RESEARCH REPORT

88

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International Water Management Institute

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“Bright Spots” in Uzbekistan, Reversing Land and Water Degradation while Improving Livelihoods: Key Developments and Sustaining Ingredients for Transition Economies of the former Soviet Union

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IWMI receives its principal funding from 58 governments, private foundations, and international and regional organizations known as the Consultative Group on International Agricultural Research (CGIAR). Support is also given by the Governments of Ghana, Pakistan, South Africa, Sri Lanka and Thailand.

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Acknowledgements: The authors wish to acknowledge the leaders of the respective farms, whose success inspired this work, and appreciate their willingness to openly share their information, experiences and knowledge with the research team. The authors also thankfully acknowledge the consultancy inputs of Professor Kosimdjon Rakhmonov and Odil Akbarov, who identified and initially documented the selected cases, collecting valuable information from the sites which were highly instrumental in reporting this research. Finally, we wish to thank the reviewers for their constructive comments and criticism in earlier drafts of the manuscript.

Ul Hassan, M.; Noble, A.; Kazbekov, J. 2005. *Bright Spots in Uzbekistan, reversing land and water degradation while improving livelihoods: Key developments and sustaining ingredients for transition economies of the former Soviet Union*. Research Report 88. Colombo, Sri Lanka: International Water Management Institute. (IWMI) 42p.

/ soil fertility / crop yield / water management / water pollution / land / mechanization / salinity / fertilizers / maintenance / agrarian reform / irrigated farming / leadership / income / farmers / sustainability / Uzbekistan /

ISSN 1026-0862
ISBN 92-9090-590-5

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Summary

Following the dissolution of the former Soviet Union (FSU) and the collapse of existing trade arrangements, the newly independent states of Central Asia have been left with the task of developing their own independent market economies. The region has undergone tremendous economic and social changes. Economies have shrunk, incomes have fallen, poverty has increased and food security has been compromised. Significant agricultural reform has occurred, mainly targeted at privatizing the large collective farms that were established during the Soviet era. These reforms include the establishment of smaller private and cooperative farms in order to improve the efficiency and equity of existing production systems. Within Uzbekistan, this move to privatize farms has, in the majority of cases, led to declining productivity and net incomes. However, there are instances where privatized farms and smaller collectives have been able to capitalize on these changes and perform at levels exceeding the norm. The objectives of this study were to identify the key attributes of these successful farms that have been termed 'bright' spots. A multistage purposive sampling technique was used to identify three cases in degraded areas of Uzbekistan, that is, locations experiencing a slow and gradual transition from a centrally planned economy to a market-based economy. Subsequently, we compared an improved farming system (research object) and the norm (control), closely analyzing each of the farming operations to identify the key drivers contributing to the success of the research objects.

Long-term yield data is presented to indicate that during the Soviet-era there were no significant differences in productivity between each of the farming units. However, this drastically changed during the privatization phase and subsequent introduction of wheat/cotton rotations, with 'bright' spots consistently outperforming the reference sites. The 'bright' spot enterprises achieved higher yields (40 percent and 64 percent higher for cotton and wheat yields, respectively), reduced salinity, increased profits between three and seven fold and increased farm workers income by 125 percent. All of the 'bright' spot farms were of a larger size than the reference sites, clearly indicating that farm size is a factor which cannot be overlooked. This suggests that there is a critical farm size that dictates financial viability under the prevailing economic and policy environment. It is suggested that there is a need to define critical farm size before embarking on wholesale privatization.

The most significant factor behind the development of these 'bright' spots has been the breakup of the FSU and the transfer of land to private ownership. This has allowed able, knowledgeable and articulate individuals to manage successful and sustainable farming operations. Individual leadership was the crucial element behind the success of these 'bright' spots when compared to the reference objects. Other striking commonalities among all the analyzed 'bright' spots were the use of organic soil amendments, attention to recommended agronomic practices, the accumulation of farm machinery, ensuring timely agricultural operations, care and maintenance of infrastructure, the use of smart financial and non-financial incentives to keep hired workers motivated and productive, honoring commitments made to workers and agencies, effective networking inside and outside the community and anticipation of and advance action for problems likely to reduce farm revenues. These have all contributed to the success of these farms and were contingent on the innate

qualities of the farm leaders. It is, thus, evident from these ‘bright’ spots that social capital has been enhanced at the community level.

With the demise of the large collective farm structure and a move towards smaller collective and private farms, there has been a transfer of collective responsibility to individual responsibility. Individuals who once were a single component within a large and diverse production unit, (for instance, as tractor drivers), have now become responsible for the operation of an entire farming unit. Clearly, there are issues with respect to skills of the new landowners in running privatized small farming units that would in part account for the poor performance of the majority of these farms in the Republic. If these ‘bright’ spots are to be replicated over a much wider area, a key prerequisite will be addressing inadequacies in skills of individuals running small farm enterprises.

These cases clearly indicate that on-farm improvements in management can have a significant positive impact on profitability and sustainability. It is anticipated that this detailed analysis of ‘bright’ spots can provide the information necessary to extend these successes to a larger number of farms in the region. For example, in an assessment of key drivers associated with the development of these ‘bright’ spots, it would appear that individual aspirations for change are a key element in the success of these cases. In addition, a low risk of failure was deemed to be important clearly indicating the farm leaders’ aversion to risk. What is unique with respect to these three cases is that they have developed internally with no external agent, (i.e., a Non-Governmental Organization or Governmental Organization), facilitating their development through incentives and/or financial support. The results and discussions in this paper have important policy implications for Uzbekistan, in particular, and for economies in transition in general. It is argued that despite the restrictive agricultural production environment in Uzbekistan, social capital attributes among communities and individuals can contribute to preventing resource degradation while improving livelihoods in relatively degraded areas. The presence of such successful cases clearly demonstrates that ‘bright’ spots might be widely replicable under a favorable enabling policy environment.

"Bright Spots" in Uzbekistan, Reversing Land and Water Degradation while Improving Livelihoods: Key Developments and Sustaining Ingredients for Transition Economies of the former Soviet Union

Andrew Noble, Mehmood ul Hassan and Jusipbek Kazbekov

Introduction

The breakdown of the former Soviet Union (FSU) has lead to the emergence of five independent states in Central Asia (Uzbekistan, Turkmenistan, Kazakhstan, Kyrgyzstan, and Tajikistan) that are in a gradual transition to market-based economies. Economic reforms are occurring at varying rates with Tajikistan, Kyrgyzstan and Kazakhstan pursuing rapid transition policies, while Uzbekistan and Turkmenistan have followed cautious approaches. Prior to independence from the FSU, the Central Asian economies were interdependent within a centrally managed Soviet economy. Each of the Republics was agriculturally specialized according to agro-climatic zones, with production and marketing distributed through the entire Soviet trade system. Following the dissolution of the FSU and the collapse of existing trade arrangements, the newly independent states were left with the task of developing their own independent market economies.

The region has undergone dramatic economic and social changes following the dissolution of the FSU. Economies have shrunk, incomes have fallen, poverty has increased and food security has been compromised. Consequently, poverty has increased in the region from 25 to 40 percent (World Bank Development Indicators Database 2001; ADB Key Indicators Database 2001). The last years of the Soviet period witnessed increasing trends in natural resource degradation due to massive irrigation and drainage system development as well as the conversion of vast tracts of deserts into irrigated agriculture. The emergence of state borders in the Aral Sea basin that was once managed as a single integrated river basin system, further aggravated the situation with respect to environmental sustainability as sovereign states in central Asia pursue national agricultural policies and reforms to make their agricultural sectors productive and efficient with a clear disregard of environmental implications downstream (Gleick 2000). Several downstream regions along the Syrdarya and the Amudarya Basins have exhibited increased trends in land and water degradation and declining crop yields as a result. Such trends have threatened food security not only within the areas where degradation is occurring, but also Central Asia as a whole (Klotzli 1994).

The agricultural reforms that have occurred have been mainly targeted at privatizing large collective farms *kolkhozes*[1] that were established during the Soviet era. These reforms included the establishment of smaller private and cooperative farms, in order to improve the

[1]Kolkhoz (Russian): A large collective farm comprising several agricultural experts and farm laborers responsible for the collective management of the production system and delivery of targeted outputs to the state. The farm administration unit was made up of representatives from the Soviet Union. A typical kolkhoz would range in size from 10-20 thousand hectares.

efficiency and equity of existing production systems. While some countries directly pursued a land privatization policy (i.e. Kazakhstan), Uzbekistan has followed a cautious approach in its pursuit of a thriving agricultural sector, by first sub-dividing the large kolkhozes into relatively smaller cooperative farms called *shirkats* [2]. The land and other assets belonging to the kolkhozes were distributed among the shirkats formed on the territory of the former kolkhoz. Since shirkats are accountable to the state and receive subsidized inputs from the state, many of them are currently suffering the same inefficiencies as those of the kolkhozes, and there is increasing evidence that the shirkat members fall into debt, instead of earning profits, even in areas where fertility and the climate are conducive for intensively managed irrigated farming. The tendency has been to liquidate such shirkats and lease the associated lands to private individuals, whereby, like shirkats, these so-called private farmers have dictated cropping patterns and yield levels that have to be achieved in order to avoid being in debt to the state. The combination of such inefficient institutional designs2 and increasing trends in land and water degradation has resulted in the bankruptcy of several farms in downstream areas of Uzbekistan, within the Amudarya and the Syrdarya Basins. There are growing concerns over increasing trends in land and water degradation, declining productivities and rural incomes in these areas that are clearly related to the exploitation of what has been termed the 'natural capital' asset within the five capitals (i.e. natural, social, human, physical and financial capital) which contribute to sustainable livelihoods (Coleman 1990; Costanza et al 1997; Daily 1997; Carney 1998; Pretty 1998; Scoones 1998; Pretty and Ward 2001; Krishna 2002).

The role of social capital as a pillar for sustainable development has received increasing interest (Pretty and Smith 2004). Social capital, in terms of resource conservation, captures the concept that social bonds and norms are important in effecting its sustainable utilization. Social capital implies that there are aspects of social structure and organization that act as resources for individuals and communities, allowing them to realize their personal aims and interests (Pretty and Ward 2001). Four central features of social capital have been identified (Pretty and Ward 2001): (1) relations of trust; (2) reciprocity and exchanges; (3) common rules, norms and sanctions; and (4) connectedness in networks and groups. In brief, each of these components has the following attributes (Pretty and Smith 2004):

- Trust lubricates cooperation, reduces transaction costs between individuals and liberates resources. Instead of having to invest in monitoring others, individuals are able to trust them to act as expected, thus saving money and time.
- Reciprocity and exchanges promote trust. Specific reciprocity refers to the simultaneous exchange of goods and knowledge of roughly equal value, while diffuse reciprocity refers to a continuing relationship of exchange that is eventually repaid (Coleman 1988; Putnam 1993).
- Common rules, norms and sanctions are the mutually agreed upon or handed down norms of behavior that ensure group interests are complementary with those of individuals (Pretty and Ward 2001). Communities that have constructive rules and sanctions are those in which individuals balance individual rights with collective responsibilities (Etzioni 1995).
- Connectedness specifically identifies the role of networks, within, between and beyond communities (Woolcock 2001). Of importance in the development of these networks are the concepts of bonding, bridging and linking. Bonding describes the links between people with similar outlooks and objectives, while bridging describes the capacity of groups to make links with others that may have different views. Linking describes the ability

[2]For a detailed analysis of institutional aspects of water management in Central Asia's Fergana Valley, see IWMI and SIC-ICWC, 2001.

of groups to engage vertically with external agencies either to influence policy or draw on useful resources (Pretty and Smith 2004).

There is increasing evidence to suggest that if these social capital conditions are met, then local people's economic and social wellbeing will improve (Pretty and Ward 2001). In this respect, households that have greater connectedness have higher incomes (Narayan and Prichett 1996; Krishna, 2002; Wu and Pretty 2004), better health, higher education achievements, increased longevity (Fukuyama 2000), improved social cohesion (Schuller 2001) and better links with government (Putnam 2000). However, there is a cautionary note that needs to be considered with respect to local trust and connectedness that deliver economic benefits (Pretty and Ward 2001). A society may be well-organized and may have strong institutions and embedded reciprocal mechanisms but still not be based on trust but on fear and power; examples include feudal, hierarchical, racist and unjust societies (Knight 1992). This may reflect some of the attributes of institutional structures within agricultural collectives under the FSU where intuitively one would view these structures as having high social capacity.

There are a number of individual cases in Uzbekistan where private and cooperative farms (i.e., shirkats) have managed to achieve reasonably high yields and profitability, while maintaining degradation at a sustainable level. These examples appear to have developed significant effective social capital as a means of coping with both biophysical and financial constraints. The objective of this study was to document selected cases through a comparative study and determine the key drivers and processes that have resulted in the development of these sustainable production systems. These so-called anomalies have been termed *bright spots*[3] and are characterized as having higher levels of income and livelihood attributes along with elements of sustainable land and water management. Three comparative case studies from the Bukhara, Syrdarya and Djizzak Provinces of the Republic of Uzbekistan were undertaken and included a well- performing collective shirkat and two private farms. The study focused specifically on the collection of quantitative and qualitative data that could be used to explain differences in the performance of these 'bright' spots with respect to similar underperforming farming enterprises.

Methodology

Site Selection and Data Acquisition

The study is based on information that can be classified into three categories, namely, secondary literature and data review from material in the public domain as well as grey literature; diagnostic surveys that included detail interviews with the respondents; and finally a structured questionnaire survey to identify the drivers associated with the development of the 'bright' spot by key respondents.

A multistage purposive sampling technique was used to select the research objects (i.e. 'bright' spot). Based on the land quality classification and the Bonitet Grade (See Annex 1 for details) of Uzbekistan, the three provinces

[3]A 'bright' spot can be defined as individuals, small communities and households that adopt innovative practices and strategies to reverse degradation of natural resources in a sustainable manner while maintaining or enhancing food security. They tend to occur in an environment that is generally degraded.

with the poorest land quality were selected in the first stage (Bukhara, Djizzak and Syrdarya). Within each of these selected provinces, the district with the lowest land quality Bonitet Grade was chosen. Since the shirkat and private farms[4] are the two major types of farming systems in Uzbekistan, it was decided to choose both farming systems in this study to capture differences attributable to individual versus collective farming systems. The precise identification of the 'bright' spots (research objects) was undertaken based on media and other published and unpublished reports and sources of information documenting them as "success stories" in irrigated agriculture using three criteria; a) highest reported yield per Bonitet grade, b) meeting the state yield target continuously, and c) positive reputation of the farm among officials, authorities and neighboring farmers. The control objects for comparison were chosen based on their representation of the general situation within the district or the province with regard to salinization, land quality, productivity and farm incomes. These control objects represent the norm under which the majority of farming enterprises are currently operating.

The basic indicators used in defining the research and the control objects were the percentage area characterized as highly salinized, yields of major crops and overall profitability of the farm. Information sources with respect to the geography, soils, land and water resources, and weather were obtained from various issues of national, provincial and district reports (Goskomzem 2001; Uzdaverloyiha Annual Report 2002; Ministry of Agriculture and Water Resources 2002; Goskomzem 2002a, Goskomzem 2002b, Goskomzem 2002c). In addition, the records of the district land management departments were also consulted.

To collect detailed information on the processes and strategies pursued by farming unit members and their management, a number of players were identified, visited and interviewed in detail. Several rounds of interviews were held with farm management, including the chairmen, farm accountants, agronomists and key farmers. In addition, relevant staff of land management departments was interviewed to cross-check the information provided through the documented sources. Service providers, such as heads of banks, representatives of service companies, heads of water management organizations, district government staff, staff of land reclamation services and seed distribution services, were also interviewed to enhance our understanding of these farming systems. Maps and schematic diagrams of the selected objects were also widely consulted. The yield, income and irrigation water volumes were obtained from the records of farms, as well as through the interviews. However, in several cases there was some reluctance on the part of farm managers to divulge exact income figures; hence the value of production has been estimated from production levels, average production costs associated with cropping systems and current prices paid by the state for key commodities.

A questionnaire survey was undertaken of the three 'bright' spot leaders to assess the key drivers associated with their development. Within the survey, farm leaders were requested to respond on a scale of 1 to 5 whether the following 10 key drivers were important in the development of the 'bright' spot:

1. *Quick and tangible benefits*. Immediate tangible benefits to the community or individual are an important requirement for the development of a 'bright' spot. For example, this may include increased yields within the first year of implementing changes; a reduction in the costs of labor etc.
2. *Low risk of failure*. Resource poor farmers by their very nature are risk-averse, hence any changes that are made to create a 'bright' spot need to have an element of low risk.

[4]A private farm is land that is leased to an individual, who is obliged to meet and deliver the production target to state marketing system.

3. *Market opportunities*. Markets are essential for a 'bright' spot to develop. If there is to be a change in practices that are contingent on the production of a new or alternative crops/ products, markets need to be present and assured to effect this change.
4. *Aspiration for change*. This reflects an internal demand by an individual or community for change that may be driven by faith or a wish to try something different.
5. *Innovation and appropriate technologies*. Innovations, new technologies and information are important key components in the development and continuance of a 'bright' spot. This includes new skills and knowledge that contributed to the development of a 'bright' spot.
6. *Leadership*. There has to be strong leadership, if a 'bright' spot is to develop and continue. This may include a single individual or group that champions change.
7. *Social Capital*. 'Bright' spots develop where there are community organizations, networks and partnerships (private as well as public). This social capital also includes intangible aspects of social organizations such as norms and rules of behavior that can play an important role in promoting sustaining change.
8. *Participatory approach*. 'Bright' spots require deliberative processes that actively involve the community in the decision-making process. This includes a strong element of learning and teaching.
9. *Property rights*. Secure (individual or communal) property rights, which facilitate change, are essential for the development and continuance of a 'bright' spot.
10. *Supportive policies*. Favorable changes in supportive policies at the local, regional and national levels are key drivers for the development and continuance of 'bright' spots.

These 10 drivers were developed through 'expert knowledge' from a panel discussion group held at a workshop in Bangkok in February 2003.

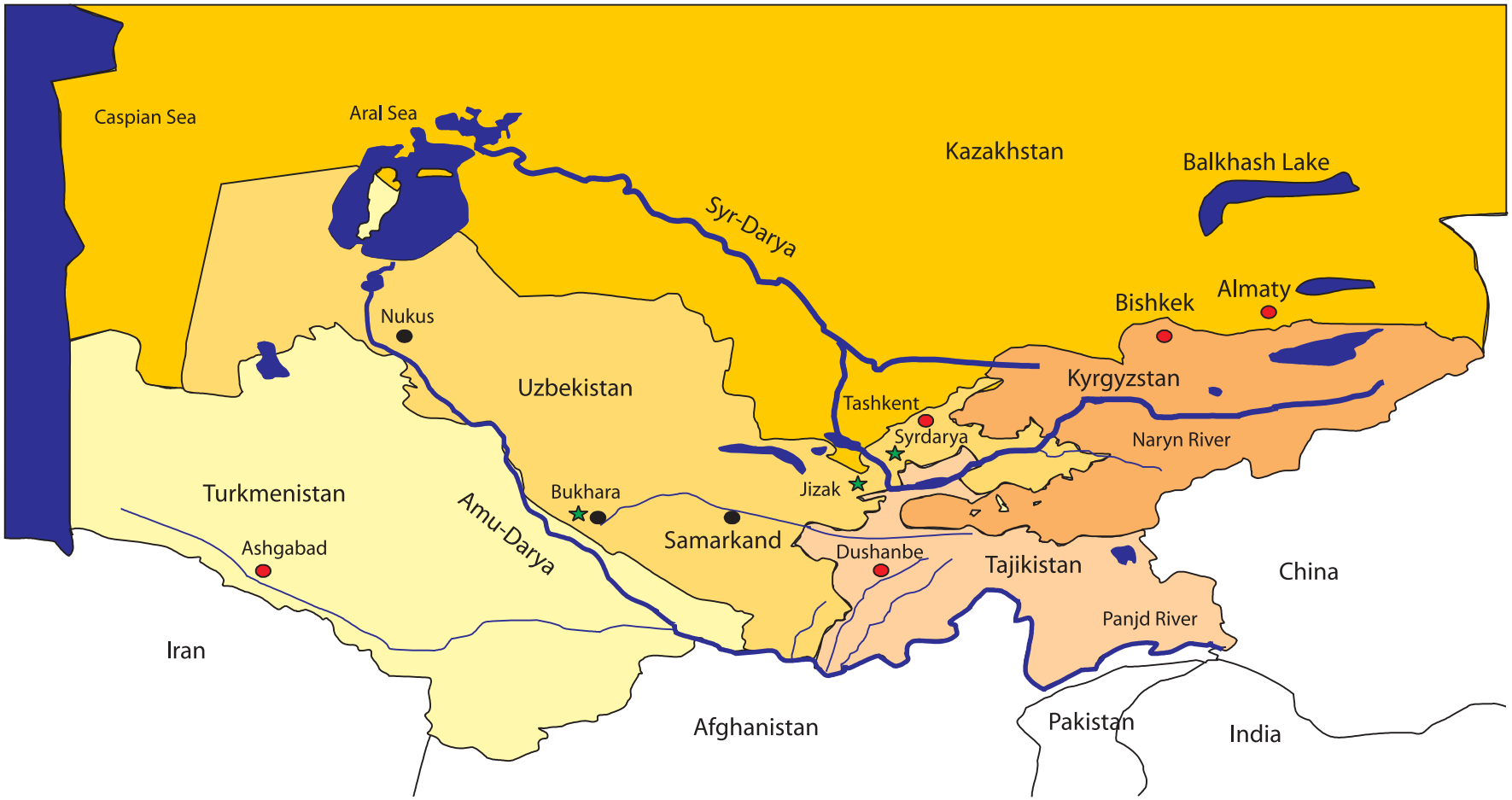
Description of Case Study Sites

Bukhara Province

The overall farming unit under investigation is one of 16 shirkats in the Province of Bukhara. Each shirkat comprises a collective of individuals forming a cooperative farm. The shirkats are managed by a chairman appointed by the District government whose responsibility is to first achieve the state quota (referred to as the 'Plan') in the production of specified crops and secondly, to generate profits for members of the shirkat. Of the 16 shirkats in Bukhara province, only 3 are performing exceptionally well and achieving above expected production levels, while the remainder are either achieving or falling below expected district levels.

Bukhara shirkat (research object) is situated in the south-east of Shafirkan district, while Osiyo shirkat (control object) is located in the northern part of the district (figure 1). Shafirkan district lies within the semi-desert zone of Central Asia with a mean annual rainfall of 120 mm. It is characterized by an abundance of cloud free days and hence high levels of incident radiation. Temperatures in July often exceed 45ºC and fall below -29ºC in January. The area lies within the geological recent delta of the Zarafshan River and is situated on an old alluvial plain (Rakhmanov and Akbarov 2002).

FIGURE 1.
Map showing the three case study sites in Uzbekistan, Central Asia.



Irrigated agriculture is the dominant agronomic activity in the district with wheat and cotton being the major crops cultivated. The current irrigation scheme was constructed in the 1950-1960s and has since had relatively little upgrading or modernization to conform with changes in irrigation management. The scheme is dominated by a concrete lined main canal (the Djulvan channel) that conveys water from the Zarafshan River over 96 km to a series of 10 inter-farm channels and subsidiary canalettes that distribute water to individual fields. The total length of such channels is 1,274 km. The supply of irrigation waters from the Zarafshan River is irregular; consequesently, drainage and return flow from irrigation is often reused for irrigation leaching activities. A secondary source of water to the scheme is the northern channel that conveys sewage effluent over a distance of 111 km.

Shirkat Bukhara has 160 and 570 ha allocated to irrigated cotton and wheat production. Osiyo shirkat has 80 and 293 ha under these crops (table 1). Besides the irrigated cropping mentioned above, lands that fall within the direct control of the shirkat administration, a further 31 individual farms with an average size of 21.1 ha on the Bukhara shirkat and 70 farms with an average size of 7.9 ha on the Osiyo shirkat have been distributed to farmers to manage and run as individual entities, although they are an integral component of the overall shirkat. Additional farming activities include the production of fruits and vegetables, viticulture, sericulture and the production of goats and sheep (table 1). Extensive pastures and forests on the Bukhara shirkat add to the diversity of the farming unit. As the region is prone to excessive wind erosion, the establishment of windbreaks on Bukhara shirkat has been promoted by the farm manager in order to reduce the negative impact of wind blast on crops.

Soil types on each of the shirkats are similar. However, a significant issue in irrigated areas on both the research and control objects is the existence of varying degrees of soil salinity. On a percentage area basis, 17 percent and 12 percent of the soils are classified as having moderate to high levels of salinity on the Burkhara and Osiyo shirkats respectively (table 2). It is significant that in the case of Osiyo, 8 percent of the irrigated area is categorized as having a high level of salinity in contrast to 4 percent at Bukhara (table 2).

On the Bukhara shirkat, organic composts and manures are applied to soils on a routine basis during the land preparation phase. The amounts applied are equivalent to 15 t ha^{-1}, of which 50 percent is incorporated into the soil surface (0-20 cm) using a disc plough and 50 percent is mixed and applied with irrigation water. These organic materials are produced from penned goats and sheep on the settlement and trucked in from cattle farms situated 20 to 30 km from the shirkat. Additionally, organic household waste materials produced on the shirkat and organic wastes from a wheat processing plant in close proximity to the shirkat are used as soil organic amendments. In contrast, at Osiyo, shirkat a total of 5-10 t ha^{-1} of organic fertilizer is applied annually, of which 80 percent is applied as a broadcast application at planting and the remainder through the irrigation waters during the growing season. This strategy of routinely applying organic matter to fields has had a positive impact on maintaining soil structure and fertility. Mean soil organic carbon contents on the Bukhara and Osiyo shirkats are 0.45 percent and 0.27 percent respectively, clearly demonstrating the positive impact of routine applications of organic amendments (table 2). A strict crop rotation policy is adhered to on the Bukhara shirkat with respect to the production of cotton and wheat, entailing a cropping sequence of cotton/wheat/fallow. In contrast, such crop rotational management strategies are not practiced on the Osiyo shirkat or the other shirkats in the District.

In spite of the relatively difficult conditions and the degraded state of soil resources in the District—based on Bonitet grades (table2)—average yields of cotton and wheat on the Bukhara and Osiyo shirkats were 2.85 and 7.00 t ha^{-1} and 1.69 and 4.21 t ha^{-1} respectively (table 3). These levels of production are in general

TABLE 1.
Attributes associated with selective human and biophysical characteristics of the three cases studied.

		Bukhara Case		Dijizzak Case		Syrdarya Case	
		Research	Control	Research	Control	Research	Control
		Bukhara	Osiyo	Shermat	Nigora	Ikrom	Masariddin
Indicator	Unit	Shirkat	Shirkat	Farm	Farm	Farm	Farm
Population of farm	heads	421	196	14	6	33	12
Number of households in the object	heads	65	39	5	3	11	2
Total area of enterprise	ha	4,730	1,904	54	31	138	57.2
Area under cotton	ha	160	80	25	15	80	24.4
Area under wheat	ha	570	293	20	13	40	25
Area under pasture	ha	3,447	0	0	0	0	0
Area under corn	ha	0	0	0	2	0	0
Area under long-term crops, vineyards, gardens	ha	37	439	3	0	0	1.8
Area under forest	ha	32	7	0	0	0	0
Area under vegetables, melons	ha	0	0	4	0	0	0
Area under households	ha	23	12	0.2	0	0	0
Area under drainage and conveyance network	ha	15	18	1.5	1	6.5	2.5
Area for other purposes	ha	446	1,055	0	0	11.5	3.5

TABLE 2.
Selected soil quality attributes associated with each of the case studies. Data provided by State Departments.

Indicator	Unit	Bukhara		Dijizzak		Syrdarya	
		Research Bukhara Shirkat	Control Osiyo Shirkat	Research Shermat Farm	Control Nigora Farm	Research Ikrom Farm	Control Masariddin Research
Organic matter content	%	0.45	0.27	0.85	0.72	0.9	0.6
Bonitet	Grade	39	40	42	42	40	41
Phosphorus, P	mg kg^{-1}	17.2	19.3	18	15.3	25.7	20.6
Potassium, K	mg kg^{-1}	221.2	199.7	250	199.8	472	377.2
Low saline soil	%	62	40	30	40	40.5	12
Moderate saline soil	%	13	4	40	37	49	53
Highly saline soil	%	4	8	12	9	10.5	35
Non-saline soil or not assessed for salinity	%	21	48	18	14	0	0

above the District average of 2.5 and 2.8 t ha^{-1} for each of the crops and exceed the indicative production levels estimated from the Bonitet grades on which Plan production levels are based (table 3). It is interesting to note that overall production levels of each of the aforementioned commodities in 2002 were significantly above Plan production levels as set by the state (table 3).

As reported yield levels only reflect a single year's data, it is difficult to undertake a statistical assessment of productivity differences between the two shirkats. Using long-term (1980–2002) farm records and dividing the period into distinct periods, a statistical assessment of the performance of each of the shirkats was undertaken. The periods coincided with distinct political and policy changes and differed for each of the crops as follows:

Cotton:

1980 – 1991	The former Soviet era.
1992 – 1997	Privatization of farming units.
1998 – 2002	Wheat self-sufficiency achieved within the Republic of Uzbekistan.

Wheat:

1994 – 1997	Wheat-cotton rotations introduced.
1998 – 2002	Wheat self-sufficiency achieved within the Republic of Uzbekistan.

During the Soviet era (1980–1991), cotton yields between the two cases were not significantly different; this suggests that the two farming enterprises were operating at similar levels (figure 2). During the period 1992–1997, privatization of state owned farms occurred. During this period, significant increases in yields between the two cases started to emerge with average cotton yields on Bukhara and Osiyo shirkats reaching 2.53 and 2.15 t ha^{-1} respectively (figure 2). Over the period 1998–2002, coinciding with the Republic of Uzbekistan's self-sufficiency in wheat production, yields of cotton continued to increase significantly on the Bukhara shirkat, while production levels declined dramatically on Osiyo shirkat (figure 2). These data clearly demonstrate the significant positive impact of privatization and the introduction of a cotton/wheat rotation has had on productivity levels in the Bukhara case, when compared to the Soviet-era. These positive effects were not evident on the Osiyo shirkat. Similarly, wheat yields were significantly high on the Bukhara shirkat when compared to Osiyo shirkat over both the introduction phase of wheat-cotton rotations (1994–1997) and the self-sufficiency phase (1998–2002) (figure 3). It is also of note that the between these two phases, wheat productivity increased to a higher level on the Bukhara shirkat (figure 3).

TABLE 3.
Production levels associated with the cotton and wheat on each for each of the cases.

		Bukhara Case		Dijizzak Case		Syrdarya Case	
		Research	Control	Research	Control	Research	Control
		Bukhara	Osiyo	Shermat	Nigora	Ikrom	Masariddin
Indicator	Unit	Shirkat	Shirkat	Farm	Farm	Farm	Farm
Planned cotton yield (Bonitet grade x 0.04)	t ha^{-1}	1.56	1.6	1.68	1.68	1.6	1.64
Planned wheat yield (Bonitet grade x 0.06)	t ha^{-1}	2.34	2.34	2.52	2.52	2.4	2.46
Plan cotton production	t yr^{-1}	256	125	42	25	128	40
Planned wheat production	t yr^{-1}	1,254	645	50	33	96	62
Actual cotton yield	t ha^{-1}	2.8	1.6	3.2	2.8	2.5	1.8
Actual wheat yield	t ha^{-1}	7	4.2	2.8	2.4	6.3	3
Actual cotton production in 2002	t yr^{-1}	456	135	81	43	202	46
Actual wheat production in 2002	t yr^{-1}	3,990	1,233	56	31	252	75

Insufficient and irregular supplies of fresh water mean that approximately 70 percent of water used to irrigate crops is derived from drainage. This increases the risk of secondary salinization developing in fields and, consequently, influences the long-term sustainability of these systems. To enhance the performance of the irrigation supply network on Bukhara shirkat, channels are cleared of silt deposits and undesirable plants twice annually. In addition, deepening of collector drains where groundwater levels require lowering is undertaken. Excavation of ditches and channels on the Bukhara shirkat is primarily achieved through mechanical methods with only 20 percent of these field operations being undertaken manually. Costs associated with the maintenance of this network are covered by the shirkat. However, on the Osiyo shirkat, the clearing of drains and channels is carried out annually using manual labor, which is less efficient.

Leaching of accumulated salts from the profile is undertaken on an annual basis and is directed by District officials. There are clear differences in the approaches that managers of the shirkats take in achieving these leaching plans. The manager of Bukhara shirkat has a strong background in mechanization and pays particular attention to detail with respect to field leveling, salt leaching operations and monitoring. An initial annual leaching of fields occurs in the fall using sewage effluent derived from the Northern channel in December. A second leaching event is undertaken in January or February using recycled drainage water. By undertaking field leveling operations, the shirkat is able to make savings in fresh water usage of between 15-20 percent that can then be used to irrigate crops later in the season. In fields that are not established to winter wheat, checks are constructed to a height of 30-40 cm, which permits the slow dissolution of salts. On the other hand, in fields established to winter wheat, leaching water levels do not exceed 20 cm in order to avoid waterlogging that would harm the sown winter wheat. In the control object, 70-75 percent of the water used to leach salts is derived from drainage water and due to poor land leveling, there is improper leaching and non-uniform water distribution at field level.

There are permanent structures which house the farm's workforce and administration buildings within the boundaries of each of the study shirkats. Production fields are approximately 8-12 km from the settlements and there is considerable competition from qualified

FIGURE 2.
Changes in productivity of cotton between the control (Osiyo) and research (Bukhara) shirkats over three distinct periods that coincide with political and policy changes. Vertical bars represent the least significant difference ($LSD_{0.05}$) between treatment means at each period.

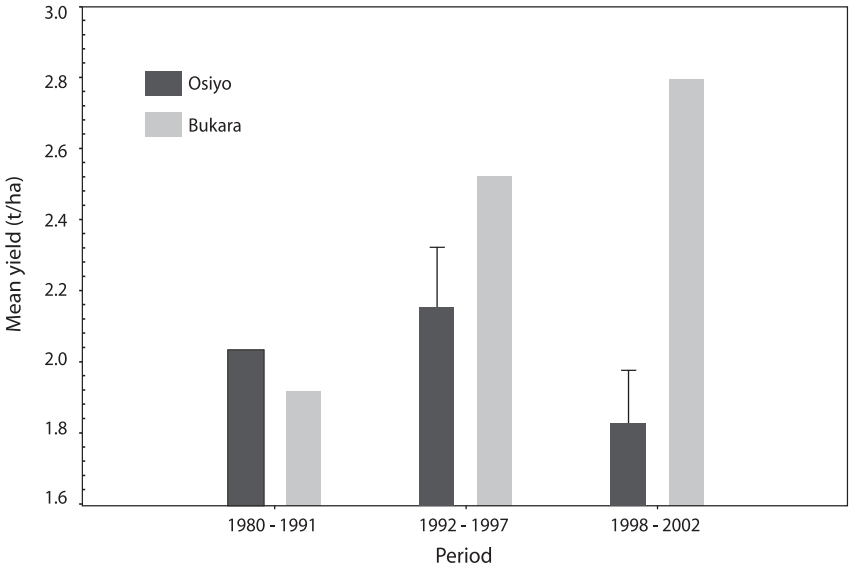
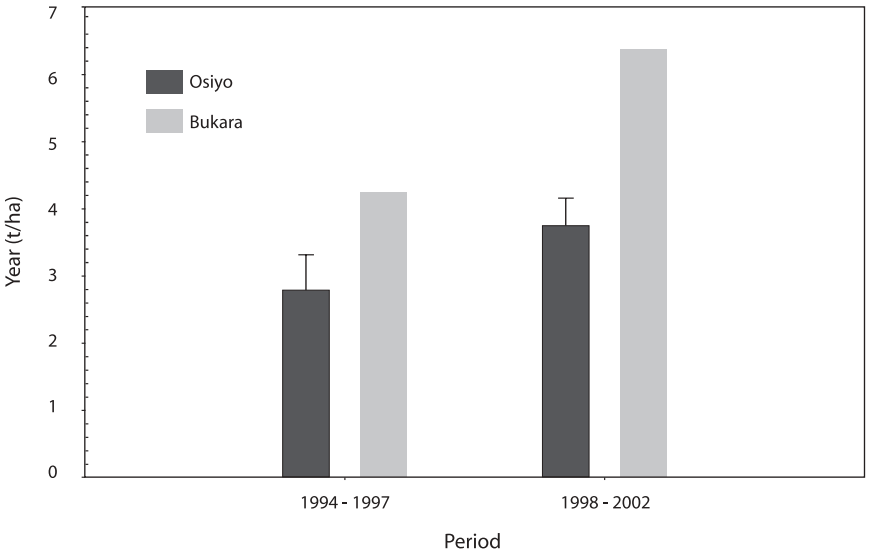


FIGURE 3.
Changes in productivity of wheat between the control (Osiyo) and research (Bukhara) shirkats over two distinct periods that coincide with policy changes with respect to achieving self-sufficiency in the commodity. Vertical bars represent the least significant difference ($LSD_{0.05}$) between treatment means at each period.



professionals (i.e., agronomists and tractor drivers) to secure contracts on the shirkats although they may come from other settlements. Contracts to undertake field operations (i.e., land preparation and seeding) are distributed on a sectional basis and these activities are overseen and managed by a senior contractor. Section contracts range in size from 15 to 90 ha. Within each of these sections, family contracts are established resulting in a further sub-division of land. In the Bukhara shirkat, each family contract covers 3-5 ha, while this is reduced to 1-1.5 ha on Osiyo shirkat. Family contracts are effectively ten year leases and their renewal is dependent on the performance of the shirkat in achieving production targets and hence meeting the Plan. In view of the aforementioned production targets set out in the Plan, in 2002, 10 percent of these leases were withdrawn from farmers on the Bukhara shirkat, while this value increased to 40 percent on Osiyo shirkat, clearly indicating the poor performance on average of these farmers. The average family size on each of the shirkats studied is similar, namely five persons including two persons that are able to undertake farm related work. The number of family contracts established in the Bukhara and Osiyo shirkats is 47 and 63 respectively. The average size of irrigated land in the aforementioned shirkats is 15.5 and 5.9 ha, respectively.

Within the Bukhara shirkat, there are several farm specialists (i.e., agronomists, irrigators and land organization specialists) who constantly supervise, advise upon and adjust practices to meet prevailing conditions. Periodic soil and water sampling is undertaken to assess changes in attributes and corrective measures are taken to minimize resource degradation. This attention to detail is not evident within the management of Osiyo shirkat. Nevertheless, the leaders of both shirkats have a vocational level of education and all field experts have higher education certificates in their disciplines.

Year round monitoring of fields, the leaching of fields and the performance of the crops is achieved through the establishment of field camps that are distant from permanent settlements. Workers are required to spend varying lengths of time away from their families. The camps are well-equipped and provide the necessary cultural and community focus that is common to the settlements. Additional income generating activities are undertaken by members in these camps, these include the rearing of livestock. One of the major factors associated with enhanced productivity levels on the Bukhara shirkat, is to do with stimulating labor productivity through a sense of land ownership and team building. This is best observed in field camps.

The average annual incomes per head for family contractor members in the 2002 financial year on Bukhara and Osiyo shirkats was US$360 and US$196 respectively (table1). These incomes appear to be rather low, presumably because of the low prices paid for state quota crops. Furthermore, livelihoods are supplemented by secondary products that include wheat, cotton seed oil and other commodities that can be used at the recipient's discretion. The extent of these secondary payments is contingent on exceeding planned production levels.

Both shirkats are dependent on a centralized district automobile-tractor park that provides tractors and harvesters on request. These services are often expensive and require payment for services prior to the activity taking place in order to ensure timeliness. At certain times of the year, timely operations cannot be assured due to demand for these services by several farmers. In an effort to minimize these negative influences on their operations, the Burkhara shirkat has adopted two approaches. First, by increasing their fleet of on-farm machinery in order to undertake in-house operations (table 4) and secondly, paying up front when the services of the District owned automobile-park are required in order to assure timeliness of activities (i.e., harvesting of crops). Increased mechanization on the shirkat enables it to contract out these services to neighboring farms thereby increasing net income.

TABLE 4.
Farm machinery asset for each of the cases studied.

		Bukhara		Dijizzak		Syrdarya	
		Research	Control	Research	Control	Research	Control
		Bukhara	Osiyo	Shermat	Nigora	Ikrom	Masariddin
Indicator	Unit	Shirkat	shirkat	Farm	Farm	Farm	Farm
Tillage machinery	Number	7	6	0	0	1	1
Transport vehicles	Number	17	14	1	0	1	0
Tractors	Number	6	0	3	0	2	0
Water pumps	Number	5	3	1	0	2	0

Dijzzakh Province

Dijizzak province is located in the central part of the Republic of Uzbekistan. The province is divided into three Districts: Zarafshan, Kizil-kum and Mirzachul. The mild weather, high temperatures and relatively humid climate of Zarafshan District create conditions conducive for dryland agronomic cropping (termed *bogara* in Uzbek). However, the Kizil-kum District is dominated by extensive grazing lands, where the climatic conditions are conducive for the production of fine wool, (termed 'astrakhan'), for export. Mirzachul District is dominated by a flat extensive plain that is under irrigated agriculture. Water resources of the Province are dominated by two rivers, namely the Syrdarya and Zarafshan Rivers. The climate of Mirzachul District is described as continental with mean temperatures in July ranging between 26-32ºC and -3ºC in January. The mean annual precipitation for the District is 230 mm.

The research object in this case study is the farm, Shermat, which is a privately owned farm established within the confines of the shirkat U. Khatamov. Similarly the reference object, Nigora, is within the same district and is part of the shirkat, Samarkand Kuduk. Both sites are on relatively degraded soils with a low production potential.

The research object farm (Shermat) comprises a total area of 54 ha, that includes 45 ha of irrigated crop lands and 7.2 ha devoted to home gardens and horticultural crops. A further 1.5 ha of the farmer is devoted to irrigation canals and collector-drains (table 1). In 2002, the total area established to cotton was 25 ha and wheat 20 ha. The total area of Nigora, the control object, is 31 ha of irrigated land, with 1 ha being occupied by irrigation and drainage infrastructure (Rakhmonov and Akbarov 2002). In 2002, 15 ha were established to cotton, 13 ha to wheat and 2 ha to corn. Both farms have similar levels of soil fertility and classes of salinity with Shermat having slightly higher levels of moderate to high salinity than Nigora (table 2).

Although the Shermat farm specializes in the production of cotton and wheat, there is a high degree of diversification through the production of livestock and domestic gardens as well. The farmer allows laborers 3.8 ha of land to grow alternative crops. A further 0.15 ha is devoted to the production of corn, melons and watermelon. This provides a supplementary source of income to the farmer. In order to maximize productivity per unit area, the farmer utilizes land adjacent to collector drains for the production of crops and vegetables. These areas are commonly referred to as waste-lands and, thus, do not contribute to the overall planned area of the farm. Consequently, harvests produced on these areas fall outside of the Plan and are not subject to official declaration. However, the cropping system has not been diversified on Nigora. Cotton and wheat remain the only cash crops.

In the 2002 cropping season, the mean levels of production for cotton and wheat on the Shermat and Nigora farms was 3.25 and 2.80 t ha^{-1}, and 2.85 and 2.40 t ha^{-1} respectively (table 3). In evaluating the average production levels for cotton and wheat over these periods, it appears that the research object (Shermat) lagged behind the control object (Nigora), before it showed significant increases in productivity levels (figures 4 and 5). It was only after the adoption of wheat/cotton rotations and self–sufficiency in the former had been reached, that cotton and wheat yields between the two cases differed significantly. In the case of the Nigora farm, yields of cotton declined dramatically during the period 1998–2002, clearly indicating the deteriorating circumstances of the farm.

On the Shermat farm, organic matter conservation is undertaken through the recycling of livestock manure and composts derived from household activities. Moreover, cattle manure is brought in from neighboring cattle production enterprises. Organic amendments are applied through the irrigation waters along with an equivalent of 10 t ha^{1} of organic fertilizer. These practices have invariably contributed to high levels of organic matter present in the soils (table 2). At Nigora, only a limited amount of inorganic fertilizers is used, and no organic wastes applied.

The supply of water to the farms and collection of tail waters are dependent on the performance and maintenance of associated infrastructure. On Shermat, a drainage pump has been installed and is operated to lower the groundwater table over 25 ha. Collector drains are cleaned and maintained by the farmer. In times of water deficiency, drainage water is used to irrigate the crop but this does not exceed 10 percent of the total demand. In contrast, previously installed vertical and open drainage systems on Nigora are poorly maintained if not abandoned. The reason for this is the lack of finances.

Labor resources on Shermat consist of 14 individuals, each responsible for 3.3 ha. On Nigora, there are 5 individuals that are each responsible for 6 ha. Both farms employ approximately 30 casual laborers during peak periods in the season. In discussions with the farm manager at Shermat, it became evident that the manager pays laborers at a higher rate than the district average and, more importantly, pays them on time. This is not the case with most farmers in the district. This strategy enables the farmer to maintain an excellent working relationship with employees and he is able to mobilize casual labor at critical periods during the cropping season as a result.

The fact that the farmer's son at Shermat is a trained motor mechanic has worked out to their advantage, too, since the latter assists in the modification of farm implements and maintenance of equipment. This has allowed the farmer to purchase tractors using personal finances and leasing agreements with the banks (table 4). The farmer is, consequently, independent of the collective auto-park to a large degree. However, the farmer is dependent on the above system for harvesting equipment. Furthermore, in order to ensure timely early harvesting of the cotton crop that carries a premium price, the farmer uses personal financial resources to pay for these operations prior to the event. The Nigora farmer does not have these resources and is entirely dependent on the centralized District tractor-park for in-field operations and harvesting. These services are often more costly and require either pre-payment for the operation to be undertaken or waiting in line for the service.

Syrdarya Province

Syrdarya province is in the lowlands of the Syrdarya River in the Republic of Uzbekistan (figure 1). The province is characterized as having a dry continental climate with an annual precipitation of 333 mm, most of which occurs in the winter and spring. Annual temperatures are notably extreme with the highest temperatures in summer occurring in July (45ºC) and the lowest in January (-29ºC).

Over the past several years, saline groundwater has risen over significant areas, with dissolved salt concentrations of 5-10 g/L. In July

FIGURE 4.
Changes in productivity of cotton between the control (Nigora) and research (Shermat) private farms over three distinct periods that coincide with political and policy changes. Vertical bars represent the least significant difference ($LSD_{0.05}$) between treatment means at each period.

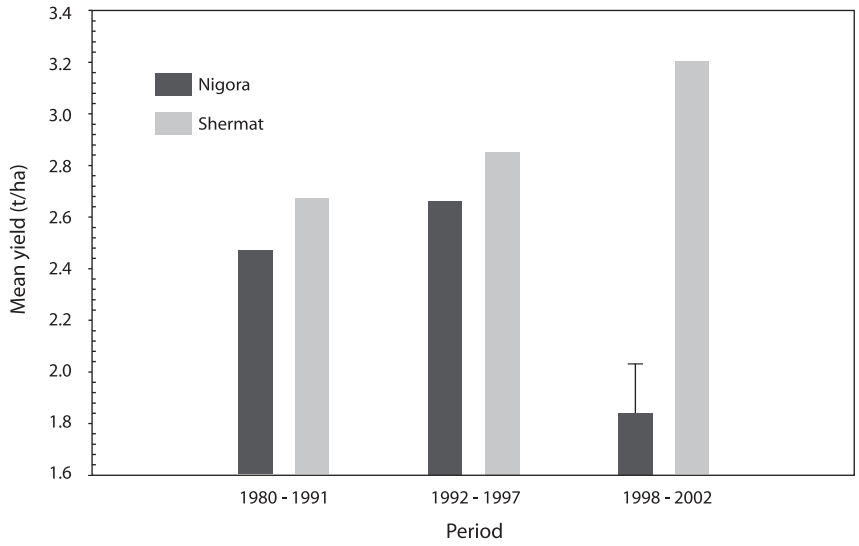
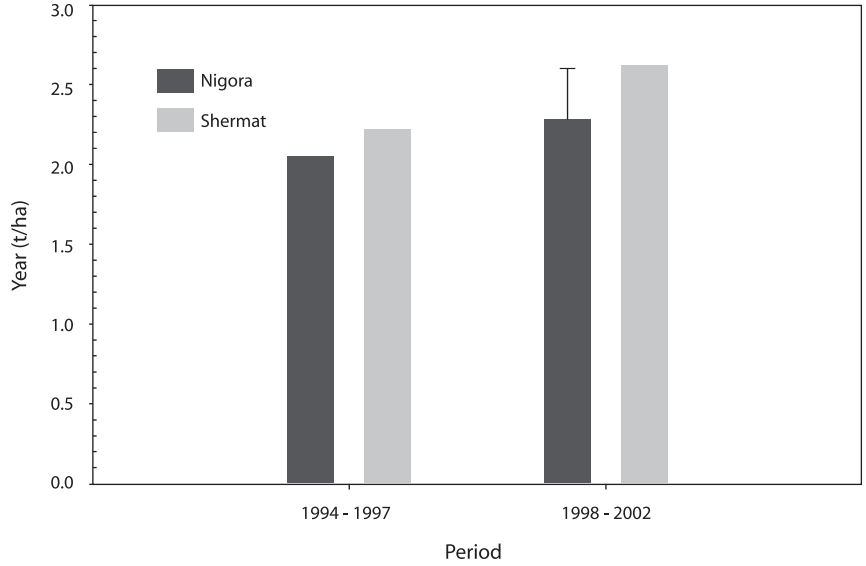


FIGURE 5.
Changes in productivity of wheat between the control (Nigora) and research (Shermat) private farms over two distinct periods that coincide with policy changes with respect to achieving self-sufficiency in the commodity. Vertical bars represent the least significant difference ($LSD_{0.05}$) between treatment means at each period.



2002, it was estimated that 89,879 ha were affected by rising groundwater resulting in salinity. This rise in groundwater is associated with the inherent topographical characteristics of the area, namely flat to undulating plains, poor irrigation practices related to the reuse of drainage water for irrigation, waterlogging and the relatively poor quality of water used for irrigation. The region as a whole is affected by wind erosion and dust storms that have an impact on productivity. Poor vegetation cover is primarily responsible for damage to crops through wind blast.

After independence from the Soviet Union, Kolkhozes that occupied 132,293 ha were divided up into 4,325 individual private farms with an average size of 30.5 ha. According to the specialization of the previous collective farming units, these private farms were designated to produce crops or livestock (cattle). The production levels of these private farms are set at the district level and are based on the state Plan and the Bonitet values for the farm. Farmers are required to achieve these production targets in order to avoid either going into debt or having the farm repossessed. Based on the performance of these private farms, a total of 47 farms were given an additional 641 ha of irrigated land due to their success in managing their operations and achieving district plan objectives. These farms have been termed 'advanced' farms and are characterized by greater financial resources, as well as technical expertise, that have been instrumental in achieving their current elevated output levels. An initiative by the Presidential State Advisor (Goskomzem, 2002a) to replicate the successes of these advanced farms was undertaken through the establishment of farmer training schools. The knowledge and experience of the advanced farmers is transferred to heads of farms through schools within the district (Uzdaverloyiha Annual Report 2002). These training schools focus on the development of on-farm business plans and advanced farmer experiences.

The example 'bright' spot is an advanced farm, Ikrom, a component of the shirkat Akmedov which is in the district of Mirzaabad. The research farm was compared to a typical private farm in the province, Masariddin, part of the Yangi yer shirkat, situated in the adjacent district of Meknatabad. Both farms specialize in the production of cotton and wheat. Secondary activities on the farms include sericulture and stock breeding along with home gardening. A strict systematic rotation on individual fields between wheat and cotton is adhered to on Ikrom. Systematic rotations on fields of Masariddin farm are not practiced. The farm Ikrom covers 138 ha, comprising 120 ha under irrigated agronomic crops, 6.5 ha of irrigation and collector drains and 11.5 ha for other activities. In 2002, cotton was cultivated on 80 ha and wheat on 40 ha (table 1). Corn and melons were grown on the remainder. Masariddin farm is 57.2 ha in extent and includes 49.4 ha of irrigated crops, an additional 1.8 ha of gardens, 2.5 ha of irrigation canals and collector drains and 3.5 ha that are not used for agricultural production. In 2002, cotton was established on 24.4 ha and wheat on 25 ha (Rakhmonov and Akbarov 2002).

Soil salinity is a major constraint to sustainable production in the region. On the Ikrom, farm, 59.5 percent of the cropped lands is classified as having moderate to high salinity levels (table 2). The farm Masaridden, on the other hand, has a total of 88 percent of its land classified as falling into the moderate and high salinity classes (table 2).

Two vertical drainage systems on Ikrom assist in lowering the watertable, thus enhancing the efficacy of salt leaching. It is probable that the use of these drainage pumps has resulted in a decline in the degree of salinization on the farm as evidenced by the percentage area that falls into the moderate and high classes (table 2). In contrast, a similar vertical drainage system is not operative on Masaridden farm and there is no maintenance of drainage collectors. There are

several factors that contribute to the ineffectual operation of the vertical drainage systems in the district as a whole. These include increased prices for electricity, a lack of maintenance and destruction of pump drainage systems, as well as the continual pilfering of pump and drainage components (i.e., electric wiring, pipes and transformers). Hence, the lack of operative drainage pumps and the poor maintenance of drainage infrastructure contribute to ineffective salt leaching from fields and continual resource degradation on most of the farms in the district.

Average cotton and wheat yields on Ikrom and Masariddin farms are 2.52 and 6.3 t ha^{-1} and 1.88 and 3.01 t ha^{-1} (table 3). It is evident that during the Soviet era, production levels of cotton were similar and there were no significant differences between farming units (figure 6). However, with the advent of privatization, yields of cotton dramatically declined at Masariddin and remained at this level up until 2002 (figure 6). Yields of cotton on the Ikrom farm, in contrast, were maintained at previous levels during the privatization phase and increased slightly during the period of wheat self–sufficiency (figure 6). Wheat yields were significantly higher on Ikrom during both periods with yields rising during the last period (figure 7). Wheat yields remained static at a level of 2.9 t ha^{-1} on the Masariddin farm over the entire period (figure 7). These differences in productivity can in part be attributed to fertilizer management strategies applied on each of the farms. The following fertilizer applications are made annually at Ikrom: N–130 kg ha^{-1}, P–90 kg ha^{-1} and K–60 kg ha^{-1}. In addition, organic soil amendments (cattle manure) that are generated on farm are applied routinely to fields; but on Masariddin, a lack of financial resources and technical expertise has resulted in the absence of fertilizer applications.

The farm manager of Ikrom has a higher education and is a qualified engineer. The total number of officially employed members of the farm is twelve people, (eleven workers and one accountant). The manager employs three tractor drivers. Each member of the farm is responsible for 11.5 ha of irrigated land. At certain times of the year, the labor force may grow to 100 workers per farm. The total area under irrigation on Masariddin is 49.4 ha and the work force is made

FIGURE 6.
Changes in productivity of cotton between the control (Masariddin) and research (Ikrom) private farms over three distinct periods that coincide with political and policy changes. Vertical bars represent the least significant difference ($LSD_{0.05}$) between treatment means at each period.

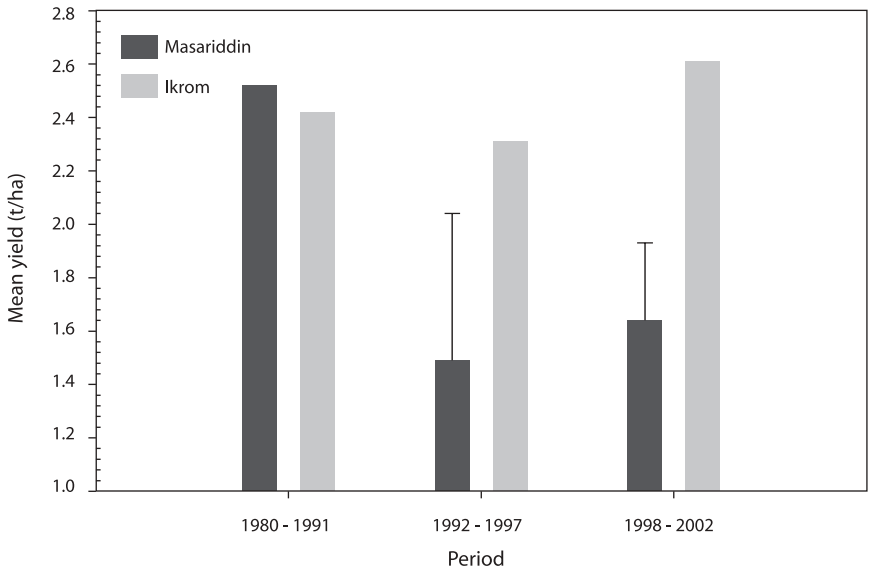
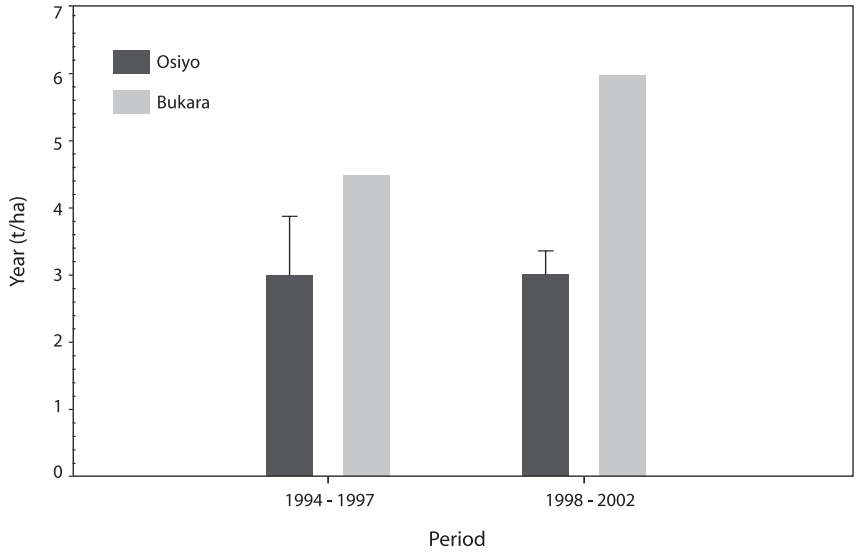


FIGURE 7.
Changes in productivity of wheat between the control (Masariddin) and research (Ikrom) private farms over two distinct periods that coincide with policy changes with respect to achieving self sufficiency in the commodity. Vertical bars represent the least significant difference ($LSD_{0.05}$) between treatment means at each period.



up of 25 workers and head of the farm; hence 2 ha of irrigated lands are managed per worker. The work force is dominated by female laborers (70 percent) who undertake many of the manual tasks on the farm.

The two farmers have contrasting management styles with respect to motivating labor. Ikrom laborers are paid US$18/month, in addition to receiving material rewards that include cotton and wheat products that they are able to use or sell for their own benefit. This approach appears to motivate workers to perform at a high level. At Masariddin, however, there are limited incentives for labor in that salaries are limited to the District average, advanced payments to workers are inadequate and there is a lack of technical expertise. Due to a lack of financial resources, payments to labor are in general made through products produced on the farm.

Ikrom farm is self-sufficient with respect to farm implements, tractors and technical expertise in their maintenance (table 4). This assures timely field based activities at considerably lower operating costs, when compared to centralized services of the auto-park. In contrast, Masariddin farm has a single DT 75 tractor that undertakes ploughing and transportation activities. While the farm has its own maintenance workshops, they lack the technical expertise to undertake servicing of machinery. They are, therefore, reliant on services provided by the centralized auto-park. These services are expensive and may not take place at the most opportune time due to high demands for these services.

Discussion

Key Achievements of the 'Bright' Spots

To combat increasing levels of land degradation and sustain or increase crop yields, farm production and income levels, the 'bright' spot examples studied have pursued several short-, medium and long-term strategies to achieve their enhanced levels of performance. As a result of these efforts and strategies, they have reversed or maintained trends in land and water degradation and achieved higher yields. While there is no single factor or strategy that has affected the development of these so-called 'bright' spots, there are some common characteristics and attributes that appear to have contributed to positive outcomes. All the research objects had clear strategies for the application of non-degrading activities and crop improvement measures that have lead to higher yields and improved soil quality (table 5).

Improvements in Soil Fertility

Table 2 shows that two of the three cases have a lower proportion of land categorized as highly or moderately salinized when compared to the control farm. The strategies employed by the farmers have clearly resulted either in an improvement or no further deterioration in the situation. For example, on the shirkat 'Bukhara', the proportion of highly salinized lands was 4 percent, while the figure for the control object, shirkat Osiyo, was 8 percent (table 2). Similarly, in Syrdarya province, the difference was even higher, where the proportion of land categorized as highly saline on the research object was one-third of that observed on the control object. This was in striking contrast to Dijizzak Province, where soil salinity was higher under the research object when compared to the control object, suggesting that improved management by the farmer negated the potential negative impact of high levels of salinity. These improved management strategies included the effective flushing of soluble salts from the soil profile at strategic periods in the growing of the crop; the maintenance of a saline watertable below the effective rooting zone through groundwater pumping and the growing of deep rooted plant species (i.e., alfalfa); reducing the use of drainage water for irrigation; the growing of leguminous break-crops (mung bean) and maintaining irrigation and drainage structures in order to improve their effectiveness. In general, it would appear that the research objects acknowledged the importance of managing salinity as a significant component in maintaining production levels and deployed resources to achieve this end.

A common strategy among all of the 'bright' spots was their efforts to enhance the fertility status and, hence, the quality of soils through the use of inorganic fertilizers and the implementation of an organic matter conservation policy that resulted in increased levels of surface horizon soil organic matter (table 2). In all three 'bright' spot cases, clear recognition of the importance of enhancing the organic matter content of soils was evident. In this respect, apart from the practice of conserving and cycling organic waste products from plant and animal by-products on-farm, in two cases, namely Shermat farm and Bukhara shirkat, waste animal and plant products were imported from off-farm sources i.e., livestock production farms and processing plants. In addition to routine applications and incorporation of these materials to the field in both cases, farmers used organic waste products (animal manures) to enrich irrigation waters flowing into the field by constructing primitive mixing wells filled with manure at the field inlet. This would effectively result in a continuous supply of nutrients to the developing crop. The effects of these strategies to improve the fertility status of soils are evident in the elevated levels of soil phosphorus and potassium (table 2). The conservation and maintenance of elevated organic matter levels in the soil would also assist in

TABLE 5.
Summary of strategies applied to address degradation issues by each of the research objects.

Bukhara shirkat	Ikrom farm	Shermat farm
a) Regular and scientifically planned leaching of salts by flushing the furrows during cotton irrigation season instead of post harvest leaching due to water shortage;	a) Preparing field layouts to suit the major crops ;	a) Keeping livestock for accumulation of organic fertilizers and buying additional cow dung from surrounding communities if needed;
b) keeping livestock on the farm for manure application to the fields directly or through the irrigation waters;	b) crop rotations and increasing cropping intensity;	b) fertilizer and manure application through irrigation waters;
c) compost application;	c) installation, maintenance and repairs to vertical drainage infrastructure in high water table fields;	c) installation and repair of vertical drains to lower groundwater;
d) keeping a balance between chemical and organic fertilizers;	d) cleaning drainage canals in a timely manner;	d) timely cleaning and repairs of channels;
e) following appropriate crop rotations so as not to deplete soil fertility;	e) using appropriate volumes of water for irrigation and leaching;	e) procurement of machinery to make operations timely and income generation through renting out these services;
f) intensification of some areas with nitrogen fixing crops as a second crop;	f) reusing drainage water to meet water shortages, as the water availability is 75% of the demand;	f) weed removal;
g) extending irrigation and drainage infrastructure and repairing pumps and cleaning channelettes;	g) use of organic fertilizers;	g) maintaining appropriate cash flow to attract best labor force during peak seasons.
h) deploying mechanized means for large channel cleaning;	h) weed control;	
i) frequent but short irrigations.	i) application of silt from irrigation and drainage channels to crop fields to supplement fertility;	
	j) hiring professional workers to do a quality job at various critical stages of crop growth;	
	k) mechanized agricultural operations.	

Doe this include proper irrigation channel and field layout, grading etc.

mitigating the potential negative effects of salinity (Na^+), in that increased levels of organic matter would alter the selectivity coefficient for Na^+ on the exchange complex, thus facilitating great leaching of the aforementioned ionic species (Nelson and Oades 1998). This effectively offers a potential means of managing salinity on these soils.

Higher Yields of Major Crops

Land productivity throughout the former Soviet Union (FSU) countries is still tied to the Bonitet grade. This empirical index estimates the potential production capacity of land and is used to set yield targets or quotas for a district, province and at the state level. It is significant that the Bonitet grades were similar in the research and control objects in all cases (table 2) and are lower than the state average (Bonitet value 55), indicating that the cases studied are in areas of relatively low productivity. The Plan yields as determined by the Bonitet values did not differ markedly between the research and control objects over all three cases and ranged from 1.56 t ha^{-1} to 1.68 t ha^{-1} for cotton and from 2.20 t ha^{-1} to 2.52 t ha^{-1} for wheat (table 3). When one compares the estimated production levels for cotton and wheat based on Bonitet values with those achieved, in most cases production levels of these commodities either equaled or significantly exceeded Bonitet predicted values (table 3 and figures 2 to 7). This would suggest that the Bonitet production targets are conservative in their estimates and it is not beyond the abilities of most farmers and farming enterprises to achieve these levels of production under prevailing climatic and resource conditions.

In all three research objects, the yields per unit area (t ha^{-1}) of the two major crops, cotton and wheat, were higher than those in the control object (table 3). For example, yield differences between the research and the control objects for cotton in 2002 were 69 percent, 14 percent and 34 percent higher in Bukhara, Dijizzak and Syrdarya Provinces respectively. Similarly, yield increases in wheat over the control objects for the same period were 66 percent, 17 percent and 109 percent in the research objects. An analysis of long-term production levels for these crops suggests yields of cotton were similar and not significantly different between production units during the Soviet era (figures 2, 4 and 6). However, post-Soviet era yields of cotton in the research objects have increased significantly, while the control objects either remained static or declined. Similar trends were observed with respect to wheat yields (figures 3, 5 and 7). This would suggest that privatization and the break up of larger farming units has had a positive impact on productivity on the research objects that is not evident in the control objects.

Irrigated agriculture is highly regulated within Uzbekistan. Centralized government dictates the cropping pattern for most parts of the irrigated area in order to maintain production levels of commodities such as cotton, wheat and a few other crops. The government also monopolizes and controls markets for cotton and wheat in that it procures these commodities at prices well below those of other Central Asian countries and world markets. Although the government provides input to the farms at a subsidized rate, the delivery mechanisms are often inefficient and supply is often below demand. Irrigation water is neither charged nor measured adequately. Thus, farmers tend to over-use water and produce excessive drainage volumes. There are several state agencies whose mandate is to assist farmers in improving productivity levels and water use efficiencies, but their effectiveness is minimal due to institutional structures and budgetary constraints that still retain attributes of the FSU era.

Higher Profits at the Farm Level and Higher Incomes for Workers

Due to limitations in access to revenue data, analysis of the profits derived from the two major crops, cotton and wheat, were calculated using yield data and documented production costs for

TABLE 6.
Estimated income generation from each of the case studies based on planned and actual yields for cotton and wheat.

		Bukhara Case		Dijizzak Case		Syrdarya Case	
		Research	Control	Research	Control	Research	Control
		Bukhara	Osiyo	Shermat	Nigora	Farm	Masariddin
Indicator	Unit	Shirkat	Shirkat	Farm	Farm	Ikrom	Farm
Planned income from cotton ($220 t^{-1}).	$ yr^{-1}	56,320	27,456	9,240	5,544	28,160	8,803
Planned income from wheat ($110 t^{-1}).	$ yr^{-1}	137,940	70,906	5,544	3,604	10,560	6,765
Planned total income from main crops	$ yr^{-1}	194,260	98,362	14,784	9,147	38,720	15,568
Actual income from cotton ($220 t^{-1}).	$ yr^{-1}	100,320	29,744	17,875	9,405	44,352	10,092
Actual income from wheat ($110 t^{-1}).	$ yr^{-1}	438,900	135,688	6,160	3,432	27,720	8,277
Actual total income from main crops.	$ yr^{-1}	539,220	165,432	24,035	12,837	72,072	18,369
Difference between planned and actual incomes.	$ yr^{-1}	344,960	67,070	9,251	3,689	33,352	2,801
Per ha additional revenue above plan	$ ha^{-1}	472.5	179.8	205.6	131.8	277.9	56.7
Production costs of cotton (IWMI-SIC ICWC).	$ ha^{-1}	600	600	600	600	600	600
Production costs of wheat (IWMI-SIC ICWC).	$ ha^{-1}	270	270	270	270	270	270
Total production costs of cotton.	$ yr^{-1}	96,000	48,000	15,000	9,000	48,000	14,640
Total production costs of wheat.	$ yr^{-1}	153,900	79,110	5,400	3,510	10,800	6,750
Total production cost of main crops.	$ yr^{-1}	249,900	127,110	20,400	12,510	58,800	21,390
Farm total net profit from main crops	$ yr^{-1}	289,320	38,322	3,635	327	13,272	-3,021
Average net profit of the farm from main crops	$ ha^{-1}	396.3	102.7	80.8	11.7	110.6	-61.1
Profit per worker	$ $person^{-1}$	687	196	260	55	402	-252

each of the commodities (table 6). The prices in USD were calculated according to the IWMI and SIC-ICWC Institutional Situation Analysis of Water Management in the Fergana Valley Draft.

The Bukhara case study clearly reflects that while monetary revenues generated from farming operations in the control object have stagnated in nominal terms, and therefore, declined in real terms[5], revenues for the research object more than doubled in nominal terms (table 6). Furthermore, while all of the cases were able to exceed the plan quota and enhance gross income, Massariddin had a net negative income of $ -61.1 ha^{-1} after costs of production were taken into account (table 6). The net estimated profit per hectare on those objects performing satisfactorily ranged from $11.7 in the case of the control object Nigora, to $396.3 for the shirkat Bukhara, that resulted in a net profit per individual of between $-252 to $687 (table 6). It is evident that the research objects are operating at a significantly higher profit level that would in the long-term facilitate further on–farm improvements in both productivity and sustainability. The data presented in table 6 shows that profits on a unit area basis were higher on the larger farms, indicating economies of scale playing a significant role.

An important component in production systems from Bukhara is the presence of a significant livestock component that is dominated by small ruminants (table 7). These animals are grazed on the extensive native pastures that are common to the region and contribute significantly to the overall economic viability of these farming units. We were unable to undertake a rigorous assessment of their economic contribution to overall farm income, but intuitively one can assume that diversification of farming enterprise would significantly assist in reducing risk, while enhancing the viability of the enterprise. Both the Dijizzak and Syrdarya cases had limited livestock numbers in their farming enterprises (table 7).

Strategies Used to Achieve Higher Yields and Reverse Land and Water Degradation

Management and leadership skills

A characteristic of all three ‘bright’ spot farm leaders is their ability to effectively utilize technical, managerial and social skills acquired over several decades of being in the business of farming. All of the managers of the research objects had started their careers in agriculture as semi-skilled workers on the then kolkhozes, working their way up through the system. They

TABLE 7.
Livestock numbers associated with each of the cases.

		Bukhara Case		Dijizzak Case		Syrdarya Case	
		Research	Control	Research	Control	Research	Control
		Bukhara	Osiyo	Shermat	Nigora	Ikrom	Masariddin
Indicator	Unit	Shirkat	Shirkat	Farm	Farm	Farm	Farm
Cows	No	N/A	N/A	10	N/A	4	20
Sheep and goat	No	820	265	10	N/A	6	N/A
Poultry	No	N/A	N/A	N/A	N/A	N/A	N/A
Horse	No	N/A	N/A	1	N/A	2	1

N/A=not applicable

[5]The Government of Uzbekistan estimated a 22 percent inflation during 2001–2002.

have an intimate knowledge of the land and resources at their disposal. For example, at the age of 25, the Bukhara manager started working as a mechanic and tractor driver on the then kolkhozes and slowly advanced through the system to become *brigade*[6] manager before taking over as manager of the kolkhoz. The manager's ability to motivate and enhance the performance of staff is best exemplified through an example. In discussions, the manager mentioned an individual excelled in raising cattle. On becoming manager of the shirkat, the respondent appointed this individual as a cattleman who was responsible for organizing community cattle pasturing. This had the positive effect of alleviating any fears within the community of poor animal husbandry practices being administered to an individual's livestock. In this respect, the manager believes that the attributes of a good manager are "…the leader must be a role model" and "….to get 100 percent efficiency in work from people, the leader must work 200 percent", clearly demonstrating the concept of leading by example.

Similar characteristic backgrounds and leadership attributes were observed in the manager of Shermat. The farmer has worked on the same farm for more than 35 years and started off as a tractor driver. Before becoming the manager of the farm, the respondent was a brigade manager. The manager is always questioning older farmers, agronomists and economists on how to improve farming operations, clearly indicating a constant desire for new knowledge. Through this process of knowledge acquisition, new approaches to land and water conservation have been implemented. For example, in order to improve the fertility status of soils, the manager routinely establishes mung beans, which is a non-traditional crop for the region after wheat. The respondent does not recommend planting maize, because it reduces soil fertility.

The leader at Ikrom farm in Syrdarya province is the head of the local community which is, thus, a kinship network with strong tribal roots. The farmer also grew up on the farm. He holds a university degree in drainage engineering. By combining practical knowledge and experience acquired through working on the farm with theoretical knowledge attained from academia, the farmer is able to approach problems in a logical and innovative manner. Prior to establishing the private farm, the farmer was the head of the kolkhoz which, in 1996, became a shirkat. The farmer uses the managerial skills acquired in running a large-scale agricultural enterprise to great effect on the private farm. The respondent is a strong supporter of farmers' associations and attends meetings on a regular basis. In addition, the farmer will use personal funds to finance training, as he did in a recently completed course on certified cotton seed production, which entitled the farmer to become a certified grower. This demonstrates a continued commitment to knowledge acquisition. The advantages associated with certified seed growing could relate to increased diversification of the production system and the financial gains achieved through the sale of seed.

Investment in mechanization

In Uzbekistan, a number of state-owned enterprises are responsible for providing farmers with cultivation, sowing and harvesting services through a centralized auto-park. However, these services are usually not available when required because of competition among farms for the same services. As a result, a common strategy pursued by all the three research objects is to accumulate mechanized capacity on-farm, thus reducing their dependency on these centralized monopolistic services. All three research objects have tended to purchase new or old tractors and farming implements. Their counterparts on the control objects have not pursued this line of strategic investment to the extent of the research objects due predominantly to financial constraints.

[6]A brigade refers to a sub-production and management unit within a kolkhoz.

The Bukhara shirkat has bought six tractors, seven cultivation implements and seventeen transport trucks, since the demise of the kolkhoz collective system in 1996. In 2002, the research object bought a new caterpillar tractor, "Altai," clearly demonstrating the financial soundness of the operation. On Shermat, a tractor was purchased from an auction, a second hand caterpillar bought from a farmer and a new tractor procured on a 7 year lease. The research object in the Syrdarya province has two tractors, one caterpillar and one transport tractor. An analysis of capital resources shows that the farms tend to own Russian machinery, which is cheaper, easier to procure spare parts for when needed, reliable, does not require expensive oil and within the local mechanics' expertise. This equipment is often rented out to neighboring farmers at rates lower than those of the centralized auto-park. This cash revenue provides the farms with additional cash flow to meet other farm input requirements.

Attention to agronomic detail

A common strategy followed by all the three 'bright' spots has been to ensure that agricultural operations such as sowing, weeding, irrigation, cultivation and harvesting are undertaken in a timely fashion. In order to ensure that these field operations are undertaken, farm managers will hire seasonal labor and equipment during peak demand periods. In the case of cotton, this enables the farmers to achieve higher prices as early delivery of cotton to processing plants carries a premium price. The Shermat farmer strictly adheres to recommendations from the Agricultural Ministry and personal experience acquired in the growing of wheat and cotton. This may entail the hiring of additional seasonal workers to weed and cultivate cotton fields. In addition, the farm manager's son is a qualified tractor driver and mechanic who ensures that machine downtime is kept to a minimum during critical times.

The Bukhara manager delegates responsibilities for land preparation, harvesting, ploughing and leaching to senior family contractors. In an effort to motivate these family contractors in each field division, summer camps are constructed that have several of the basic comforts as their homes. These summer camps have cooking facilities, resting places and are equipped with a radio. This social environment enables workers to meet and discuss issues that may have arisen in an informal manner. An example of the farm's high level of efficiency is seen in the time that it takes to sow cotton. The entire crop is sown in 24 hours, while on the control object this may take between 3 to 4 days.

Maintenance of infrastructure

Maintenance of irrigation and drainage infrastructure was a common priority in each of the successful cases. On the Bukhara shirkat, on-farm watercourses and drainage collectors are cleaned of vegetation and sediments as well as deepen on a biannual basis. Such a strategy ensures that the water table is kept at a level where it does not impact on crop performance and facilitates efficient water delivery and disposal. Additional pumps have been installed by both the Syrdarya and Dijizzak research objects in order to effectively lower groundwater levels. Most of this maintenance on the research objects is undertaken using machines reducing the time taken to complete this task. In contrast, in the control objects these activities are carried out by hand. During leaching events, particular attention is given to field leveling in the research objects resulting in savings of 15-20 percent in fresh water use. The research object in Dijizzak installed a vertical well with 500 m radius of influence. This maintains the drainage of 25 ha of land and is used as an additional source of irrigation water. In addition, the research object cleans a kilometer of the main drainage canal, although this is actually part of the state's responsibility. The research object in Syrdarya province inherited two drainage wells from the former kolkhoz with a 400 m radius of influence. These drainage wells are maintained and repaired by the farmer and have resulted in a reduction in the level of salinity in the soil.

Role of financial incentives

All the research objects used several financial and non-financial incentives to motivate casual labor to work their farms, as well as to keep their regular farm workers. The basic driving force that keeps workers inspired in a cash-short agricultural economy is cash flow. To meet cash demands, all the research objects practice non-traditional, low-cost and innovative approaches to raising cash flow in order to pay their workers at a higher rate and on-time. These incentives included:

1. An additional hectare of sunflower, peanuts and mung beans is grown at Shermat as a seed crop, since they have a long storage life allowing the farmer to sell off the product into the local market, as and when there is a requirement for cash. This allows the farmer to achieve higher prices since the produce is invariably sold into a market where prices are rising. During 2003, the farmer sold 1 ton of sunflower seeds into the local market and received 180,000 soums (US$ 180) which was used to pay workers for weeding cotton fields. Similarly, in the harvesting of the wheat crop during 2003, the farmer sold a cow to pay for the services of a combined harvester from the centralized auto-park to remove the entire crop. Through a process of trust and respect brought about by timely payment of wages, higher rates of pay and advanced payments, the farmer ensures that adequate labor resources are available to undertake essential activities in the field at critical periods.
2. On Ikrom private farm, the farmer pays workers 18,000 soums/month (US$ 18) but also includes additional in-kind payments in the form of natural products, secondary products including wheat, cotton seed, cotton oil, oil cake and husk.
3. As an incentive to family-contractors on the Bukhara shirkat, all surpluses above the state quota (Plan) remain with the family, thus creating motivation for family members to work hard.

The leaders of all the three 'bright' spots pay special attention to adhering to commitments made to workers with respect to payment dates and the level of payment, despite bureaucratic delays that are common within the banking system. However, the control objects are notorious in delaying payments to workers.

The head of the research object in the Syrdarya Province developed performance indicators and attached payment levels to these indicators. The principle is based on "fair payment for fair work". The farmer motivates workers by encouraging them that their contribution to the overall production system is important and that attention to detail and a good work ethic increased the likelihood of achieving surpluses. Once state quotas are exceeded, each worker receives an equitable portion of the surplus in both cash and kind.

In the Bukhara case, the research object practices cash pre-payments for family-contractors and in-kind payment in cases of high productivity after the harvest. The farm manager ensures that the workers receive advance payments as a motivation. For instance, in 2002 Bukhara shirkat paid its workers 80 percent of the expected harvest in cash from a line credit established with a local bank. Once the Plan component had been met, each of the family contractors received an additional 5 tonnes of wheat for their own use.

Networking and community service

All research object leaders have excellent working relations with the district service provider agencies, such as district government officials, district farmer associations, banks, water management organizations, district land reclamation departments, seed providing agency, fertilizer suppliers, oil and fuel stations and district machinery and tractor-park officials. The shirkat Bukhara has an excellent working relationship with "Pakhta (cotton)" bank and was able to access loans for the improvement of on-farm irrigation and drainage infrastructure. It is also able to maintain cash flows to meet salary commitments through the bank due to its

reputation as a reliable customer. By making up front payments in advance of services to the centralized auto-park, farm leaders are assured of receiving services such as harvesting, on request.

Almost all of the farm leaders of the 'bright' spots are well-known and well respected community leaders. They play an active role in the community through assisting those that are less fortunate and sponsoring community activities. In Syrdarya province, the head of the research object sponsors the local soccer team, offers financial support to elderly members of the community, assisted in the provision of construction materials in the building of a local school, donates money to families with several children and low incomes and funds wedding parties in the community. The Shermat farm, in the Dijizzak province, is planning to assist in the building of a village school, provides donations to people who need money and gives advice to neighboring farmers on improved farming practices. Bukhara's farmer finances the buying of flour and cotton oil for wedding parties in the community. All leaders assist in conflict resolution within their respective communities.

Key Drivers in 'Bright Spot'

The scores to each of the questions associated with the development of 'bright' spots posed to leaders of each of the success cases are presented in table 8. In all three cases, 'low risk of failure' and 'aspiration for change' were perceived to be the most important drivers in the development of these 'bright' spots. 'Leadership', 'quick and tangible benefits' and 'property rights' followed in importance (table 8). It is interesting to note that in the case of the two private farms, (Shermat and Ikrom farms), market opportunities were ranked highly, while this aspect was ranked lowest in the case of the Bukhara Shirkat. This may reflect the inflexibility of a centralized state marketing system that dictates production and prices. In contrast, the private farms appear to have a greater degree of flexibility in their production plans and farm managers are aware of the importance of satisfying market demands associated with higher prices. It is not surprising that 'innovation and appropriate technologies' ranked relatively low since, in each of the cases, the strategies that each leader employed to enhance their production system did not require new knowledge and technologies but rather relied heavily on previous experience and knowledge accumulated. 'Social capital' and 'supportive policies' were deemed to be important in the development of the 'bright' spots. Although the prime factor in their development has been the move away from collectivized farming structures to privately owned farming units, the fact that there is limited 'bright' spot development since this change in policy, clearly demonstrates the importance of individual leadership skills, individual aspirations and the importance of low risk in their development. In short, the above drivers encapsulate the social and human capital associated with livelihoods development (Coleman 1990; Costanza et al 1997; Daily 1997; Carney 1998; Pretty 1998; Scoones 1998; Pretty and Ward 2001; Krishna 2002).

The study has clearly demonstrated the importance of social and human capital in the development of these 'bright' spots. It has been suggested that social and human capital are necessary for sustainable and equitable solutions to natural resource management and that this generally occurs through the presence of an external facilitator (Pretty 2003). External agencies or individuals can assist or work with individuals to increase their knowledge and skills, their leadership capacity and their motivations to act. With respect to communities, these external

TABLE 8.
Scores to questionnaire associated with the development of a 'Bright' Spot for each of the farming systems studied.

Question	Bukhara Shirkat	Shermat Farm	Ikrom Farm
1. Quick and tangible benefits	5	4	5
2. Low risk of failure	5	5	5
3. Market opportunities	1	4	5
4. Aspiration for change	5	5	5
5. Innovation and appropriate technologies	3	3	4
6. Leadership	5	4	5
7. Social Capital	4	4	5
8. Participatory approach	5	3	4
9. Property rights	4	5	5
10. Supportive policies	4	4	5

facilitators can assist in creating conditions for the emergence of new local associations with appropriate rules and norms for resource management (Pretty 2003). What is probably unique with respect to the development of these three 'bright' spots cases is that there were no financial incentives or support in terms of facilitation and mobilization tied to their development. They could, therefore, be viewed as developing through internal circumstances and classified as 'spontaneous,' having similar attributes as selective innovative farmers documented in East Africa (Mutunga and Critchley 2001; Critchley et al 1999; Wu and Pretty 2004). It is clear that in each of the successful cases there have been external influences that have directly contributed to the performance of the enterprise. These have been in the form of technical information that has been obtained through networking with governmental services and forged relationships with centralized services.

Conclusions

The transformation in the structure of agricultural enterprises in the post-Soviet era could be viewed as the 'priming' agent for the development of 'bright' spots in the region. With the break up of the Kolkhoz and Sovkhoz collective structure and the emergence of individual farming units, a degree of autonomy and, hence, a gradual perception of land ownership has developed. While land rights, through formal deeds and titles, haven't been granted yet, there is a strong perception of ownership among individuals and groups that was not present under the FSU. In this respect, recent changes in the law governing leasehold land, has resulted in leases being extended from a mandatory 10 year period to 50. In discussions with farmers, this was determined to be a positive move in that it effectively secures one's right to farm a piece of land. In the case of shirkats, which still maintain the attributes associated with collective farms, recent trends have signaled to shirkat leaders that private leaseholds could be as large as current shirkats, in the future and thus the opportunity arises to potentially inherit a significant land

holding as a private farm. This may in part be an incentive for current shirkat leaders to retain their positions rather than moving into the current private small farming sector.

The existence of a farming unit is contingent on the individual / shirkat leaders meeting planned production levels, as failure to achieve this will result in land confiscation and the accumulation of debts. This may be a hidden incentive for an individual / shirkat leader to perform, as confiscation of land would effectively mean economic destitution. However, as we see in the case of Masariddin farm, meeting the plan does not inevitably guarantee economic security. The accumulated debt becomes the responsibility of the individual or shirkat as a whole and can have a debilitating effect on the viability of these farming units. In the current study, accurate economic analysis could not be undertaken, but it is clear that the 'bright' spot farms have achieved significant economic returns based on recorded yields and conservative estimates of production costs. These estimates of economic returns are conservative, as they do not include the value of in-kind contributions that comprise 'non-plan' payments in the form of commodities. These non-plan income payments can be a significant contribution to net income. For example, a 5 tonne per family payment of wheat made to contractors on shirkat Burkhara would equate to US$550. In addition, livestock and its contribution to net farm income is not included in the discussion and, in the case of Burkhara, could have a significant impact on the overall viability of the farming enterprise.

It is important to note that in all three research objects, the size of the farming unit was larger than the equivalent control object and this may have directly contributed to the enhanced performance of these research objects (table 1). It is, however, also significant that the long-term yield statistics for these cases were not very different from each other during the Soviet era, suggesting that each of these units was performing at an equivalent level during this period. Clearly, the confounding effect of farm size cannot be overlooked and this may in itself suggest that there is a critical farm / shirkat size that dictates financial viability. There is, thus, an urgent need to define this critical size before embarking on wholesale privatization.

An interesting characteristic of all three 'bright' spots is that there has been no external force (i.e., economic stimulus or facilitation inputs to adopt change) driving the development of a 'bright' spot as is common in several documented case studies of watershed development programs, farmer field schools (FFS), micro-finance institutions, irrigation and water user groups, joint forestry management programs and community based wildlife management programs (UNEP 2003; Pretty and Ward. 2001; Singh and Ballabh 1997; Uphoff 1992, 2002; Fernandez 1992; Gibbons 1996; Malla 1997; Shrestha 1997; Kenmore 1999; Duffy 2000). The stimulus for change in all cases appears to be internally driven by resourceful individuals who have a vision. These individuals exhibit strong leadership skills, innovative approaches to addressing biophysical and economic issues and a strong social commitment to their labor force and the community as a whole. It is well documented that with the breakup of the FSU and the subsequent demise of the large collective farm structures and a move towards smaller collectives, (the shirkats), and private farms, there has been a transfer of collective to individual responsibility. In this respect, individuals who once were a single component within a large and diverse production unit (i.e., tractor driver) have now become responsible for the operation of an entire farming unit. Clearly, there are issues with respect to skills of the new landowners in running privatized small farming units that would in part account for the poor performance of the majority of farms in the Republic. It is suggested that if these 'bright' spots are to be replicated, a key prerequisite will be addressing this issue of skills and leadership.

In irrigated river basins, river flows are systematically depleted by the diversion of irrigation water while, on the other hand, the remaining flow is increasingly loaded with saline drainage water (Smedema 2000). In the case of the Aral Sea basin, it has been generically

classified as having what has been termed a 'mobilization profile' where fossil, primary or other resident salts in the basin are being mobilized and enter the river system, thus resulting in a negative salt balance with respect to the land (Smedema 2000). There are a number of measures that can be taken to control or reduce increased downstream river salinity. However, these measures become difficult to implement in river basins where water resources have been almost fully allocated and used, as is the case for the Aral Sea basin. The principal choice that policy makers have in reducing salt loading of the river system is to reduce the amount of water being diverted from the river, thereby allowing a higher environmental flow component and restricting / preventing the return of mobilized salt to the river system. Through improved on-farm water management and the judicious use of water for salt leaching, as is observed in these 'bright' spots, significant savings could be made in water delivered to the farm. The adoption of the strategies employed by the 'bright' spots over a large proportion of the basin would significantly reduce the amount of water being diverted.

The results from this study clearly indicate that on-farm improvements in management and attention to detail can have a significant impact on profitability and sustainability. This gives us reason for cautious optimism with respect to addressing problems associated with high watertables, increased salinization and declining productivity. Changes in current farming practices, without the introduction of new technologies, can have a significant impact on sustainability at the farm level. The replication of these 'bright' spots would enhance the sustainability of farming enterprises within the region, thereby delivering positive environmental benefits on a larger scale to the Aral Sea basin as a whole.

The economy of Uzbekistan is based primarily on agriculture and agricultural processing, with cotton being the major export crop. This dependence of the economy on agrarian based activities is unlikely to change in the foreseeable future. Given the negative performance of agriculture in Uzbekistan in the first decade after independence, the government of Uzbekistan committed itself to promote a voluntary transition of farming enterprises from the public to the private sector (Egamberdi et al 2000). However, to date, land restructuring has been extremely cautious and remains incomplete and command style interference of the state in the agricultural sector is still the norm, a legacy of the Soviet era. Substantial structural reform is needed, particularly in the area of improving the investment climate for foreign investment and in freeing the agricultural sector from smothering state control. The government's restrictive trade policies have crippled economic growth and there is an urgent need for these policies to be rescinded. It is argued that if current restrictive market policies associated with dominant commodities in Uzbekistan were removed and replaced by a free market economy as adopted in neighboring Kazakhstan, this would facilitate the spontaneous, and most probably rapid development of further 'bright' spots, as discussed in this paper, with financial and environmental benefits to the Uzbekistan and the basin as a whole.

The documented cases have adequately demonstrated that despite an extremely unfavorable policy environment for agricultural production in Uzbekistan, communities do possess significant social capital that, if provided with the right enabling conditions, has the potential to curtail natural resource degradation, while improving rural livelihoods. Instead of allocating newly privatized farms to the circle of kith and kin through opaque land allotment procedures, it is important that state functionaries allocate land to able individuals, as discussed in these 'bright' spots cases. The research presented above has important policy implications for Uzbekistan, in particular, and for economies in transition in general, namely, that it is not only the machines, tractors and infrastructure that can ensure environmentally sustainable and socially and economically beneficial agriculture, but the social capital and people behind it. Thus, it is equally and, possibly, more important to invest in peoples' capacity.

Annex 1

Bonitet Land Productivity Classification

Bonitet Grade: A land productivity classification system, termed the Bonitet, is used by land resource managers and Government Officials to classify land into classes based on their potential productivity and to set annual production targets for each farming unit (State Plans). Bonitet Grade reflects the soils potential productivity (i.e., yield potential of selected crop commodities) based on inherent fertility and quality. It is expressed as an index on a scale of 1 to 100 (table 1.1). The higher the index value, the greater the productive potential of the soil. The average value of bonitet for Uzbekistan is estimated to be 55. Soils with a Bonitet value of 41–60 are regarded to be average, according to the classification. By using the Bonitet value for a field/shirkat and multiplying it by a coefficient assigned to each crop commodity, the yield per ha for that crop can be calculated. For example, the crop coefficients for cotton and wheat are 0.06 and 0.04 respectively. If the Bonitet value for a shirkat is 44, the expected yields of cotton and wheat are 2.64 and 1.76 t ha^{-1} in order to satisfy State planning requirements. By stratifying Bonitet values into classes, a semi-quantitative evaluation of the soil resource can be achieved (table 1.1).

TABLE 1.1.
Classification of land productivity levels into classes based on their Bonitet values.

Classes	Name	Bonitet grade
10	Best	91-100
9	Best	81-90
8	Good	71-80
7	Good	61-70
6	Average	51-60
5	Average	41-50
4	Below the average	31-40
3	Below the average	21-30
2	Bad lands	Nov-20
1	Bad lands	0-10

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IWMI International Water Management Institute

FUTURE HARVEST
IWMI is a Future Harvest Center supported by the CGIAR

ISSN 1026-0862
ISBN 92-9090-590-5