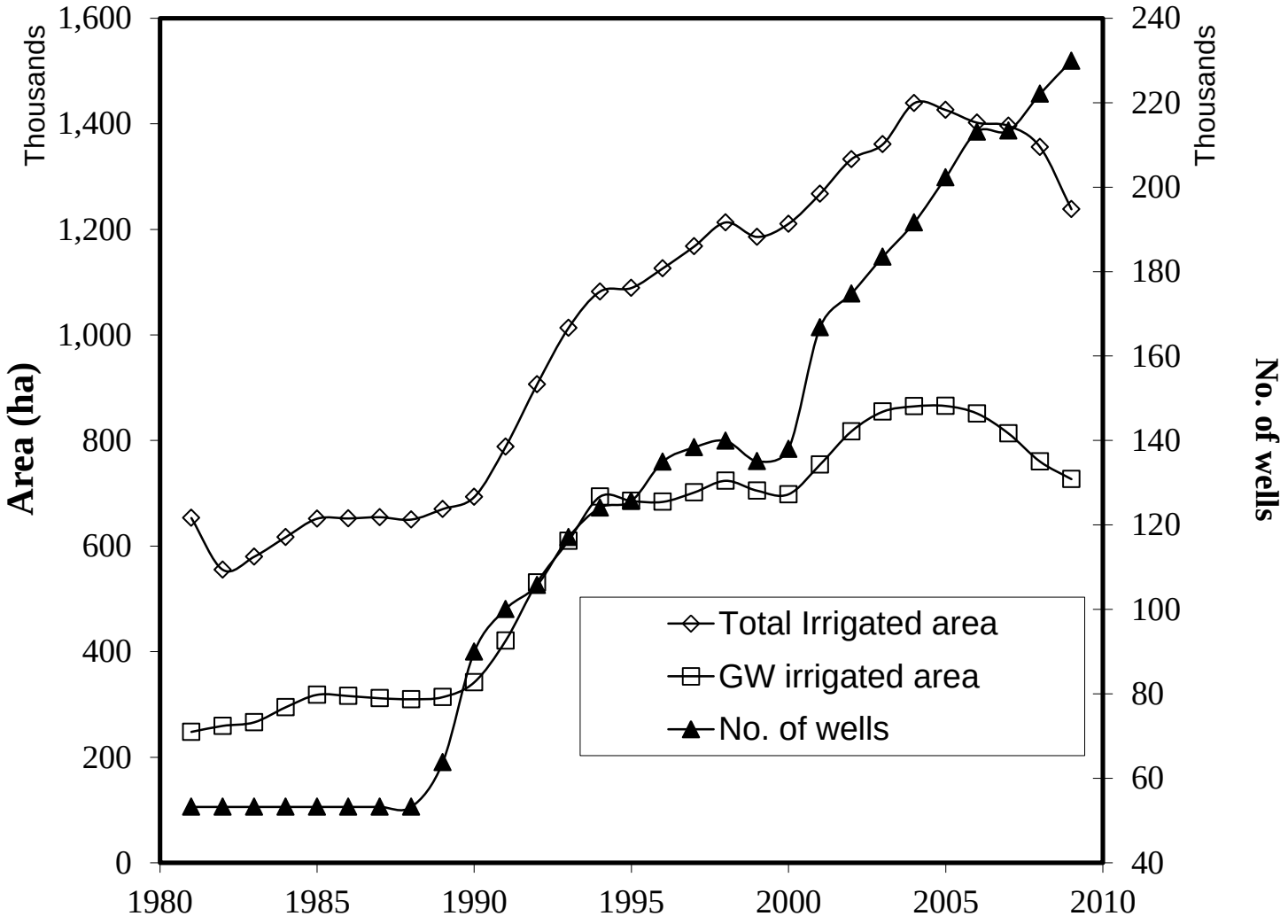
Total irrigated, groundwater irrigated wheat and cotton areas and number of wells in Syria, 1980-2010



Sources: FAOSTAT, 2012. MAAR 2010, The Annual Agricultural Statistical Abstract for year 2010. Syrian Ministry of Agriculture and Agrarian Reform, Damascus, Syria

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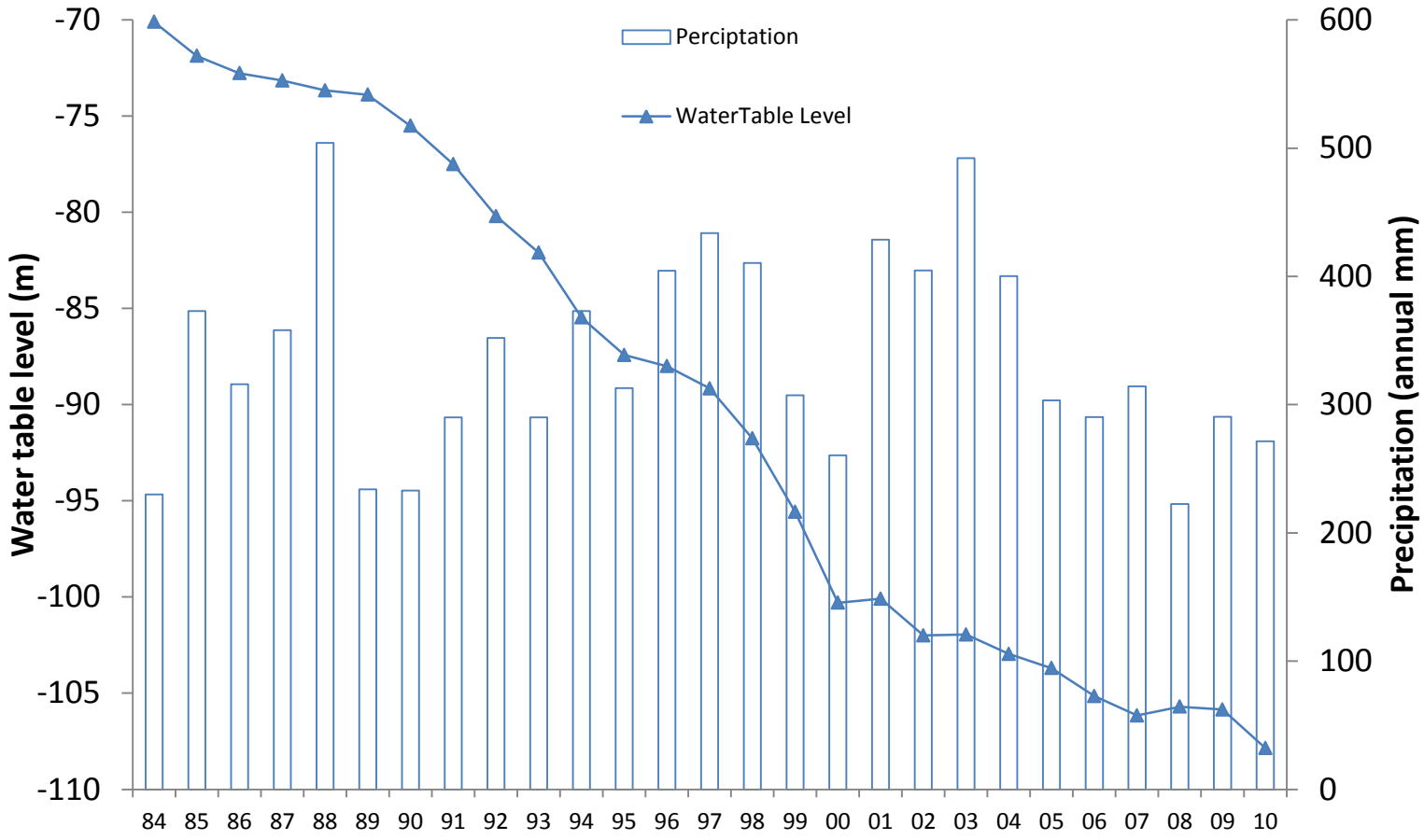
Water table level and annual precipitation at Tel Hadya Research Station (Aleppo – Syria) for the period 1984-2010



Note: ICARDA, for more than 25 years, has been recording water table data and precipitation levels at its research station and headquarters in Aleppo – Syria. The data shows that the water table has been dropping at an average rate of 1.5 meters per year.

Source: ICARDA water table and pluviometry data, 1984 - 2010.

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Model –Marginal product and costs

Marginal physical product (MPP)

$$MPP = \frac{\partial y}{\partial w} = b + 2cw$$

y → crop yield; *w* → quantity of water applied
b and *c* → parameters to be estimated

Marginal irrigation cost (*MIC*) → cost for each additional unit of water pumped

$$MIC = \frac{\partial c}{\partial w} = a + 2bw$$

w → Groundwater abstracted from the aquifer
b → Parameters measuring number of pumping hours, cost of fuel

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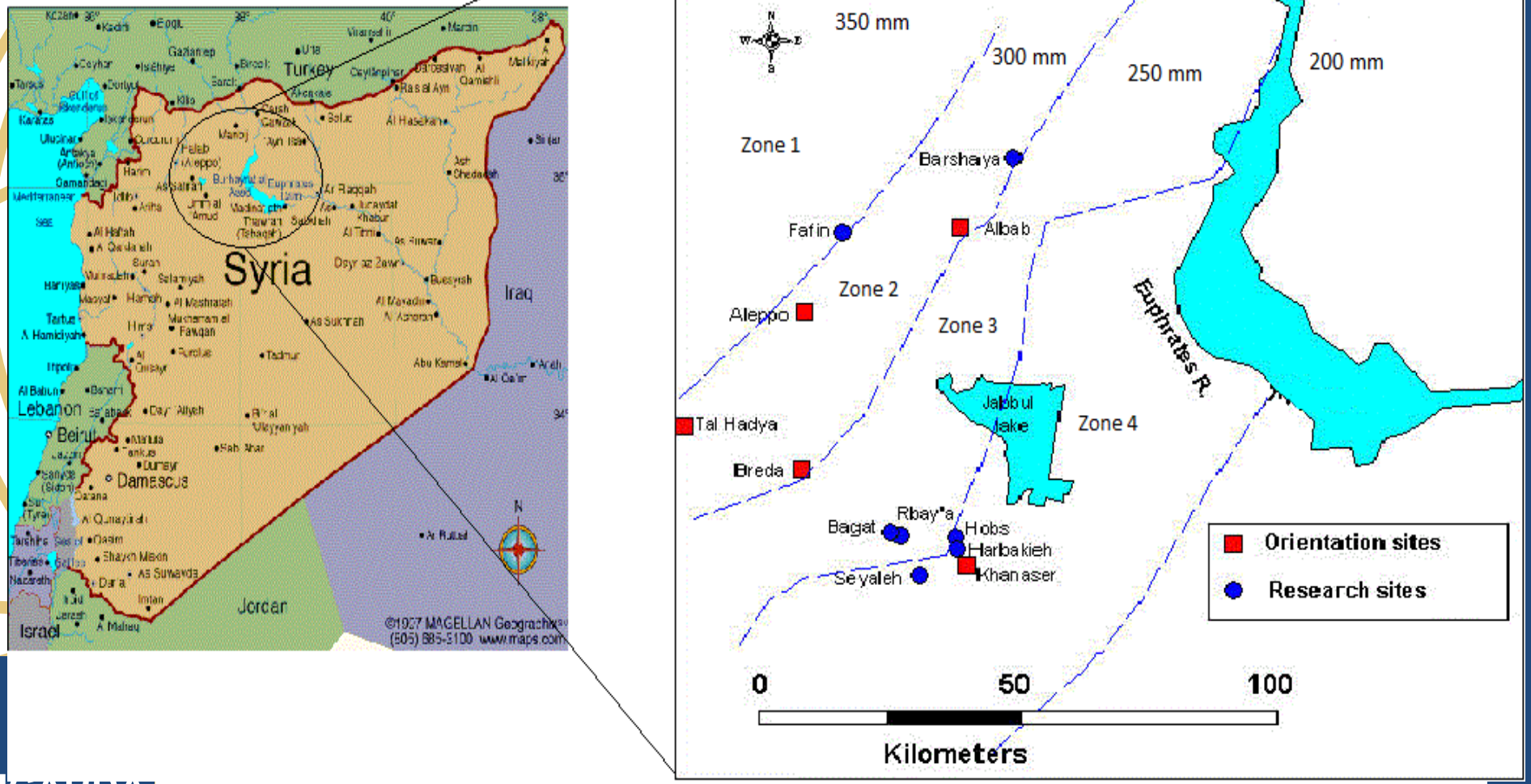
Villages location in northern Syria (rainfall isohyets in blue dashed lines)



Source: Own elaboration based on Magellan Geographix Maps (www.maps.com)

Household characteristics of five villages of northern Syria

Item	Village					Total/ Average
	Fafin (Zone 1)	Barshaya (Zone 2)	Rubia & Bagat (Zone 3)	Harbakieh & Hobs (Zone 4)	Seyaleh (Zone 4)	
Number of surveyed farmers (no)*	6	6	6	5	7	30
Total cultivated land (ha)*	2500	600	1500	600	600	5800
Average size of holding (ha)*	13	15	30	10	17	17
Type of land holding, private (%)*	100	95	100	100	100	-
Wells /Drilled (no)*	70	10	80	20	15	195
Wells /Dug (Arabic)(no)*	3	1	4	4	5	17
Shared wells (no)*	0	0	0	0	0	0
Abandoned wells (no)*	100	200	73	15	70	458
Beginning of well irrigation (years)*	35	50	50	20	30	-
Initial well depth (m)*	15	7	25	15	40	-
Current well depth (m)*	55-120	50	100	50	90	-
Depth of water intake (m)*	45-90	35	90	40	80	-
Diesel irrigation energy used (%)*	100	100	100	100	90	-
Electricity irrigation energy used (%)*	0	0	0	0	5	-
Elevation (m)*	416	461	362	416	390	409
Average Precipitation (mm)**	350	300	265	235	225	275
Average Evapotranspiration (mm)***	1500	1493	1544	1576	1571	1537

Sources: *Own elaboration based on survey data generated by Rida (2003).
** Own elaboration based on data derived from ICARDA spatial datasets. De Pauw et al. (2001).
*** Own elaboration based FAO (2001) climate station data, and ICARDA climate stations in Qurbatiyah and Breda (Syria).

Annual average values for water cost, crop price and well depth, and marginal cost per cubic meter for different crops across the Stability Zones

Crop	Stability Zone	Water quantity (m^3/ha)	Total cost (SYP/ha)	Marginal cost (SYP/m^3)	Well depth (m)	Crop price (SYP)	Gross Margin (SYP/ha)	Gross margin (SYP/m^3)
Cotton	1	16800	42000	3.41	50	29	42168	2.51
	2	14300	37800	2.91	63	29	35607	2.49
	3	14400	37000	2.93	96	29	29232	2.03
	4	10400	44000	2.13	51	29	17368	1.67
	4	8700	47000	1.79	62	29	10875	1.25
Wheat	1	3800	9000	0.81	50	11.1	17214	4.53
	2	5400	10000	1.13	63	11.2	10368	1.92
	3	5100	12200	1.07	96	10.6	1530	0.30
	4	8300	15000	1.71	51	10.3	5395	0.65
	4	5100	13750	1.07	62	11	5500	1.1
Faba beans	1	3600	16215	0.77	50	21	14508	4.03
	2	3600	10200	0.77	63	21	55368	15.38
Cucumber	1	6400	12000	1.33	50	6	70336	10.99
	2	6400	8400	1.33	63	5	59392	9.28
Beans	1	6400	10925	1.33	50	10	41792	6.53
	2	6600	10800	1.37	63	10	28710	4.35
Tomato	1	7000	10000	1.45	50	5	23170	3.31
	2	7600	11250	1.57	63	5	92872	12.22
Potato	1	3800	15000	0.81	50	5.5	43852	11.54
	2	3200	21000	0.69	63	5.5	34368	10.74
Onions	1	5300	18000	1.11	50	5	16271	3.07
	2	2000	16000	0.45	63	5	29260	14.63
Garlic	1	4900	22500	1.03	50	10	26803	5.47
	2	4900	19250	1.03	63	10	29253	5.97

Source: Farmer crop budget research survey data.

Value margin changes under different fuel prices scenarios

Crop	Village	Zone	Value margin per area unit (SYP/ha) under different scenarios				
			Current fuel cost	25% fuel cost increase	50% fuel cost increase	75% fuel cost increase	100% fuel cost increase
Cotton	Fafeen	1	42251	33501	24751	16001	7251
	Bershaya	2	35596	27896	20196	12496	4796
	Rubia&Bagat	3	29256	21256	13256	5256	-2744
	Hubs &Hurbakia	4	1448	-11073	-20698	-30323	-39948
	Sayala	4	17318	8918	518	-2483	10883
Wheat	Fafeen	1	10845	8895	6945	4995	3045
	Bershaya	2	17212	15112	13012	10912	8812
	Rubia&Bagat	3	10388	7738	5088	2438	-4112
	Hubs &Hurbakia	4	1550	-5200	-8450	-11700	-14950
	Sayala	4	5435	2497	-3940	-6787	-9815
Faba beans	Fafeen	1	12771	9187	5603	2019	-5185
	Bershaya	2	14504	12354	10204	8054	5904
Cucumber	Fafeen	1	55365	53165	50965	48765	46565
	Bershaya	2	70307	68907	67507	66107	64707
Beans	Bershaya	2	59374	57505	55636	53768	51899
	Fafin	1	41775	39750	37725	35700	33675
Tomato	Fafin	1	28680	26743	24805	22868	20930
	Bershaya	2	23195	21226	19258	17289	15320
Potato	Fafin	1	92860	90110	87360	84610	81860
	Bershaya	2	43850	39300	34750	30200	25650
Onions	Fafin	1	34361	31161	27961	24761	21561
	Bershaya	2	16250	11625	7000	2375	-370
Garlic	Fafin	1	29261	27461	25661	23861	22061
	Bershaya	2	26800	24400	22000	19600	17200

Source: Crop budget data from the research survey.

Conclusions

- **Policy is short term**, depletion can be long term (lack of coordination between government institutions);
- Agricultural policy had a **positive results**, but …. declining well productivity and falling aquifer water table levels;
- **Removal of diesel fuel subsidy** will affect the profitability;
- **Shifting from crops** with high water consumption to those with a short growing season, such as vegetables;
- Regular **monitoring** of groundwater levels;
- **Credit facilities** so farmers can easily adopt improved irrigation technologies
- **Overall agricultural policies** that look long-term that limit the mining and absolute depletion of groundwater aquifer, and lead to more economically sustainable use in the long-term.

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Thank you

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