

AN INVESTMENT BASED APPROACH TOWARDS THE IMPROVEMENT OF IRRIGATION WATER USE EFFICIENCY IN UZBEKISTAN, CENTRAL ASIA

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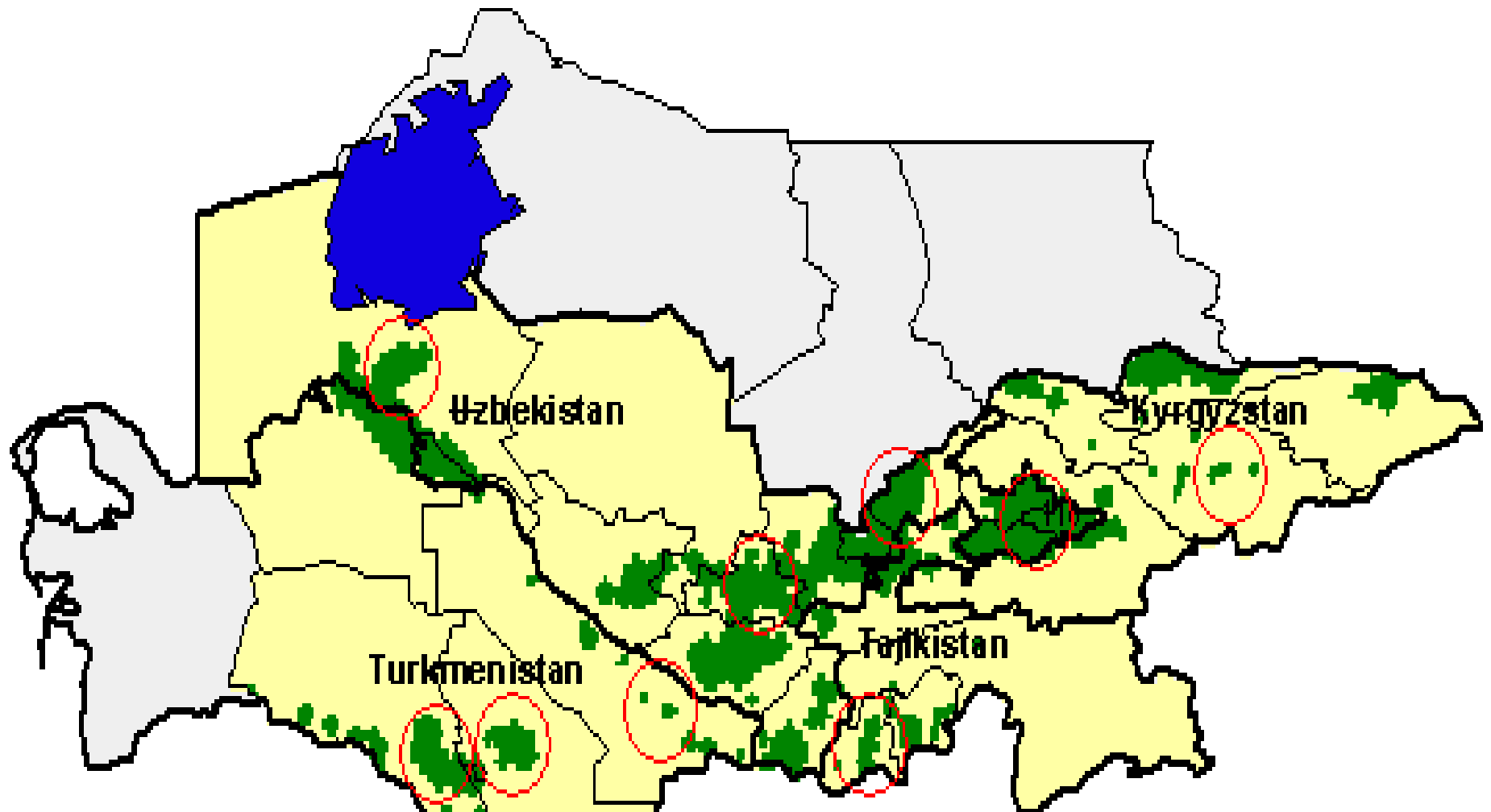
The Caucasus and Central Asia





Central Asia

Main Agricultural Regions



Green indicates main crop-production areas.
Click within red circles to view precipitation graph.

Introduction

- Uzbekistan's economy depends heavily on agricultural production.
- It is estimated that about 44 percent of the irrigated land in Uzbekistan today is strongly salinated.
- Irrigation efficiencies in Uzbekistan are poor; this refers to the distribution of the irrigation water and the infield application thereof.
- Yields in general, are low.
- This, amongst others, contributes to the financial hardship of the farmers of Uzbekistan.

Introduction....

- Water logging concerns, salinity issues, infrastructure erosion, high infrastructure maintenance, inadequate water supply/lack of capacity – not only the farmers - negative impact/threat on the regional, provincial and national economy
- It is a technical and economic problem – alternative technical solutions, impact on quality and quantity of soil and water, choices between alternative government investments (cost and benefits), the affordability of water and on farm rehabilitation for end users
- Impact of What if? on the regional, provincial and national economy

Background to Uzbek agriculture

- **The single-minded development of irrigated agriculture, without regard to consumption of water or other natural resources, has had adverse effects such as heavy salinization, erosion, and water logging of agricultural soils, which inevitably have limited the land's productivity.**
- Conditions attributed to poor water management had caused more than 3.4 million hectares to be taken out of production in the Aral Sea Basin alone.
- The total extent of agricultural land of Uzbekistan is 44 million ha. Of these approximately 24 million ha is regarded as arable, of which 4.3 million ha is under irrigation.
- Very few food crops can be produced in Uzbekistan under rain fed conditions. This is due to the limited raining season, which coincides with the very low winter temperatures. Therefore, almost 100% of all farming in Uzbekistan relies on irrigation

Strict production rules

- Quota system for cotton and wheat
- Cotton production is controlled through quotas on area and output as well as related controls on input prices and marketing.
- However, the most malignant aspect of the cotton quota system concerns the designation of particular areas to be sown with cotton, irrespective of their current appropriateness.
- As a result, **even if farmers fulfil their cotton production quota, they can still be penalized if the area they planted to cotton is less than the requirement.**
- In effect, this gives farmers **little incentive to increase land productivity** as long as their overall output is sufficient to meet the production quota.
- The quota system for wheat production is somewhat more flexible than that for cotton. Farmers are allowed to sell 50% of their quota in the open market or to keep it for home consumption.
- The land to be sown with wheat is also strictly controlled and the same rules are applied as for cotton.

Encouraging private initiative work

- Uzbekistan began transformation in 2003.
- They began to transform the collective farms into individual farms.
- Between 2004 and 2006, 55% of the collective farms were to be transformed into individual farms. By 2004, individual farms already occupied 16.7% of agricultural land, hired 765 300 workers and provided 10.5% of the agricultural gross product, including 51.5% of cotton production and 46.2% of grain production.
- Much of the production, primarily fruits and vegetables, grown on dehkan farms is exported to neighboring Russia and Kazakhstan. However, what is most striking about dehkan farms is their large contribution to agricultural GDP, estimated at 25% in 2004, despite their relatively small area (Djalalov, 2010).







In Karakalpakstan, the region that contains what is left of the Aral Sea, the total area of land under cultivation has dropped by 14 percent since 1991, according to local statistics. In the Bukhara region in the south, land planted with cotton has declined by 15 percent in the past eight years, and in Jizzax, a region in central Uzbekistan, 15 percent of the cultivated land has become too salty to farm.



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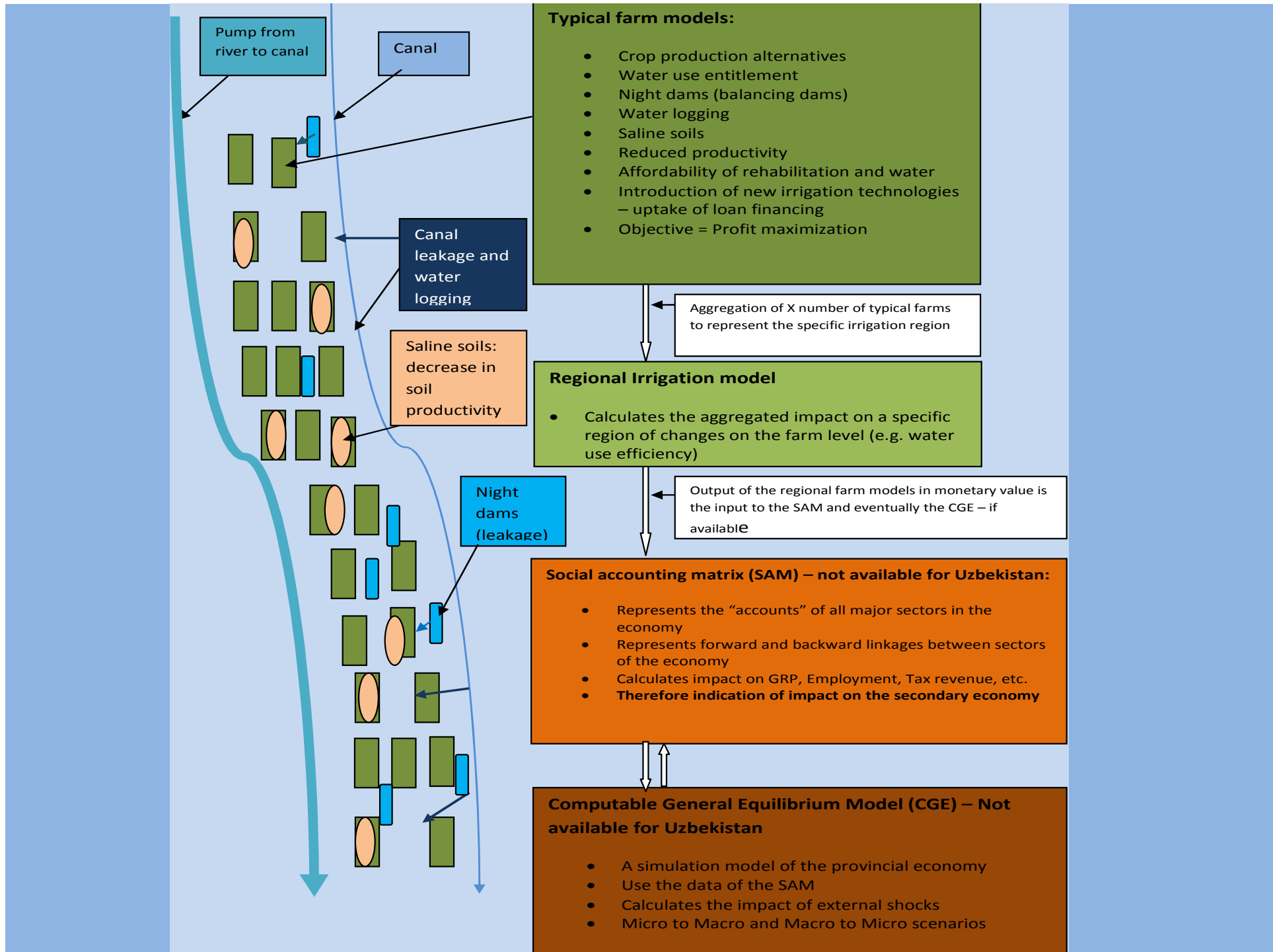












Objective

- To improve water efficiency in irrigation on farm level through implementing an investment-based approach, which is built upon a commercially viable model (e.g. by improving productivity, thereby providing payback mechanism), via intermediaries to reach out to farmers.

Methodology

- Literature study of relevant documents and reports.
- The international consultants' visited Uzbekistan between 28 February 2011 and 18 March 2011.
- Preparation of relevant technical and financial data for input in DLP models, to produce guideline results to base conclusions on and to make recommendations;
- Calibration of the models;
- Analyses of outcome from preferred/selected models, including sensitivity analyses
- Compilation of report with findings and proposals

Regions

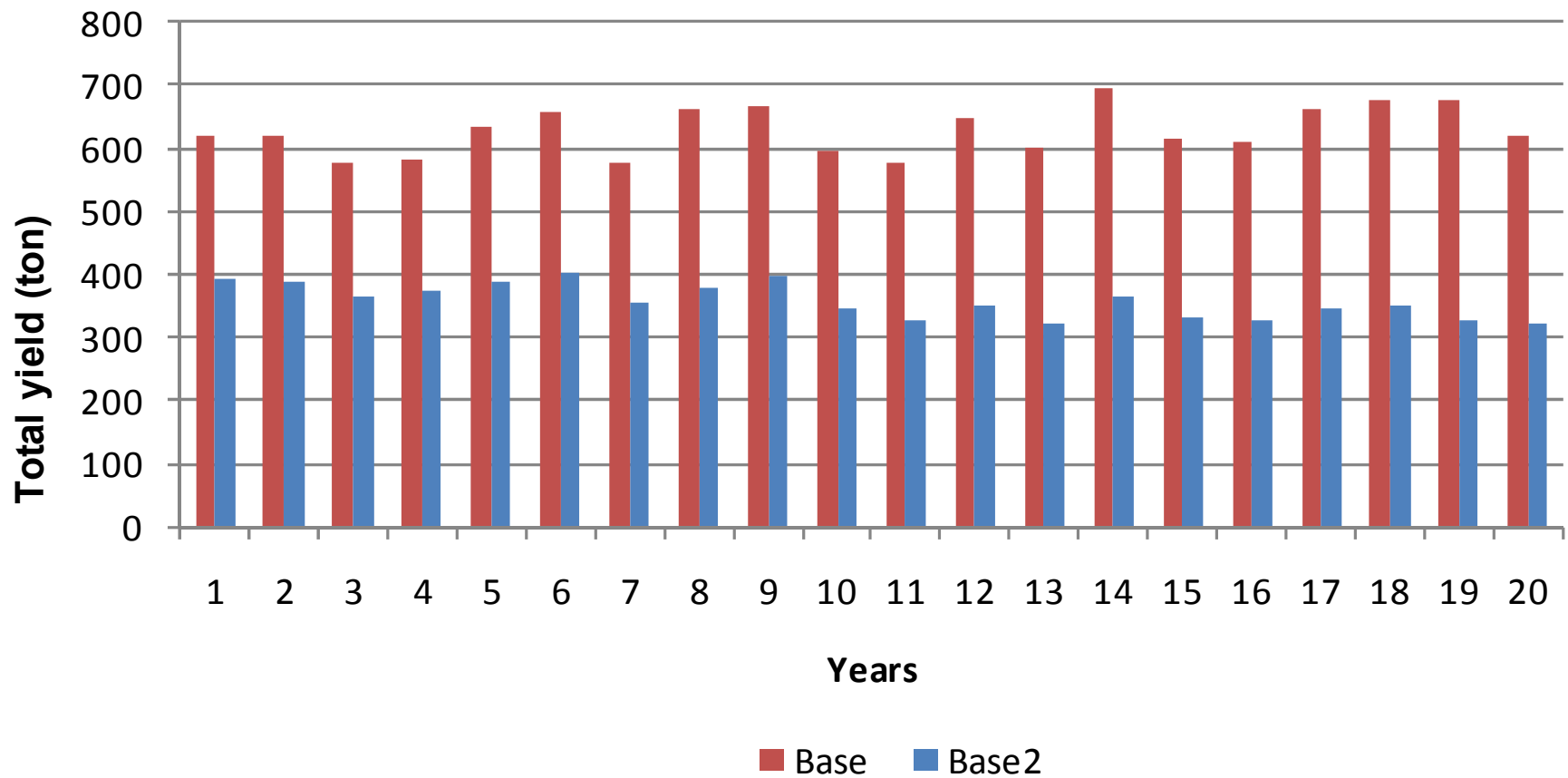
- (i) Khoresm,
- (ii) Bukhara,
- (iii) Kashkadarya,
- (iv) Surkhandarya regions.

Region	Bukhara			Kashkadarya			Surkhandarya			Khorezm			Total
Farm number	Bukh1	Bukh2	Bukh3	Kashk1	Kashk2	Kashk3	Surkh1	Surkh2	Surkh3	Khrez1	Khrez2	Khrez3	
Land ownership - total farm	49	97	195	34	69	137	43	87	173	38	75	150	1146.3
Actual irrigated	48.6	97.3	194.5	34.3	68.5	137.0	43.3	86.6	173.1	37.6	75.2	150.4	1146.3
Dryland	1.3	2.5	5.0	103.3	206.5	413.0	103.9	207.8	415.6	3.9	7.8	15.6	1486.1
Total farm size	50	100	200	138	275	550	147	294	589	41	83	166	2632.4
Land use (ha - mean) - Irrigated													
Cotton	12.7	25.4	50.9	8.1	16.1	32.2	9.0	17.9	35.9	6.1	12.2	24.3	250.8
Grain	12.5	25.1	50.2	8.9	17.7	35.5	8.8	17.6	35.3	5.6	11.2	22.5	251.0
Orchards/fruit	5.1	10.1	20.2	3.2	6.4	12.9	3.4	6.7	13.4	2.8	5.5	11.1	100.8
Vegetables	5.2	10.5	20.9	2.7	5.4	10.7	6.4	12.9	25.8	6.4	12.7	25.4	145.0
Grapes	1.4	2.8	5.6	0.8	1.6	3.2	2.1	4.2	8.4	1.0	2.0	4.1	37.2
Gourd	1.2	2.4	4.9	1.1	2.1	4.3	4.6	9.2	18.5	5.3	10.5	21.0	85.2
Unengaged	2.3	4.5	9.1	5.5	11.0	22.0	0.6	1.1	2.2	2.8	5.5	11.1	77.7
Clover	3.5	7.0	13.9	1.1	2.1	4.3	0.7	1.4	2.8	1.2	2.4	4.8	45.2
Maize	3.7	7.3	14.6	0.1	0.3	0.5	3.9	7.8	15.7	0.9	1.8	3.7	60.5
Oil-bearing crops	0.3	0.7	1.4	0.4	0.8	1.6	1.0	2.0	3.9	0.3	0.6	1.1	14.1
Rice	0.3	0.7	1.4	0.0	0.0	0.0	0.0	0.0	0.0	4.8	9.6	19.2	36.0
Legumes	0.2	0.3	0.7	0.3	0.5	1.1	1.7	3.4	6.7	0.0	0.0	0.0	14.9
Mulberry	0.2	0.3	0.7	2.1	4.3	8.6	1.1	2.2	4.5	0.6	1.1	2.2	28.0
Total Irrigated area (ha)	48.6	97.3	194.5	34.3	68.5	137.0	43.3	86.6	173.1	37.6	75.2	150.4	1146.3
Land use (ha - mean) - Dryland													
Cotton	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grain	0.0	0.0	0.0	220.0	74.5	0.0	50.0	33.3	0.0	0.0	0.0	0.0	377.9
Orchards/fruit	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Vegetables	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	6.3	0.0	12.6
Grapes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gourd	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unengaged	0.0	0.0	0.0	100.0	58.0	0.0	560.0	124.4	0.0	0.0	0.0	0.0	842.4
Clover	0.0	0.0	0.0	64.0	64.0	0.0	3.0	2.6	0.0	0.0	0.0	0.0	133.6
Maize	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil-bearing crops (earth-nut, se	5.0	2.8	0.0	10.0	10.0	0.0	50.0	47.5	0.0	1.5	1.5	0.0	128.3
Rice	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Legumes (haricot, <i>maw</i> , pea)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mulberry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Dryland area (ha)	5.0	2.8	0.0	394.0	206.5	0.0	663.0	207.8	0.0	7.8	7.8	0.0	1494.7

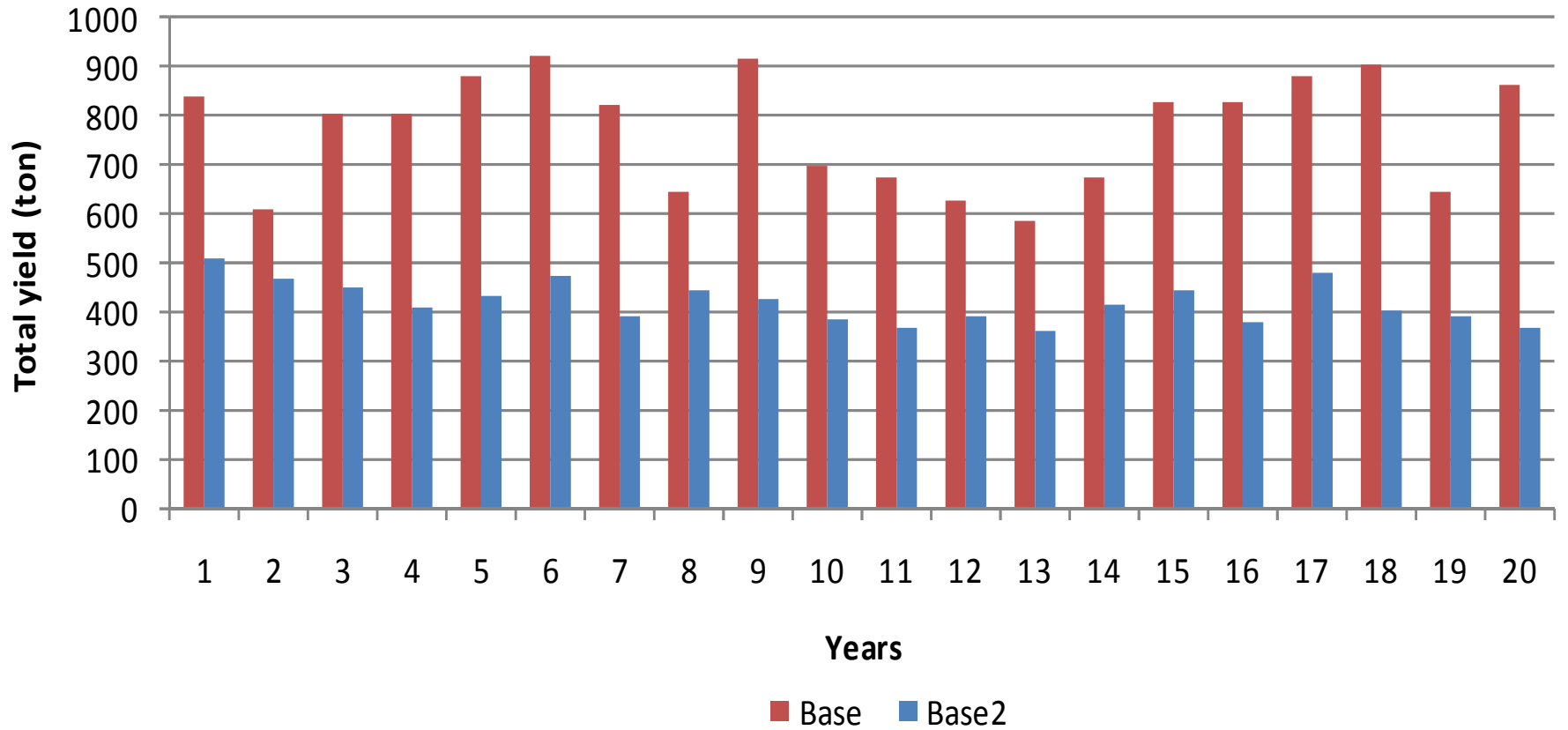
Scenarios analysed

- **Base:** Current land use, **conventional flood irrigation** only, **only short-term credit** available and restricted to a maximum level. Simulates **business as usual** with **no reduction in yield and or increase in water requirements**.
- **Base2:** Same as Base but **gradual reduction of yield with 1%** per annum and **gradual increase in water requirement** to flush salinated soils (also with 1% per annum).

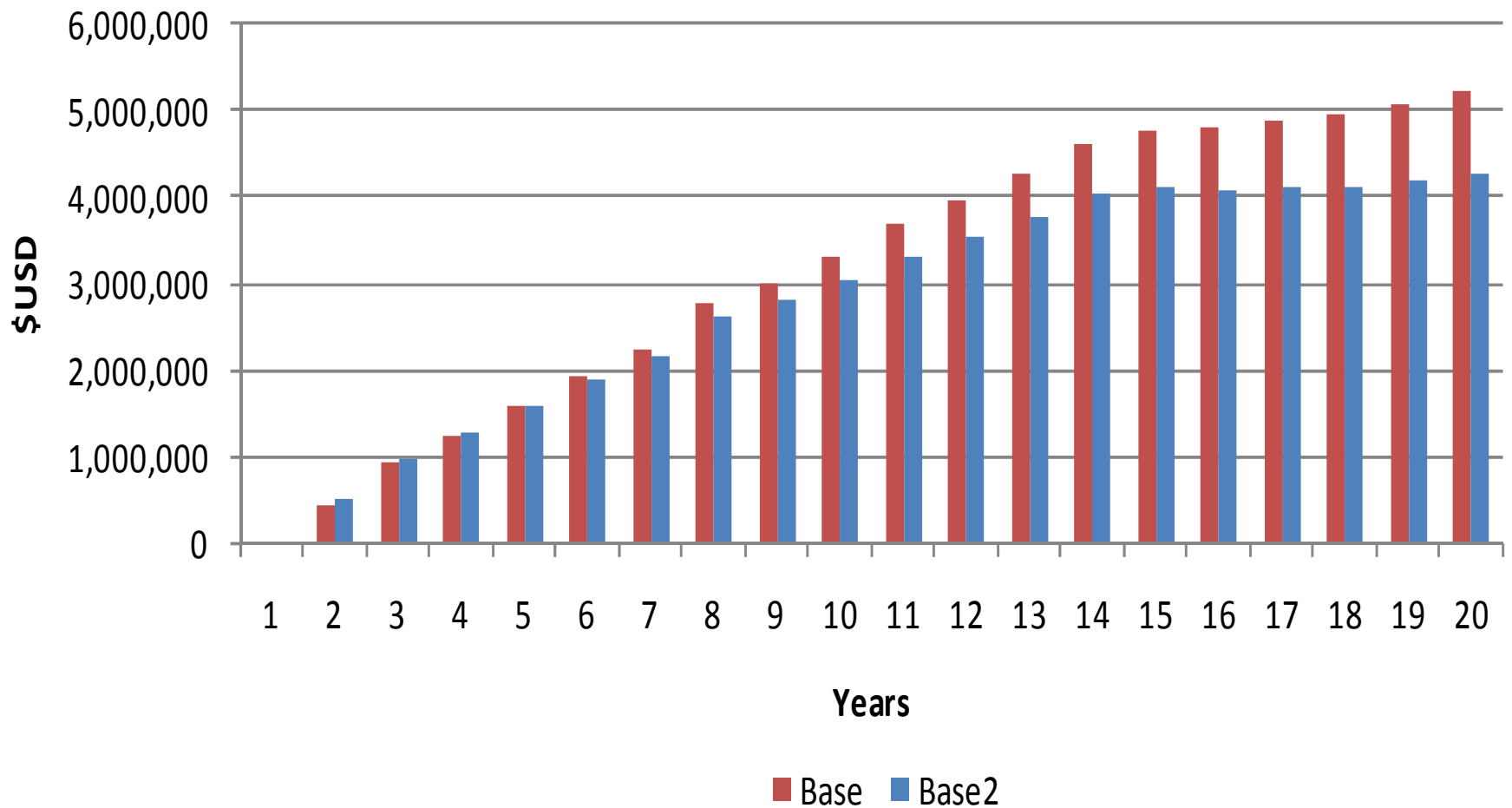
Cotton total yield (ton)



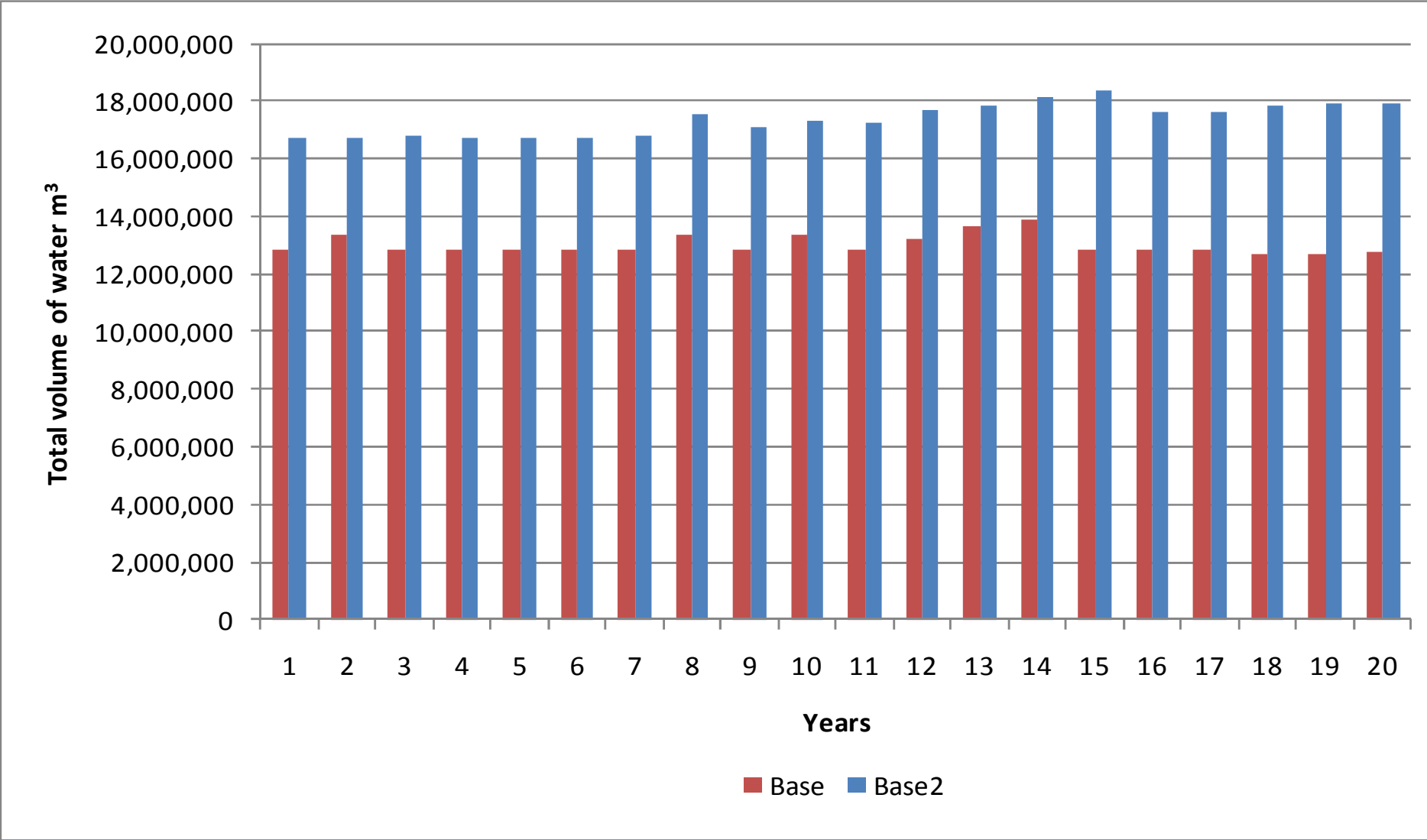
Wheat total yield (ton)



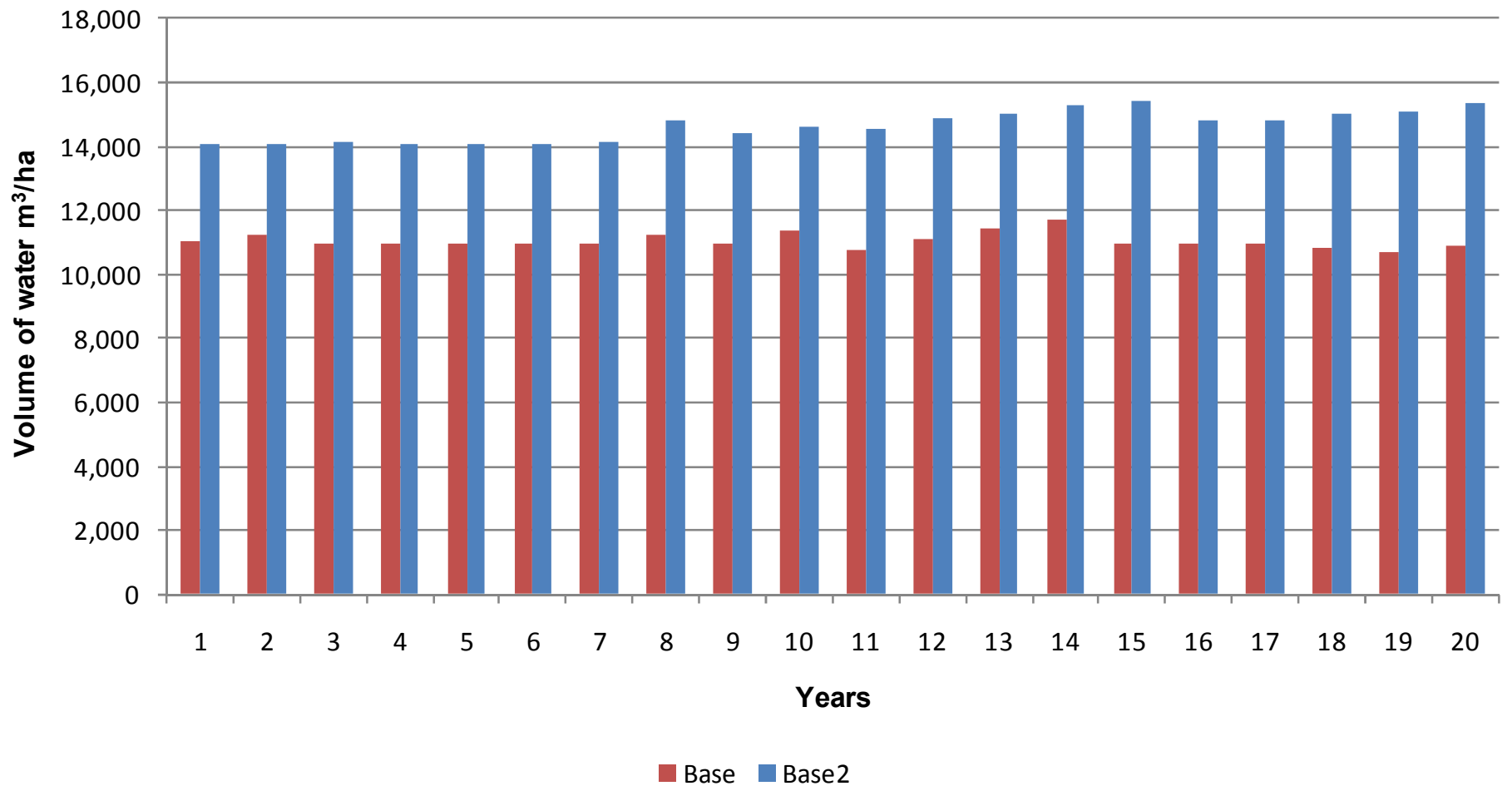
Cumulative Cash Surplus (\$USD) – all regions



Total annual water requirement (m³)



Gross Irrigation Water Requirement per ha (m³/ha)



Other scenarios – increases in efficiency, credit, relaxed control

- **Scen1:** Same as base, but **short-term and long-term credit available** and total max loan amount per ha. **30% increase in yield for other irrigation technologies** and **40% for micro and drip** - very small deviation in land use from base - **strict land use control**.
- **Scen2:** Same as **Scen1**, but **relax control over cotton and wheat with 30% up and down** variation.
- **Scen3:** Same credit available as in Scen1, but **50% subsidy** on capital of new irrigation technology - **same land control as base**
- **Scen4:** Same credit available as in Scen1 but **50% subsidies and relaxed control on land use**
- **Scen5:** Same as Scen2 but **15% increase in price** due to quality improvement for crops grown with new technology - no subsidy on new technology
- **Scen6:** Same as Scen2, but **interest rates on loans 20% higher**

Crops and water

Result	Base: Current Luse*, only ST credit max \$500/ha	Base2: Current Luse, only ST credit max \$500/ha, 1%/annum decrease in yield, 1% increase in water requirement	Scen1: Current Luse, ST+LT credit max \$2000/ha, 30% yield increase other tech, 40% micro, drip	Scen2: Same as Scen1, relax cotton-wheat control 30%	Scen3: Same as Scen1, 50% subsidy, strict control wheat/cotton	Scen4: Same as Scen1, 50% subsidy, relaxed control wheat/cotton	Scen5: Same as Scen1, relax cotton-wheat control 30%, 15% price increase, no-subsidy	Scen6: Same as Scen1, relax cotton-wheat control 30%, 20% increase interest rate
Cotton production all regions (ton)	629	358	1048	785	1059	851	909	773
Relative change (compared to Base)	0%	-43%	193%	119%	196%	138%	154%	116%
Wheat production all regions (ton)	773	420	1029	711	1244	870	725	713
Relative change (compared to Base)	0%	-46%	145%	69%	196%	107%	73%	70%
Gross water requirement (total in m3/ha irrigated)	11 032	14 630	10 014	9 632	9 245	8 990	9 478	9 640
Relative change (compared to base)	0.0%	32.6%	-9.2%	-12.7%	-16.2%	-18.5%	-14.1%	-12.6%

Energy

Result	Base: Current Luse*, only ST credit max \$500/ha	Base2: Current Luse, only ST credit max \$500/ha, 1% /annum decrease in yield, 1% increase in water requirement	Scen1: Current Luse, ST+LT credit max \$2000/ha, 30% yield increase other tech, 40% micro, drip	Scen2: Same as Scen1, relax cotton-wheat control 30%	Scen3: Same as Scen1, 50% subsidy, strict control wheat/cotton	Scen4: Same as Scen1, 50% subsidy, relaxed control wheat/cotton	Scen5: Same as Scen1, relax cotton-wheat control 30%, 15% price increase, no-subsidy	Scen6: Same as Scen1, relax cotton-wheat control 30%, 20% increase interest rate
Total energy requirement (KwH)	0	0	1 203 225	1 357 483	1 940 522	1 970 260	1 937 002	1 318 098
KwH per ha irrigated (Kwh /ha)			999	1 127	1 610	1 635	1 607	1 094
Relative change compared to Scen1				12.8%	61.3%	63.7%	61.0%	9.5%
Total energy costs (\$USD)	0	0	60 161	67 874	97 026	98 513	96 850	65 905
On-farm energy costs per ha irrigated (\$USD/ha)			51	55	82	80	80	54
Relative cost change compared to Scen1			0.0%	9.0%	61.1%	57.7%	56.6%	5.8%

Total investment in new tech and Cumulative Net Farm Income

		Base2: Current Luse, only ST credit max \$500/ha, 1% /annum decrease in yield, 1% increase in water requirement	Scen1: Current Luse, ST+LT credit max \$2000/ha, 30% yield increase other tech, 40% micro, drip	Scen2: Same as Scen1, relax cotton-wheat control 30%	Scen3: Same as Scen1, 50% subsidy, strict control wheat/cotton	Scen4: Same as Scen1, 50% subsidy, relaxed control wheat/cotton	Scen5: Same as Scen1, relax cotton-wheat control 30%, 15% price increase, no-subsidy	Scen6: Same as Scen1, relax cotton-wheat control 30%, 20% increase interest rate
Result	Base: Current Luse*, only ST credit max \$500/ha							
Cumulative Net Farm Income (NPV 20-years)	6 655.8	6 016.7	10 460.8	15 622.2	11 974.2	17 064.8	20 815.8	15 254.9
Relative change	0.0%	-9.6%	57.2%	134.7%	79.9%	156.4%	212.7%	129.2%

Estimated possible yield gains

Crop	Yield (ton)					
	Bukhara	Kashkan darya	Surkhan darya	Khorezm	Global Average (2008)	Best Practices (irrigated)
Cotton	3.21	2.7	2.8	2.75	2.1	6
Wheat	3.63	5.6	4.12	4.2	3.1	8
Barley	3.5	4.1	3.9	4.19	2.7	7
Maize	20	30	15	30	5.1	15
Rice				4.3	4.3	6
Millet	1.4	1.6	1.7	1.3	1	?
Potatoes	25	15.7	16.2	18.4	18	75
Tomatoes	25	22	35.3	24.8	28.2	100
Cabbage	20	26.5	31.5	22.4	22.3	120
Onions	30	23.76	26	27	19.4	80
Carrots	26.5	22.6	25	25.4	22.8	80
Cucumber	24.55	23	23.7	18	16.7	35
Watermelon	20	16	15	19	26.6	60
Apples	15	7.39	9.7	13	14.5	45
Apricots	14.9	8	7.7	10	7.4	30
Grapes	12	7.24	6.3	12	9	25
Lucerne	20	21	14	20	?	25

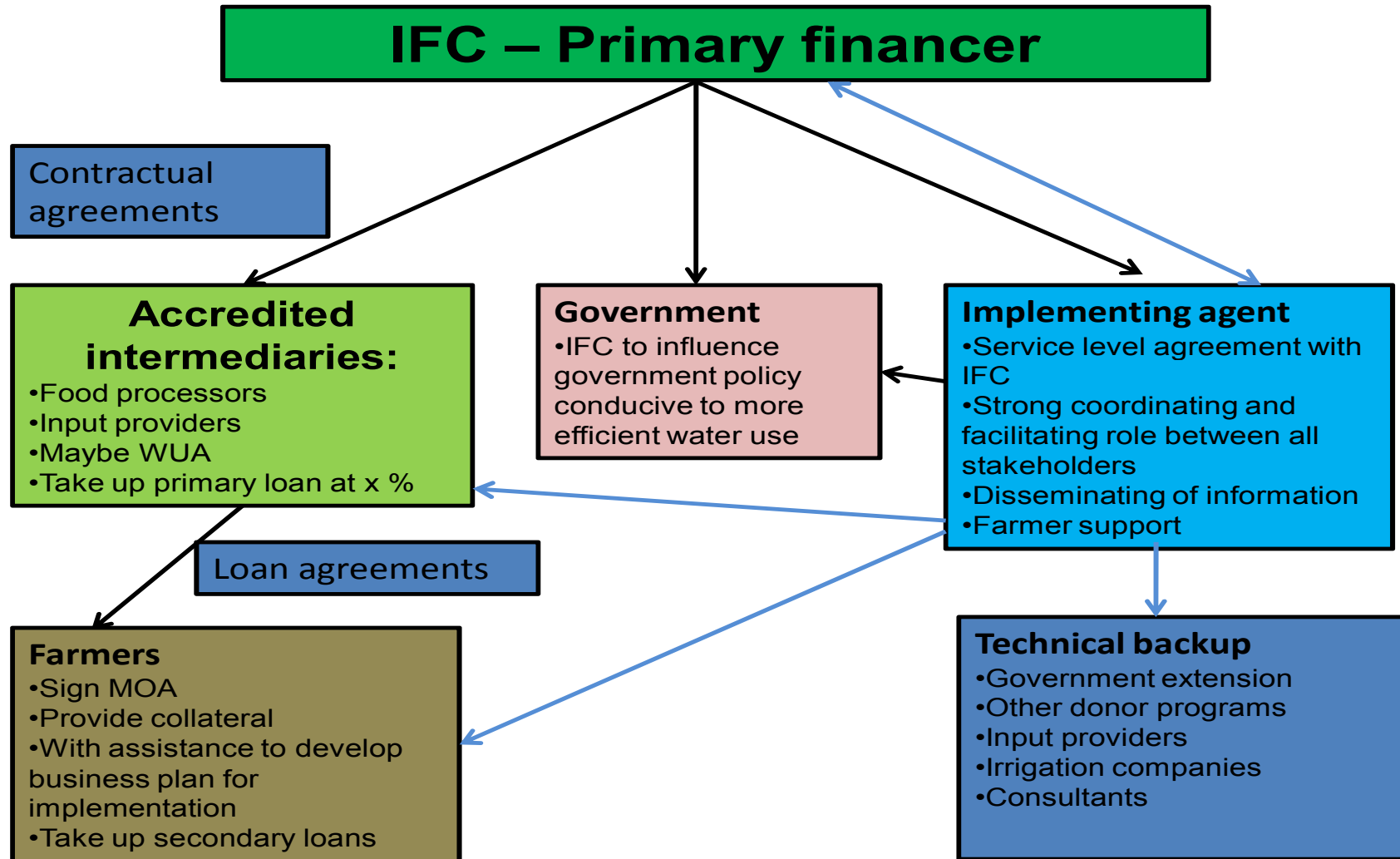
Scenarios to calculate payback of subsidies to the community

- **Scen10:** 20% up and down variation in cotton and wheat area allowed and 50% up and down variation in vegetable/fruit area allowed, run without yield gain for Sprinkler - 20% yield gain for the other irrigation technologies and 30% for drip and micro on long-term crops.
- **Scen18:** Same as Scen10, but 20% subsidy on the capital cost of irrigation systems
- **Scen19:** Same as Scen10, but 30% subsidy on the capital cost of irrigation systems
- **Scen20:** Same as Scen10, but 40% subsidy on the capital cost of irrigation systems
- **Scen21:** Same as Scen10, but 50% subsidy on the capital cost of irrigation systems

Subsidies and payback by community

Item	Scen10: Relax control, no yield gain Sprinkler, 20% yield gain other	Scen18: 20% subsidy	Scen19: 30% subsidy	Scen20: 40% subsidy	Scen21: 50% subsidy
Area converted (ha)					
Lazer	541	737	1002	809	780
Drip	55	125	156	209	241
Micro	0	0	0	0	0
Pivot	0	0	0	143	143
Sprinkler	0	0	0	0	0
Government subsidy (\$USD)					
Lazer	NA	265,215	541,141	582,357	702,167
Drip	NA	100,136	187,000	333,657	482,251
Micro	NA	0	0	0	0
Pivot	NA	0	0	194,769	243,461
Sprinkler	NA	0	0	0	0
Total government subsidy (\$USD) - Present Value		365,351	728,141	1,110,782	1,427,879
Objective function value over 20-years (Present Value)	16,979,767	17,801,256	18,311,466	18,816,006	19,328,346
Additional output resulting from subsidies (total)		821,489	1,331,699	1,836,239	2,348,579
Assume value added in secondary industries of 3		2,464,467	3,995,097	5,508,717	7,045,737
Average additional output per annum (20-years)		123,223	199,755	275,436	352,287
Assume say 25% tax paid on additional output per annum		30,806	39,951	55,087	70,457
Subsidy payback by community (years)		11.9	18.2	20.2	20.3

Proposed institutional model



Mitigating the risks

- **Form of ownership** – legal entity.
- **Land tenure** (security and or ownership)
- **Lack of credit facilities** and access to electronic banking. This is a risk for farmers and for the project since it makes credit transactions difficult for farmers. Electronic banking also contributes to improved financial record keeping and hence a reduced risk for financiers.
- **Access to information**
- **The availability and prices of inputs.** Similar to the above point. Farmers market risks increases significantly if they do not have access to this information.
- **Inefficient market structures.**
- **Bureaucratic inefficiency.** The financing model should not be complicated, it must be transparent, there must be advantages for all the stake-holders, it must be institutionalize in such a way that there is a minimum of bureaucracy to reduce transaction costs for farmers.
- **Deficient program design.** Top down approach leads to failures.
- **Public orientated, staff-intensive information delivery services.** The electronic media and direct linkages to technical input providers can reduce the risk of a lack / failure in information delivery.
- **Top-down approach in technology transfers.** If famers are not involved, there is a risk that they will not implement models and or recommendations.

- **Short-term loans should not be used to finance long-term capital.**
- It is therefore proposed that the financing vehicle consists of **both short and medium-term loans.**
- A contract with the terms and conditions should be signed between the intermediaries and the **IFC and between the intermediaries and the farmers.**
- The contract should make provision that farmers **are not exploited and that the interest rate is fixed to a maximum level.**
- The intermediaries on the other hand should follow a **stringent screening process** (not bureaucratic) to select farmers to qualify for a loan.
- In support of the abovementioned **minimum management practices**; it is proposed that the intermediaries also play a facilitation role to connect farmers with technical support from irrigation service providers and extension officers and or other experts (which is a scarce commodity in Uzbekistan).

Key conclusions

- *In order to encourage more sustainable rotations, it may make sense for government to review their policies on cotton and wheat production control.*
- To date there has been **very little private sector participation in the formulation of policy for the fruit and vegetable subsector**
- The lack of extension services per se and scarce knowledge is a **contributing factor towards the slow adoption of new irrigation technologies.**
- **Efficiency is not only about the hardware (i.e. irrigation systems); management systems and strategies would often yield far greater benefits than switching from one system to another.**
- **An incentive for change is very important**
- In the Uzbekistan situation **where ownership of land is not secure**, this will play an important role in the selection of a more efficient irrigation system.
- Uzbekistan probably **had the comparative advantage to produce cotton** (even if there were to be a free market environment). However???
- For the greater benefit of the Uzbekistan economy, **there should be value added to agricultural produce.**

- The authors are of the opinion that the proposed financing program can make a huge contribution **towards being the catalyst for increased** agricultural output.
- **It can be concluded, that without technical backup and extension services, which will contribute to the attainment of higher yields, farmers will not convert large areas to new technologies** since they will not reap the full benefit of their investment.
- A significant result is that **it can be concluded that government fears that cotton and wheat production will be reduced significantly when control is relaxed is not substantiated.**
- The results also indicate that as farmers become **more efficient their ability to take up loans increases.**
- It can be concluded from the results that **subsidies will make a huge contribution towards the introduction of new irrigation technologies.**
- The results indicate that **it will take approximately 15 years for the community to pay back a subsidy of 20%, 18 years with 30%, 20 years for 40%.**

Key recommendations

- **Greater awareness and knowledge about irrigation systems are much needed.**
- **Care must be taken to ensure that there is a responsibility on the irrigation engineer / technician selling the system to the farmer**
- **Efforts must be made to discourage the use of equipment of poor or inferior quality.**
- **Training alone (extension officers and farmers) in the use of micro irrigation systems will be insufficient for successful implementation. Experienced technical people (which may include farmers) from countries where these technologies are used will have to be consulted for a period.**
- **The implementation of more efficient infield irrigation systems must go hand in hand with implementation and/or restoration of effective drainage systems.**
- **The WUA's must be assisted and empowered**
- **An enabling environment should be created for farmers to increase their productivity and their profitability. This is probably the most difficult since it will require a political will to relax the current control on the cotton and wheat industry and to PROMOTE the production of higher value crops**
- **Consider the introduction of subsidies on on-farm irrigation infrastructure and new technologies.**
- **It is recommended that the financing model be implemented in those areas with the highest level of technical support.**