Are Collective Farms Water User Associations? Land Reform and Irrigation Management in Uzbekistan

D.J.W. Berkoff

ABSTRACT

THE CAUTIOUS APPROACH of Uzbekistan to land reform is understandable given that over-hasty land privatization might undermine an irrigation management system that has proved relatively effective in recent years. Collective farms provide a critical link in this system, *inter alia* playing the role advocated for water user associations in many other parts of the world. No doubt collective farms also perform functions best left to private initiative, and major reforms are undoubtedly necessary. Nevertheless, there are strong arguments for building on existing institutional structures rather than endangering the irrigation management system by more radical change. The paper argues that the challenge in Uzbekistan is thus to transform existing organizations in ways appropriate to an evolving market economy, rather than to transfer management to newly created user associations.

INTRODUCTION

Privatization of agricultural land is among the most important reforms being implemented in the former Soviet block. Arguments in favor of privatization are familiar and persuasive. Farmers on their own land, in control of their own resources and receptive to market signals, are typically more flexible and productive than when employed by the State, besides having the satisfaction of working for themselves.

The pace and character of land privatization have varied. In Poland, land was already largely in private hands. In a few other countries, e.g., Albania, Armenia, Bulgaria, state and collective farms were transformed at an early stage in the reform process. But in most former Socialist countries, reform programs have been more cautious. "Farmers are not rushing to leave the large-scale socialized structures [to] establish independent farms on private land" and "the process of private farm development...is taking a course which seems to be different from the original expectations of many Western observers" (Csaki et al, 1993).

Perhaps no country has been more cautious than Uzbekistan (World Bank, 1993). It is true that the Government has embarked on a program to convert state farms into collective farms and other forms of ownership, and that state and collective farms are empowered to lease land to private farmers and distribute land to member families. But these processes are moving slowly.[1] Leased land remains the property of the state, and private farmers continue to receive services from their "parent" state or collective farm. Moreover, there has yet to be serious reform of the overall supply, procurement and marketing system.

This caution reflects political factors. But it is also understandable given the predominance of large-scale irrigation in Uzbekistan's agricultural economy. Land reform would be risky without thinking through how private farms fit into the irrigation management system. Bulgaria provides an abject lesson. Failure to anticipate how pumping and other joint facilities were to be managed, how individual farms were to be supplied, and how water charges were to be collected, contributed to severe deterioration in the physical system. This has been associated with a collapse in the irrigated area which is now less than 10 percent of the irrigable potential. Similar events have occurred in Albania, Armenia and elsewhere. Irrigation in these countries is perhaps less critical than in Central Asia, and some schemes are no doubt uneconomic and should be abandoned. But the World Bank and other donor agencies are to fund rehabilitation programs so that there is a presumption that at least some irrigation is justified. And it seems clear in retrospect, at least in regard to irrigation, that the reform process has been unnecessarily costly.

---

[1]State farms are financed under the government budget and their workers are state employees, whereas collective farms are financed through the banking system and are in principle run by their members. State farms predominate in newly developed areas (since settlers are less amenable to cooperative action and financial self-sufficiency cannot initially be assured) and collective farms tend to predominate in settled areas. Estimates of the numbers of state and collective farms vary, for instance depending on whether livestock and other specialized enterprises are included. According to MOA statistics, on 1 January 1992, there were 971 collective farms (average size about 1,500 ha), 1,141 state farms (average size about 2,250), and 96 "inter-farm enterprises". A total of 0.48 M ha was reported under private plots, with an average size of about 0.20 ha. (MOA, 1992). Separate estimates suggest that as of April 1, 1993, 0.30 M ha had been provided to (mostly rural) families while 0.11 M ha of land had been leased to 10,000 farmers. It is not clear how these relate to the estimates for private plots provided by the MOA for 1992.

The autonomy of collective farms has been severely limited but this is changing and it is government policy in due course to convert all state farms other than those needed for research and comparable purposes into collective or private farms. Unless otherwise indicated, the term "collective farm" includes state farms in the period until such an objective is achieved.

Moreover water user associations (WUAs) are invariably promoted under rehabilitation projects since, though land can be privatized, surface irrigation inherently requires cooperative effort. Advocates of WUAs often draw on experience elsewhere as though little of interest had occurred locally. Yet collective farms have long performed the irrigation functions proposed for WUAs and, indeed, share some of their characteristics. They are financially autonomous, interact with national agricultural and water agencies, distribute water within the tertiary system, and operate and maintain tertiary facilities. No doubt financial autonomy is often a mirage, and no doubt they also perform production and other functions best left to private initiative, besides being undemocratic and suffering from poor motivation and "free rider" problems. But experience with WUAs has also not been uniformly successful, while there is some evidence that collective farms have handled irrigation in Central Asia fairly well. If so, there are strong arguments for building on existing institutional structures rather than risking the dangers of more radical change.[2]

This paper argues that the challenge in Uzbekistan is thus not to transfer management to newly created local or farmer organizations (the theme of the Wuhan Conference) but to transform existing organizations into farmer agencies appropriate to an evolving market economy.

WATER RESOURCES MANAGEMENT

The General Context

Rainfall in Uzbekistan is about 150-300 mm per year and the winters are cold. Some 95 percent of crop production is irrigated, predominantly during the summer months (April-September). Cotton is the major crop, accounting in 1991 for 46 percent of the cropped area, with rice (29%), other grains (7%) and fruits and vegetables (18%) comprising the balance. More recently, there has been a shift from cotton to grains, with the cotton area shrinking to perhaps 35 percent of the total.

Traditionally, irrigation was based on inundation canals exploiting the flood waters of the Syr Darya and Amu Darya, and on diversion of smaller rivers and springs coming off the mountains. Large-scale expansion dates from the Russian conquest and the first major storage dams to the 1940s/50s. But it was only with the "virgin lands" campaign of the 1960/70s that there was major development of the intervening Steppes, requiring improved control of the major rivers, some major pumping lifts, and the provision of a full settlement infrastructure.

By the mid-1980s, the irrigated area had extended almost to its present area of 4.5 M ha. Not only was the water resource approaching full development, but environmental problems associated with the shrinking of the Aral Sea raised serious concerns, and the financial crisis associated with the unravelling of the FSU limited funds not just for new development but even for O&M.

Water Resources

The water resources of Central Asia comprise two major rivers that outfall in the Aral Sea-the Amu Darya (annual flow 63 BCM) and Syr Darya (37.5 BCM); smaller rivers that terminate in the deserts (10.3 BCM); and usable groundwater (5.8 BCM) (Micklin, 1992). Irrigation expansion was largely responsible for reducing annual flows to the Aral Sea from about 50-60 BCM prior to 1960 to an average of 6-7 BCM since 1980. As a result, the sea level has declined by about 14 m, and its surface area has shrunk to about half its historic extent. This process continues.

Irrigation accounts for more than 80 percent of water use in the Aral Sea basin, with about 55 percent of the total irrigated area of 7.5 M ha being in Uzbekistan. Significant allocations are made for leaching, especially in the lower Amu Darya. Municipal and industrial users, flood protection, and hydropower generation are other purposes. A large and complex system of dams, barrages, levies, canals and drains has been constructed to serve the various users.

Countries sharing the basin besides Uzbekistan are Afghanistan and four other states of the former Soviet Union (FSU): Kazakhstan, Kyrgyzstan, Tadjikstan and Turkmenistan.

Levels of Management

Water allocations between the five republics of the FSU are governed by an agreement signed in February 1992, shortly after independence. This agreement confirmed the allocations then in force, maintained the role of the river basin

[2]This is consistent with trends extending well beyond irrigation: "...large-scale farms are reorganizing into associations of smaller productive subdivisions owned by team members which continue to rely on cooperative supply, marketing and financial services provided by the central farm structure...new independent farmers are also forming cooperative organizations to help them overcome the difficulties caused by nonexistence of input and product markets." (Csaki et al, 1993).

management agencies (the Amu Darya and Syr Darya BVOs), and established an Inter-Governmental Coordinating Committee for Water Supply (the ICCWS). Water management can thus be said to occur at five levels:

1) *At the international level*, the ICCWS meets at least quarterly inter alia to approve seasonal allocations between the Republics and target flows to the Aral Sea. Use by Afghanistan is recognized although it is not a member of the ICCWS.

2) *At the river basin level*, the BVOs distribute water from the upstream dams to the point at which downstream use lies wholly within one Republic.[3] Major dams are operated by national agencies (mainly power utilities) according to release schedules proposed by the BVOs and approved by the ICCWS

3) *At the national level*, a Ministry of Land Reclamation and Water Management (MLRWM) delivers water received from the BVO to the collective farm, municipal utility or public enterprise. The MLRWM is also responsible for distribution upstream of the dams; river basins falling within national borders; and major drainage and river training works.

4) *At the enterprise level*, farm managers are responsible for water distribution and surface drainage within the collective farm (MLRWM is responsible for pumped drainage) and municipal utilities handle distribution and wastewater collection in a similar manner.

5) *At the end-user level*, the state farm employee, collective farm brigade, or private farmer/ lessee distributes water on the fields (households are comparable agents in a municipality).

After meeting M&I demands, priority is given to irrigation. Hydropower is thus generated chiefly as a by-product. Reregulating reservoirs optimize power output subject to this constraint.

Water Management Processes

The annual water management cycle can be summarized as follows:

1) *November-December.* The BVOs propose broad allocations to the ICCWS based on international agreements and projections for the specific year. Separate allocations are made for the vegetative (April-September) and non-vegetative (October-March) seasons, allowing for return flows but excluding non-river inflows to the Aral Sea.

2) *January-February.* Within these broad allocations, the Ministry of Agriculture (MOA) prepares a cropping plan, reconciling collective farm proposals with oblast and national planning objectives. Based on approved crop norms, and allowing for non-agricultural uses and losses, MLRWM accumulates discharge requirements to each diversion point.

3) *February-March.* Supply projections are finalized by a ten-day period. Demands are reconciled with available supply. River flow, reservoir release and diversion schedules for the vegetative period are prepared for review and approval by the ICCWS, for dissemination to operators and the general public.

4) *April-September.* The BVOs update reservoir release and diversion schedules every ten days based on actual river flows and regular indents from the national water agencies. In the event of a flood, the BVOs assume emergency control on an hour-to-hour basis.

5) *August-September.* MLRWM completes surveys of salinity to establish leaching requirements. Demands are accumulated to each diversion point and reconciled with revised water projections. Ten-day schedules are prepared for the *non-vegetative* period and are submitted to the ICCWS for approval and dissemination.

[3]There are important exceptions to this general rule. For instance, Turkmenistan controls the headworks of the massive Karakum Canal and Uzbekistan, the main Karshi Pumping Station; smaller canal systems serving two or more countries may be operated by the national ministries concerned; and Kazakhstan is responsible for the long reach of the lower Syr Darya below the Chardara Dam, including ensuring the target flows to the (international) Aral Sea.

6) *October-March.* The BVOs update reservoir release and diversion schedules every ten days based on actual river flows and indents from the national water agencies (demands are more predictable than in the vegetative season and fewer revisions are typically required).

Throughout this process, the BVOs maintain close contact with the national power agencies, taking their demands into account in preparing detailed schedules subject to the over-riding priority given to M&I and irrigation uses.

THE COLLECTIVE FARMS

How Independent?

Under the classical Soviet system, collective farms, and even less so state farms, had virtually no freedom of action. Cropping patterns were set in Moscow, inputs--including water--were allocated in support of these plans, and performance was judged in terms of success or otherwise in meeting planning targets. Irrigation in Central Asia was primarily for cotton, so cotton was grown. Since Moscow was a long way away, inadequate account was taken of local conditions. Since planning by material balances ignored important criteria of true scarcity, agriculture was often inefficient. And since little account was taken of local initiative, motivation was poor.

Uzbek apologists for the present system argue that this is changing and that farm managers now have considerable freedom to distribute and lease land, modify cropping patterns, and purchase inputs and market outputs. Some outside observers dispute these views, arguing that the cotton economy remains largely as it was and that Uzbek agriculture remains in many ways frozen in a Soviet time warp. There is little independent evidence to determine the true picture but it is probably closer to the views of the outside skeptics than to those of the local apologists. Farm managers continue to be appointed rather than elected; the centralized procurement and marketing system remains largely intact; and limited land has been distributed or leased.

Water Management

Irrespective of their independence or otherwise, collective farms remain a crucial link in the water management system. And irrespective of the economic system, functional responsibilities and links much like those described above would be required. Indeed, substitute bottom up for top down processes and a system much like that in any well managed river basin in a market economy emerges. Water rights, rather than central directives might set the general planning context, and private farmers rather than central planners might take the cropping decisions. But it would still be necessary for a water retailer (e.g., a WUA or irrigation district) to manage water at the tertiary level; for an irrigation wholesaler (e.g., an irrigation department) to collate water demands and manage water in the main system; and for a water wholesaler (e.g., a basin agency) to reconcile demands with available supplies in a systematic way throughout the basin.

Whether or not 1,000-3,000 ha is an optimum size for a tertiary command area is debatable. But this size seems preferable to the smaller watercourse commands of the equally large schemes of the Indian sub-continent. Not only is the MLRWM relieved of much detailed regulation and maintenance, but this area justifies employment of specialized water management staff and, sometimes, the purchase of O&M machinery. Moreover, it is sufficiently large for each farm to be issued with a separate water schedule that can be readily accommodated in water balance and scheduling software. Measurement may be of doubtful accuracy but supply to each farm is on a volumetric basis. Water is still supplied free but a pilot water charge scheme was undertaken in 1989; detailed proposals for introducing a charge countrywide have been prepared; and legislation has been drafted to provide the necessary backing. It is thus possible to envisage contractual agreements between MLRWM and collective farms that provide incentives for improved operations and efficiency to both, besides contributing to main system costs. This might be difficult to implement if the tertiary command area was significantly smaller.

Collective farms typically employ between 1-4 water management staff for water distribution (including operation of pumps within the farm area). Water is supplied to, say, 10-20 brigades each responsible for 50-150 ha, as well as to private farmers and leaseholders within the farm area. Irrigation costs are recorded along with other costs to be deducted from income (mainly derived from crop sales). However, there is no reason in principle why brigades should not be provided with incentives for efficient water use along with the production incentives already provided. Nor is there any reason why private farmers should not be charged on a volumetric basis or, if this proves difficult, some proxy such as the number or time of irrigations.

Maintenance and Improvements

Water management staff are also responsible for maintenance and improvement works. Many farms prefer to contract the local MLRWM office for major works, not just for improvements such as tile drainage but also for regular maintenance. In either case, they are required to pay although there may be subsidies for improvement works. The profitability of collective farms is still primarily determined by input and output prices set by government, and is therefore largely outside their control. Nevertheless, the principle of financial autonomy is well established and the government faces fewer direct pressures to finance on-farm and tertiary works than in many other countries. Of course, in the event that a farm is unprofitable, the government almost invariably has to cover its losses, either directly or indirectly through the banking system.

Irrespective of what tertiary area is appropriate, there is the practical consideration that the system was designed to serve collective farms. Not only was the distribution system built accordingly but field size is typically much larger than would have been the case if the area had been under peasant farmers, the theory being that large fields facilitate mechanization and achieve other "economies of scale." Countries such as Bulgaria which have rushed into land privatization have encountered enormous problems in this regard. Not only has the operation and maintenance of the tertiary system been cast into limbo, but individual landowners desperate to ensure supplies for their own (smaller) fields have taken matters into their own hands, breaking canal banks and bypassing control structures. This free-for-all has aggravated losses and tailender problems, besides having disastrous consequences for the physical system.

INDICATORS OF PERFORMANCE

Agricultural Performance

It is beyond the scope of this paper to provide a general evaluation of agricultural performance in Uzbekistan although there is general agreement that the sector is performing well below its potential. For instance, a recent World Bank report (World Bank, 1993) states that:

> "Productivity gains in Uzbekistan agriculture are potentially large, since yields are relatively low, and both input use and spoilage rates are high. Realizing these gains will depend on establishing incentives for generating and adopting new technologies in line with Uzbekistan's underlying comparative advantage. Important policy and institutional changes will be required, both in the transition from a planned to a market-based economy and over the longer term, to sustain technical progress and efficient resource use".

Yield comparisons are notoriously difficult since so many factors are involved. Cotton yields are in fact high by world standards even if rice yields are low (Table 1). But the real question is whether yields are high or low given Uzbek conditions. Other things being equal, irrigated yields should be higher than rainfed yields and crops in Uzbekistan are invariably irrigated. On the other hand, Central Asia is as far north as cotton is planted and the growing season is short. And 75 percent of the rice is grown under generally adverse conditions in the lower Amu Darya.

Perhaps a more profitable comparison is trends in Uzbekistan over time. Table 2 shows that cotton yields rose by a third between 1960-90 but in recent years have tended to decline, possibly associated with declining use of chemical inputs, land degradation and water constraints.

Water Use per Hectare

Of more direct relevance to this paper are measures of irrigation performance. Again, recent publications refer repeatedly to the inefficiency of irrigation systems in Central Asia, for instance: "At present the efficiency of irrigation systems in the region is extremely low--according to various estimates only 55-67 percent. Under available technology, the efficiency of irrigation systems can be increased to 80 percent." (Glazovskiy, 1991). It depends to what these figures refer but, assuming they are overall project efficiencies, an efficiency of 55-67 percent if by many standards high, certainly for massive schemes such as those found in Central Asia. Moreover, efficiencies as high as 80 percent must refer to intensive micro-irrigation technologies which are inconceivable in Uzbekistan for the foreseeable future other then for limited pilot projects.

Table 3 summarizes trends in water use since 1980, together with targets that SANIIRI (the foremost irrigation research institute in Tashkent) considers achievable by modernizing the system without a radical change in technology. Average water use in irrigation declined from 17,200 m^3/ha in 1980 to 14,500 m^3/ha in 1990, and again to 12,600 m^3/ha in 1992. These were substantial reductions, and while they reflected water constraints and may have adversely affected crop yields, they also suggest significant water savings in the agricultural sector. Delivery losses in 1990 were put at

29 percent of diversions excluding leaching requirements (supplied during the non-vegetative period), and overall efficiency at 54 percent including field losses. Further improvements are no doubt possible but these estimates are not far short of the SANIIRI target levels of 11,000 m^3/ha, 22 percent and 63 percent respectively, and compare not unfavorably with schemes in many other parts of the world.[4]

Much of the credit for the reduction in average water use must go to river basin agencies (BVOs) in cooperation with the MLRWM and similar agencies in other countries. Systematic control and rationing of water based on crop norms and responsive scheduling were effectively established during the early and mid-1980s when the BVOs were first created. At the farm level, rationing provides its own incentives. Much, however, remains to be done. A pilot MOA program has shown that water indenting based on farm-level moisture measurements and centralized data analysis has the low cost potential for reducing water use and enhancing crop yields. Expansion of this program would be difficult in the absence of relatively large tertiary units since it is dependant on good communications, and has staffing and equipment requirements that might be a problem in the context of a system of small-scale private farming.

Environmental Issues

The impact of irrigation on the environment has become notorious with the attention given to the Aral Sea issue. But given limited potential for water savings in irrigation (Table 3) and rising demands in other sectors, there is essentially no possibility of reversing this process other than through the socially unacceptable expedient of large-scale abandonment of irrigation (World Bank, 1994). Emphasis must therefore necessarily be given to ameliorative action rather than to increasing flows to the Aral Sea. The Sea itself will inevitably degenerate into a saline sink.

Besides its direct impact on the Sea and its surroundings, irrigation has also led to extensive waterlogging and associated secondary salinity. Some 50 percent of the irrigated area is affected, with 31 percent classified as weakly, 15 percent as moderately, and 5 percent as highly salinized. The water table is within 2 meters of the surface over almost a third of the area, and two-thirds of the underlying groundwater has a salt content of more than 1,000 parts per million.

These are disturbing figures. In the most affected areas, notably along the lower Amu Darya, cropping is confined to rice, and then only if sufficient water is allocated to keep the salts at bay. Indeed, the role of rice and its "wasteful" use of water can be misconstrued since, without it, large areas would have to be abandoned in a region already harshly affected by the Aral Sea crisis.

Waterlogging and salinity reflect inadequate drainage. A very costly program of collector drains was initiated in the 1980s but implementation has been severely curtailed by the financial crisis. It is now being considered for World Bank support. Investment in scheme-level and on-farm drainage has also been inadequate, in particular in long settled areas (drainage was usually provided in new settlement schemes). Inadequate on-farm drainage must in part be attributed to inaction by collective and state farm managers, and incentives to remedy this situation are critical for the future.

IMPLICATIONS FOR REFORM

Collective Farms, Irrigation, and Land Reform

This discussion of performance is no doubt inadequate and inconclusive. Detailed studies are necessary to establish with any confidence correlations between the performance of irrigated agriculture and the institutional structure. Nevertheless, collective farms have clearly been consistent with large reductions in average water use, and there is a strong *prima facie* case that they represent an important link within a broadly effective overall water management system. Given the critical role that irrigation plays in Uzbekistan's agricultural economy, it is important that this is fully taken into account in the implementation of land reform programs.

Motivation and Incentives

The central rationale for the privatization of agricultural land, as for other market reforms, is the creation of an incentive structure that rewards initiative and promotes efficiency in the use of scarce resources. Nevertheless "there is strong evidence that most rural residents in the former socialist countries are not ready for independent farming" and that "the model of division of large-scale farms into smaller profit-motivated functional units supported by cooperative services

[4]Crude estimates of water use per hectare are of course an inadequate measure of irrigation performance and, moreover, do not take account of effective rainfall. Table 4 summarizes estimates by major region, suggesting that rainfall does have a measurable impact and that there are also large variations in leaching requirements (they are particularly high in the mid- and lower Amu Darya regions). More detailed analysis could well indicate substantial differences in performance amongst the different regions besides identifying explanations for these changes that are much more complex than suggested in the paper.

appears to provide a fairly faithful generalization of the diversity of reorganization modes which are occurring in the agricultural sector all over the region" (Csaki, 1993). Though rural residents in Uzbekistan have perhaps been given little opportunity to express their views, there is little reason to doubt that this accurately represents the situation in Uzbekistan.

The implication is therefore that basic production activities should be privatized (e.g., by distributing or leasing land, and by removing constraints on cropping decisions) but that services will continue to be provided on a cooperative basis. In respect of irrigation, this is not surprising since the provision of surface irrigation services is a natural monopoly that inherently needs cooperative effort. In transforming the irrigation management system, the essential requirement is thus to evolve incentives which promote efficient and environmentally sustainable use of water without undermining the strengths of the present water distribution system.

Measures to be considered have been suggested above. Autonomy and accountability could be promoted by the introduction of water fees at each level--between the BVOs and the MLRWM, between the MLRWM and collective farms, and between collective farms and the "profit-motivated functional units" whether these are brigades, lessees or private farms. Accurate measurement would be required, including within the collective farm, to promote efficient water use on-field and moderate free-rider and unaccountable behavior. Incentives are also required inter alia to promote the systematic allocation of maintenance tasks, irrigation in response to field-level moisture measurements, on-farm improvements (e.g., tile drainage), and systematic development of the tertiary network in response to the evolving pattern of land ownership.

As in any context, the effectiveness of irrigation incentives will be closely related to the effectiveness of the general incentive system. If production incentives are grossly distorted, then so will incentives relating to water use, being reflected for instance in farmer unwillingness to pay for water or to invest in on-farm improvements. Reform in irrigation incentives must therefore go parallel with reforms in the overall pricing and incentive system

Democratization

Farm managers are traditionally appointed by the local government or party, and approved by the MOA (the ministry to which they report and from which they receive most agricultural services other than irrigation water). In turn, the farm manager appoints the governing council and selects specialist officers (treasurer, irrigator, etc.). Such procedures are consistent with centralized planning and the collective farm manager is essentially the agent of the state.

Democratization of this system would improve accountability and promote decentralization of decision making. If cooperative managers are responsible to their members rather than to a government official, they can be expected to behave accordingly. The form of the election process, and the rights and responsibilities of each of the officers, would need to be determined. One option to be considered would be to organize membership on the basis of smaller units (e.g., reflecting the traditional brigades). As in the case of the establishment of a WUA, consideration could be given to organizing members on the basis of hydrological units.

Irrigation and Other Services

The picture painted above is one where basic production activities are increasingly devolved to smaller "profit-motivated production units" while services continue to be provided on a cooperative basis within the framework of a general reform of the economic system. The question arises, whether differing services should be provided by a single multi-purpose service cooperative, or whether each should be handled separately. Specifically, is irrigation sufficiently different from other services that should be handled by a specialist organization, i.e., a WUA?

As stated above, there is an important difference between surface irrigation and other services: irrigation inherently *requires* cooperative effort, other services *can* (and in many contexts *should*) be provided privately. For instance, cooperatives worldwide have performed abysmally in the area of farm machinery, which is normally best left to private owners, but a pump serving several farmers inherently involves central management (even if operation can be centralized, e.g., under a government agency). Furthermore, the funds involved in tractor operations, or input purchases, or output marketing, are typically far greater than those involved in irrigation, despite its critical importance. The financial viability of the essential irrigation service may thus be endangered if it is handled by a multi-purpose organization.

Furthermore, it can be argued, in a more general sense, that the past involvement of collective farms in the whole range of production and service functions (i.e., in total farming) could place at the risk of what is best for irrigation since they will find it difficult to adapt. If so, and if services in general are to be provided cooperatively as in the model described by Csaki et al., then this may suggest that it is preferable to transform the collective farm into a multi-purpose cooperative delivering all agricultural services other than irrigation. In which case, irrigation would need to be hived off to a separate system of WUAs.

These issues are in no sense unique to Uzbekistan and cannot be resolved in the context of this paper. Different options should no doubt be considered and investigated. But whatever the final outcome, it is vital that reforms are sensitive to the critical need to preserve an effective irrigation management system and that a damaging hiatus of the kind encountered in Bulgaria should be avoided at all costs.

Table 1. Comparative cotton yields (kilograms of fiber per hectare).

	1991/92	1992/93
Uzbekistan	860	784
Brazil	381	315
China	869	671
India	267	299
Pakistan	756	580
Turkey	937	957
U.S.A.	731	783
World (all countries)	578	515

Source: US Department of Agriculture (May 1993) .

Table 2. Uzbekistan: Yields of cotton by year (kilograms of fiber per hectare).

1940	570
1950	590
1960	750
1970	810
1980	930
1990	890
1991	840
1992	760

Source: Ministry of Agriculture.

Table 3. Irrigation water use (thousand cubic meters per hectare).

	Evapo-transpiration	Irrigation losses	Field losses	Leaching application	Total
1980	6.5	4.9	2.4	3.4	17.2
1990	6.5	3.5	2.1	2.4	14.5
1991	na	na	na	na	13.2
1992	na	na	na	na	12.6
Target	6.0	2.1	1.4	1.5	11.0

Source: SANIIRI (1993).

Table 4. Uzbekistan: Rainfall and irrigation water use by region 1991.

	Rainfall	Irrigated area	Average norm	Water Use		
	(millimeters)	('000 hectares)		Crop use	Leaching	Total
				('000 cubic meters per hectare)		
Fergana Valley	244	924	9.9	10.0	1.9	11.9
Mid-Syr Darya	424	958	10.5	9.7	1.2	10.9
Samarkand	500	407	10.6	7.9	0.7	8.6
Mid-Amu Darya	259	1,161	14.7	11.2	3.5	14.7
Lower Amu Darya	112	750	19.3	14.2	3.8	18.0
Uzbekistan	290	4,200	13.1	10.8	1.94 9	13.2

Notes: Fergana Valley = Andijan, Fergana and Namangan Oblasts.
Mid-Syr Darya = Tashkent, Syr Darya and Djizak Oblasts.
Samarkand = Samarkand Oblast.
Mid-Amu Darya = Sukandarya, Karshi and Bhukara Oblasts.
Lower Amu Darya = Khorezm Oblast and Karalkapak Autonomous Region.

Source: Ministry of Agriculture (1993).

References

Csaki, Csba and Zvi Lerman. 1993. Land reform and the future role of cooperatives in agriculture in the former Socialist countries in Europe. *In* ["_____"], Westview Press.

Glazovskiy, N.F. [1991.] Ideas for an escape from the "aral crisis". Soviet Geography, XXXII: 73-89.

Micklin, Philip P. 1992. The aral crisis: Introduction to the special issue. Post-Soviet Geography(formerly Soviet Geography) XXXIII: 269:282

Ministry of Agriculture, Uzbekistan. Agricultural Statistical Bulletin. Various Issues. Tashkent.

SANIIRI. 1993. Informal communication.

US Department of Agriculture. May 1993. World cotton situation. Washington D.C.

World Bank. 1993. Uzbekistan: An agenda for economic reform: A World Bank Country Study. Washington D.C.

World Bank. 1994. Aral sea program: Phase 1. Briefing Paper for Donor Meeting in Paris on 23-24 June 1994. Washington D.C.