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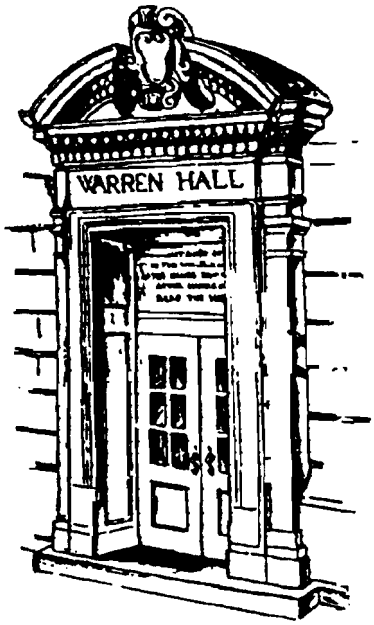

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AGRICULTURE IN THE REPUBLIC OF KARAKALPAKSTAN AND KHOREZM OBLAST OF UZBEKISTAN

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ABSTRACT

This paper describes the agricultural sector in the western region of Uzbekistan, the most populous of the former Soviet Central Asian Republics. Agriculture in this region, as in all of Uzbekistan, is entirely dependent on irrigation, as has been the case for millennia. Evidence of settlement of the desert oases and the banks of the Amu Darya River (known as the Oxus in ancient times) dates back many millennia, as does settlement of the short of the Aral Sea, largely based on fishing. However, the Aral Sea Region of Uzbekistan, including the Autonomous Republic of Karakalpakstan and Khorezm Oblast, the currently undergoing severe ecological stress, as is the entire Aral Sea Basin. Massive expansion of irrigated area starting in the 1960's has resulted in a steady shrinkage of the Aral Sea, whose shoreline is now some 100 kilometers beyond its former location. There are now problems with extreme salinization of the sea water, which supports many fewer species than previously, as well as wind-blown salt from the flats left by the retreating waters. In addition, poor irrigation management has caused severe problems with waterlogging and salinity in upstream areas.

Agriculture in the Republic of Karakalpakstan and Khorezm Oblast of Uzbekistan

Introduction

This paper describes the agricultural sector in the western region of Uzbekistan, the most populous of the former Soviet Central Asian Republics. Agriculture in this region, as in all of Uzbekistan, is entirely dependent on irrigation, as has been the case for millenia. Evidence of settlement of the desert oases and the banks of the Amu Darya River (known as the Oxus in ancient times) dates back many millenia, as does settlement of the shore of the Aral Sea, largely based on fishing.

However, the Aral Sea Region of Uzbekistan, including the Autonomous Republic of Karakalpakstan and Khorezm Oblast, is currently undergoing severe ecological stress, as is the entire Aral Sea Basin. Massive expansion of irrigated area starting in the 1960's has reduced the river flow to nil in low water periods, and has resulted in a steady shrinkage of the Aral Sea, whose shoreline is now some 100 kilometers beyond its former location. There are now problems with with extreme salinization of the sea water, which supports many fewer species than previously, as well as wind blown salt from the flats left by the retreating waters. In addition, poor irrigation management has caused severe problems with waterlogging and salinity in upstream areas.

The collapse of the Soviet Union has not been accompanied by massive social or political reorganization in Uzbekistan since the former communist party boss remained in power as the dictator of the country and the state control apparatus is largely still functioning. Nevertheless, it is recognized that some market oriented reforms would be beneficial, though there has as yet been no radical redirection of the economic system. In agriculture, this means a continuation of the old system in which planting decisions are made by the central government in Tashkent, and transmitted down through the hierarchy to the oblast level, the raion level and the collective farm level. The designated crops are then cultivated with machinery and supplies provided by the state, and are sold at prices dictated by the state, which has a monopoly on trade of important cash crops. There has been some liberalization, particularly in the area of fruits and vegetables, but the bulk of the land is still farmed as it was under the Soviet Union.

Cotton is the dominant crop in Karakalpakstan and Khorezm, as it is in the country as a whole, though production in the Aral Sea

region accounts for only around 10% of national cotton production. Given the fact that agriculture accounted for 28.5% of GDP in 1995, between 40 and 50% of total employment, while providing between 2/3 and 4/5 of export revenues, it is clear that the development of agriculture in general has significant implications for the country as a whole as well as being the dominant sector in the western region. For this reason, successful reforms in the Aral Sea region can be important in terms of demonstrating possibilities for the whole country.

Other important crops in this area include rice, which has long been grown in the delta of the Amu Darya, cattle and fodder crops, and various horticultural products, most of which are produced on private plots rather than larger units. Wheat has recently become more important as state orders have been imposed to fulfill the central government desire for grain independence, particularly from Kazakhstan. Alfalfa is grown to feed cattle along with some maize, and cattle are also fed byproducts from cotton and rice production. Aquaculture is also practiced in Khorezm region in lakes in the east of the oblast.

Output Trends

Tables 1 and 2 show agricultural output in Karakalpakstan and Khorezm for the past two years. It can be seen that cotton and grains are the dominant crops. Of grains, rice is the most widely cultivated but wheat has become increasingly important over the past few years. Tables 3 and 4 show the areas planted to the major crops.

Cotton is still produced almost entirely by the collectives, and its absence on private lands reflects the poor incentives inherent in the state order and pricing system. Table 5 shows returns on cotton producing kolkhozes in Karakalpakstan, where it can be seen that every one lost money last year and only one rayon had a positive result in 1995. Private sector producers concentrate on horticultural crops and livestock, together with rice. Tables 6 and 7 show figures for livestock breeding, where the large share of the private sector in the total is evident. Table 8 shows that livestock is the predominant activity of dekhan farms in Khorezm.

Yields in Karakalpakstan are quite low compared to those in other parts of Uzbekistan. Table 9 shows figures for the five regions, and it can be seen that the Aral Sea region lags behind all others by a substantial margin. The figures above indicate that Karakalpakstan is in fact lower still than that for the Aral Sea Region in general.

Declining yield is a particular problem in the cotton

subsector and one that is recognized by the authorities. There are various reasons for this, including both economic and technical problems. Foremost in economic terms are the low prices received for seed cotton, as well as the difficulties and vagaries of state supply of fertilizers. One macronutrient, potassium, was not supplied at all in 1996 while supplies of phosphorus were negligible (see below). Foremost among technical problems are those associated with irrigation, with salinity, rising water tables, and hard pans being the most important.

It should be noted that yield figures from the soviet era may well be overstated and so cannot be regarded as a reliable benchmark from which to measure trends. However, it does seem that yields do have a downward trend in the cotton subsector.

Land Tenure

The dominant forms of land tenure during the Soviet era were the sovkhoz, or state farm, and the kolkhoz, or collective farm.

State farms (sovkhoz) were large farm units run on the same basis as manufacturing or industrial enterprises in that employees were paid a salary. There are currently no remaining state farms in Karakalpakstan or Khorezm apart from those dedicated to plant research or experimentation.

Collectives (kolkhoz) are large farms, often including housing or other activities, which are technically run by their members, though local authorities of the Ministry of Agriculture and Water are in de facto control of operations. Technically, farmers do not receive salaries, but rather are paid according to their output. In practice, monthly payments are made with a bonus at the end of the year according to the value of the crop produced. Large capital investments are paid for by the State but maintenance costs are the responsibility of the collective.

In many cases, the payment of kolkhoz workers is often made in-kind in the form of food or other commodities and is often in arrears. For example, many farms had still not been paid for the previous year's harvest by May of 1997, though planting for the following crop year had already begun.

Collectives have become by far the most important form of organization and by 1995 accounted for 1,937 miliion hectares out of a total of approximately 2,2 million in the country as a whole. This increase has come about mainly through the conversion of state farms into collectives.

Dekhan farms are independent household farms which are leased by a household, individual or group, and which, in theory, can make their own planting decisions and maintain their own finances. However, the extent to which these farms are in fact independent of centralized administration and control is quite limited in Karakalpakstan, though it seemed to be somewhat greater in at least some cases in Khorezm.

Leasehold peasant farms (arednoe khozyaistvo) are farms which are leased from a collective or local government. In practice, these are somewhat similar to private livestock farms, which result from privatization of the livestock activities of the kolkhoz, but which may be operated as a joint stock company with the state. Even in cases where the state is not part owner, there may be conditions on the granting of the lease which require provision of some portion of output to the lessor.

Household plots are areas of 1/4 hectare, usually adjacent to or surrounding the house and farmed as private holdings. These plots provide the bulk of horticultural crops as well as dairy and meat products. All of this output is freely sold and traded in urban markets.

"Privatization" - Real or Illusory?

Karakalpakstan and Khorezm have lagged behind the rest of the country in the transfer of land from central control. As can be seen in Table 10 the land under central administration in the Aral Sea Region had decreased by only 4% in 1996 as compared to 1990. While it is clear that there has been some move toward new independent farms such as dekhans and private farms, there was much confusion among people interviewed as to exactly what this meant, and also some differences between Karakalpakstan and Khorezm.

In Khorezm, it is apparent that there has been growth in the number of dekhan farmers, that many, if not most of these are free to grow the crops they wish, but that if they grow crops subject to state orders, then they must comply with them. For this reason, dekhan farmers in Khorezm avoid cotton and wheat, which are not economic in their opinion, and concentrate instead on rice and cattle, where prices are more attractive and the possibility of exceeding the plan and so having supplies to sell at free market prices is much greater. The association of dekhan and private farmers has merged into one association in the oblast, and helps supply inputs purchased from the state, and gives advice on management and other issues. Membership is obligatory, being financed by a per hectare tax averaging 500 soum.

In Karakalpakstan it is clear that in many, and probably most cases, the change from collective to dekhan farming had little practical significance. Even in cases where dekhans are formed,

these farms are still subject to state orders, still receive all inputs from state supplies, and still are subject to controlled prices set by the state. Kolkhoz managers have little option in this regard since the target amounts in state orders are not reduced when the kolkhoz spins off some or all of its land to dekhans. For this reason, dekhans formed on cotton producing kolkhozes were seen which are still required to grow cotton, in order to help meet the state plan. In effect, the move from sovkhoz to kolkhoz and from kolkhoz to dekhan has had little or no discernable effect on the actual performance and management of farming activities.

There is one exception to this generalization. Workers on sovkhoz received salaries rather than sharing the value of output produced. Accordingly, the virtual elimination of this category of farm has reduced most farmers on centrally administered units to relying on the vagaries of state payment for procurement of outputs. These payments are routinely in arrears, sometimes by a substantial amount of time. In fact, many farms had still not received payment in May of 1997 for the previous year's harvest, even though planting had already begun.

Accordingly, seeds and fertilizers are provided without prior payment, and farmers, when they are paid, are often paid in kind in the form of food or other necessities. In effect, this is a reversion to the physical planning typical of the Soviet era, and represents a further entrenchment of the command system of the past.

While there is anecdotal evidence that private plots may be expanding somewhat beyond the 1/4 hectare allowed under previous decrees, it proved impossible to verify this, as official statements were invariably to the effect that private plots were limited to this size. Without further survey information, it will be difficult to pin this factor down.

What is clear, however, is that production of horticultural crops from these holdings is substantial, and provides a large percentage of supplies to the local market. It was also clear that there is free trade in these products within Uzbekistan, as all local markets had produce originating in Samarkand or other parts of the country.

An important consideration in the move toward independent farmers is the provision of social services formerly provided by the kolkhoz or sovkhoz. In effect, these organizations provided the social safety net for the rural population, and will cease to do this as they are replaced by independent farms. The existing arrangement, whereby assistance is provided through mahalla committees, will have to be provided with sufficient resources to prevent those most vulnerable from sinking below acceptable levels. Meanwhile, it should not be expected that collectives will

immediately disappear - rather, they will be replaced as their productive functions are taken over by voluntary associations of farmers and their social functions are taken over by appropriate entities such as the mahalla committees.

Farm Labor

Approximately 75% of farm labor is performed by women. This means that increasing returns to farm labor, whether directly or through higher returns to farming on independent farms via higher output prices, will immediately improve the conditions of rural women.

In the past, agriculture has served as a sort of "residual" sector of employment in that recorded employment in this sector rose after 1989 while those of other sectors were falling. (ILO Discussion Paper No. 14, 1996) To some extent, this reflects the fact that some family members of collectives have returned full time to the farm sector as employment off-farm has become scarcer.

Overall, labor use in agriculture is reported to be relatively high in Uzbekistan, and norms for labor requirements for cotton in particular are high compared to those of other crops (see below). It is important to note that there is serious reason to discount official statistics of labor input as these are typically inflated in order to justify larger payroll payments on the part of the collective, whether or not that labor was actually used for farming. It is not surprising to see labor intensive production methods with a cost of labor amounting to 114 soum/day, but a sustained increase in agricultural incomes will inevitably bring greater levels of mechanization in the future.

However, that future is at present quite some distance away. There is among many observers a perceived aversion to manual labor and a strong bias toward heavy mechanization that is a product of the Soviet experience. However, there is every reason to believe that given the proper incentives (i.e the right to the returns generated by manual labor) people will do what is optimal, and in many phases of farm operations will opt for more labor intensive methods. The experience of the few independent leasehold farmers in Uzbekistan bears this out, as does the experience of Uzbeks and others in surrounding countries.

Irrigation Issues and Options

By far the most important technical problems for agriculture in the Aral Sea region are those relating to irrigation. Agriculture, and in fact the ability of people to subsist, is

virtually entirely dependent on it. This has been the case for as far back in time as records go - civilization on the lower Amu Darya has always depended on irrigation for survival, and has expanded and contracted along with the availability of water.

Though there is evidence of irrigation in this area as early as 3,500 years ago, it is the expansion of irrigated area during the Soviet era coupled with an emphasis on cotton that has resulted in major changes and problems. While the beginning of Soviet expansion of area for cotton production can be traced back to a 1918 decree by Lenin ("About the organization of irrigation work in Turkestan"), it was the massive expansion beginning in the 1960's that resulted in the huge environmental problems that exist today.

These issues have received much attention elsewhere. It is not the purpose of this study to attempt to resolve the problems relating to the shrinkage of the Aral Sea - rather, an attempt will be made to incorporate the results of this overall problem into calculations of the appropriate strategy for agriculture in the Republic of Karakalpakstan and Khorezm. With regard to irrigation and soil quality, there are three major and interrelated issues: salinity, high water tables, and hard pans.

Figures 1 and 2 show schematic representations of the irrigation system in the lower Amu Darya. Table 11 shows the length and type of irrigation canals in Uzbekistan. It can be seen that virtually all canals are unlined in Karakalpakstan and Khorezm, and these two regions also have the lowest overall efficiency in the country, at 0.63 and 0.65 respectively. Overall, Karakalpakstan and Khorezm are predominantly irrigated via furrow, while a substantial proportion is irrigated by basin or wild flood methods, much of this for rice production. Table 12 shows the figures for Karakalpakstan and the different oblasts in Uzbekistan.

Table 13 and Figures 3 and 4 show the extent of problems with high water tables and with salinity. It can be seen that virtually all of Karakalpakstan's water table is less than 5 meters deep, and more than 80% is less than three meters deep. The weighted average depth for the republic is 2.5 meters according to TACIS data, though data from SANIIRI from 1994-96 showed average depths of less than two meters in all but three rayons. This problem is more severe here than in any other part of the Amu Darya basin. In the Nukus region, the water table is reported now to be at an average depth of 1.6-1.8 meters. It was reported by the cotton research institute in Khorezm that the water table in that oblast is at an average of about 1.7 meters.

It can also be seen that salinity was a problem on more than half of the land in Karakalpakstan as of 1989, and there is reason to believe this problem may have increased in the years since, due to inadequate amelioration and breakdown of the drainage system.

It was reported at SANIIRI that problems are particularly severe in the Nukus region, with 1 ton/ha. of salt deposited by wind each year and 15 from water. Groundwater in this area has a mineral content of 8-10 grams per liter, a testament to the poor quality of water in the lower portions of the river. Similar levels have been found in Khorezm, though irrigation water salinity levels are somewhat better due to its upstream location compared to Karakalpakstan.

There is one fundamental point regarding groundwater that it is important to emphasize: Excessive irrigation of rice in areas unsuited to its production aggravates groundwater level problems. Though rice has long been grown in low lying areas of the Amu Darya delta, and would likely to continue to be grown there under most circumstances, it is currently cultivated on large areas upstream from the delta in both Karakalpakstan and Khorezm. According to SANIIRI, water application is typically at least 34,000 - 36,000 m^3/ha. and is often on the order of 50,000 m^3/ha. or more for each crop. Table 14 shows indicative water requirements exclusive of water used for leaching. It is clear that rice is under any circumstances a "thirsty" crop, and its widespread cultivation accounts for a large share of regional water consumption.

Levels of water use greater than 50,000 m^3/ha. are extraordinary and are far beyond anything seen in other parts of the world. Such water use is a result of the high permeability of the sandy soils typical of these regions, where rates of filtration far higher than 10mm an hour (resulting in filtration of about 0.25 meters/day) have been recorded in various areas.

What this means is that rice is being grown in areas unsuited to its cultivation, and where it would not be grown were it not for the fact that water is free. However, a larger problem is the effect of such extremely high water use on local groundwater levels. In many areas, groundwater levels are high and so are causing salinization problems, precisely because rice is being grown so extensively and via means which involve massive amounts of irrigation.

These facts point to a very important conclusion: Before committing to large and expensive drainage projects, it is essential to remove the distortions in relative prices of crops and water that generate a large part of the problem. In essence, part of the groundwater problem, and the salinization it causes are a result of large irrigation works and free water provision from them. It is fundamentally mistaken to correct such a problem via engineering solutions before correcting the distortions that are a large part of the root cause. In a context of liberalized cropping choices based on realistic prices it may well be the case that rice cultivation would expand in the lower reaches of the delta where there is low lying land and less of a problem with water availability as upstream land in rice production is diverted to

other uses, thus ameliorating drainage problems.

Nevertheless, it is still the case that there is in fact a need for rehabiltation, maintenance, and in some fields improved drainage to further ameliorate the problems of high water table and salinity. Both of these problems are aggravated by the poor condition of the drainage system throughout most of the region and would remain so even under alternative cropping patterns. In many areas, inadequate drainage was installed in the first place, while in most of the system little maintenance or cleaning has been done since independence. The casual observer can see plugged or stagnant drainage canals almost everywhere in Karakalpakstan, but the situation appears to be somewhat better in Khorezm. However, it was reported in Khorezm that the average length of drainage canals per hectare is 37 meters, and that this figure should be approximately 50 m/ha to ensure adequate drainage.

This is a key problem, since adequate or improved drainage is the main way to ameliorate the problems of salt and high water tables. Salts must be washed down through the root system and drained away in order to avoid buildup on the surface and in the root zone of the crop. This is impossible in cases where drainage does not occur or where it is inadequate. High water tables also promote surface salinization but this problem can be lessened somewhat by providing adequate drainage for fields. Anecdotal evidence suggests that on-farm cleaning and excavation of drainage canals is capable of lowering the water table significantly.

Given the expense of construction of new irrigation works, or of opening new lands, it seems clear that the best approach at present is maintenance and rehabilitation of existing structures. This means, first and foremost, the maintenance of the canals, and particularly those required to drain fields adequately. In those cases where drainage is absent or inadequate, new drainage must be installed. Given the public good nature of assuring adequate drainage in all areas to maintain the sustainability of production, a case can be made for assisting in the installation of new drainage where it is shown to be necessary, perhaps by providing extension advice or assistance via a labor intensive public works program.

Alternative methods such as drip irrigation are too expensive to make them worthwhile in the Aral Sea region. This is particularly so since the low elevations and flatness of the entire area make gravity fed furrow irrigation or basin flooding the preferred and cheapest method. Table 15 shows estimated per hectare costs of alternative irrigation technologies, where it can be seen that these methods are both more costly to install and more costly to maintain than are other methods. Evidence of this is the fact that out of 3,100 ha. of drip irrigation installed in Uzbekistan since 1991, only 200 ha. remain operational. In addition, experiments with cotton and drip irrigation show a

substantial water savings but no substantial yield gains, making the cost at the farm level prohibitive. (See, WARMAP Phase 2 "Report on Non Traditional Irrigation", December 1996)

An interesting aspect of Table 15 is that under current conditions (i.e free water) the traditional method of surface irrigation is the financially preferred option, but with water charges, various low tech improvements on these traditional methods become preferred. Under no circumstance are drip or overhead methods preferred.

Finally, perhaps the biggest single issue relating to water is the institution of water charges. Currently, the thought of this is anathema to many, given their history of free water use. In addition, there is an inherent problem in liberalizing input markets before output markets have been liberalized as this puts farmers in a cost squeeze which will make it difficult or impossible to maintain farming as a viable financial proposition. Nevertheless, if output markets were to be liberalized then water charges could indeed be afforded, and would be the single biggest factor in promoting rational water use. Several farmers interviewed said that they would be willing to pay for water if they could get more of it, indicating that water charges are not as unthinkable at the farm level as they are at some levels of the bureaucracy.

Institution of water charges would immediately provide an incentive to improve water use efficiency, avoid overirrigation, clean supply and drainage systems, and schedule water use for night hours when evaporation is less. Other water management problems include inappropriate timing of supply; for example, cotton should not be watered when first flowering and setting bolls as this may cause premature boll drop and excessive vegetative growth. However, water is often applied according to a fixed schedule, regardless of the stage of growth of the crop. One possibility, which would help prevent the problems associated with excessive water use for rice cultivation, would be to provide water at a low price up to some level, say 2 meters per hectare, with steeply increasing fees for amounts above this level.

An historical note is perhaps appropriate in view of the oft repeated assertion that "People here have never paid for water". In fact, prior to the Soviet era, that is exactly what they did. Under traditional irrigation systems installed by the various khanates in Uzbekistan, farmers were responsible for maintenance of not only their own on-farm canals, but also for providing labor for necessary maintenance on main canals and drainage. Failure to do so resulted in fines. Water users were also responsible for payments (often in kind) to the administrators who operated the water system. ("History of Irrigation in Uzbekistan and Present Problems" Paper presented by A. Karimov at USAID Workshop on Self-Adjusting Systems in Irrigation, Tashkent, April 29-30, 1997)

Cotton Issues

Cotton, as the most important crop in Karakalpakstan and Khorezm, is the subsector of most interest both to local authorities and to the central government in Tashkent. Technical and economic problems associated with it are therefore of primary importance in any consideration of a development strategy for the region as a whole. Crop budget calculations (see below) indicate that cotton is currently a profitable crop for the country as a whole, but distortions in domestic pricing and marketing have made it a losing proposition for individual farm units, while the return to the local authorities is substantially reduced by various implicit and explicit taxes. Accordingly, restoration of financial profitability and incentives appropriate to improved quality and yield are of the first importance.

Cotton is typically grown in rotation with some combination of alfalfa, a grain crop and vegetables. Rotation is not only beneficial for soil structure and fertility, but it is also the most effective control for verticillium wilt, the most important disease affecting cotton in Uzbekistan.

Yield

As noted above, cotton yields in Karakalpakstan are low and declining, while those in Khorezm are somewhat better but also show a declining trend. Authorities have taken notice of this and efforts are under way to improve the situation in several different ways. In terms of technical issues, it is clear that irrigation, salinity, and associated issues are the most important, and these can only be addressed by a combination of policy changes to improve incentives for farmers to maintain irrigation systems, and investments on the part of authorities in off-farm components of the system. These issues are discussed in detail under the section covering irrigation issues.

Another approach to yield increases is via seed improvement. In general, breeding a new variety takes about twelve years, during which time the variety is developed at the research institute. When varieties are ready for release, the seed is given to the Ministry of Agriculture and Water, which then performs multiplication and distribution. There is currently a project underway intended to strengthen seed production and certification, but it has not yet achieved substantial results.

Part of the rationale for this project are the persistent problems arising from the practice of using uncertified seeds

derived from ginning of cotton production. These seeds are of uncertain quality due to the fact that farm managers are free to choose whichever seeds they like and can and often do mix varieties. This has adverse implications both for the consistency of cotton quality even within one farm, and also means that there is almost certainly a major problem with maintenance of varietal characteristics from year to year. In general, once a variety has been released from a research institute, there is no further involvement of plant breeders in maintenance of the variety. Current efforts to address these problems under the Cotton Improvement Project should be aided as much as possible by regional authorities, and an attempt made to facilitate the integration of plant breeding and agronomic research into the seed multiplication and supply process.

Among the strategies being studied in Karakalpakstan are one to increase planting density. These methods resulted in an increase in yield of between 500 and 1000 kg/ha in experimental trials. One potential drawback of this approach is the requirement of growth regulators which must be imported. Recent problems with input supply must be dealt with before a strategy which relies on imported inputs can be widely adopted.

One recent release, Chimbai 40, has achieved yields of 3.8 tons/ha in trials in Karakalpakstan and is currently being multiplied in preparation for general release. Work continues on other varieties, with particular attention being paid to verticillium wilt. In Khorezm, a new variety called Khorezm 126 achieved yields of 5 tons/ha in trials and was reported to be able to raise yields 30% over existing varieties without altering any other inputs.

As noted above, it has been reported by various researchers that inappropriate timing of irrigation of cotton can produce excessive vegetative growth and retard boll formation. It has been estimated that correction of this problem could raise yields by 10% while decreasing water consumption by 20%.

Quality

A major problem in Uzbekistan, and one which receives less emphasis from the authorities, no doubt due to the fact that production plans are set in terms of weight, is the low quality of much of the cotton produced. There is a **tradeoff between yield and quality** both in production and in terms of plant improvement. Breeding for yield, without controlling for quality, results in fibers which are both shorter and coarser.

This has significant economic implications. The world market

places a substantial premium on quality cotton, with differentials between world market prices and Uzbek exports amounting to as much as 20% due to lack of quality control and grading according to international standards. It should be noted that this discount can be recouped simply by consistent grading and marketing according to international norms. Improvements in actual quality, in addition to these gains from improved grading of existing quality, can provide additional gains.

In addition to this quality discount, Uzbek cotton is discounted a further 4% from the average price for a particular grade on world markets largely due to problems with timely delivery. This means that improvements in quality can have as significant an impact on revenue as can increases in yield. If these impacts can be passed through to the farm level, there will be large incentives to improve quality at every stage of the growing and processing system.

One of the main reason for the increasing emphasis on quality is the development of new spinning technologies designed to increase speeds and control costs. The new high speed technologies place an emphasis both on fiber strength and fineness, but also on cleanliness, since there are reduced opportunities in the manufacturing process to check for problems with quality in the raw material.

This has implications for Karakalpakstan and Khorezm's ability to maximize the return to cotton exports, until the current reputation for inconsistent quality as well as for erratic delivery is overcome. However, it also has implications for the ability to develop a comparative advantage in the textile industry, because if Uzbekistan's textile manufacturers are forced to rely on low quality domestic cotton, they cannot take full advantage of the newer high speed, low cost spinning technologies which are in use in other countries. Given the fact that spinning is the most costly part of the process of creating cloth out of fiber, this is a significant disadvantage to moving beyond the stage of supplying raw materials to performing the downstream activities which provide value added.

Probably the greatest single factor militating against improved quality is the state order system and the problems with marketing and payment that go along with it. This system relies on targets specified by weight at the farm level and so does not directly reward farmers for improved quality. In fact, there were widespread reports of use of any and all available ways to increase measured harvest weight, such as inclusion of extraneous plant matter, dirt, rocks, or other material in bales. It is notable that Uzbek cotton gins have many more cleaning stages prior to ginning than is common in other countries.

Solution of this problem has been achieved in other countries

through concerted efforts at breeding consistent varieties, ensuring that planting zones are planted to a single variety, and ensuring that each gin operates solely on one variety. (It was reported that there are currently 10 or more varieties in general use in the study area.) Grading is also extremely important for product consistency, as this permits gins to produce runs using only a single grade of cotton.

Equally important is a pricing system which rewards farmers for quality, which is only possible if grading is attributable to particular producers and if the price premium that results is passed back to the producer. These price premia are set by the world market and could easily be disseminated locally via regular reports on radio, television, or newpaper.

Cotton Gins

It is clear that ginning capacity is inadequate. Cotton is typically still being processed in late May, and in many areas is not entirely processed until sometime in June. Given the fact that the harvest is finished in the Fall of the previous year, this implies waits of up to six months or more for processing for the last runs at these gins.

Table 16 shows generally accepted limits for safe storage of seed cotton before fiber deterioration begins. It is obvious that current practice in Uzbekistan results in delays far exceeding the recommended 30 days for even the dryest cotton. Accordingly, there is a clear case for additional ginning capacity to reduce this problem. It would be best to encourage private sector investment in new capacity in order to promote competition. A further problem in Uzbekistan is the poor quality and poor maintenance of cotton ginning equipment. This results in lower quality cotton and excessive waste, Installation of new capacity of better quality would help ameliorate this problem.

Cotton Marketing

The basis for cotton production and marketing is the state order. The state has a monopoly on cotton marketing and in the past set prices for the entire crop and required it all to be processed in state ginneries. Since 1995, the state has instituted a process whereby increasing shares of cotton target production will be procured at "free market prices". In fact, this program has been rendered largely ineffective in terms of providing adequate incentives at the farm level.

The general problem is one of excessive taxatation, both

implicit and explicit. Cotton is sold on the world market for prices which are already discounted 4% due to consistent problems with timeliness of delivery and consistency of product. These exports are actually performed by state trading companies which typically deal with international cotton traders rather than directly with processors, since the latter have strict delivery requirements which Uzbekistan has trouble meeting. As noted above, Uzbek cotton is also subject to a further discount of 20% due to lack of appropriate grading.

This revenue is then taxed by the state at a rate of 32%. Payment from the trading companies to domestic producers is denominated in local currency. Here, a major implicit tax is imposed in the use of the official exchange rate. Currently, that rate is 61 soum/$. Given parallel rates of between 140 and 145, it may be estimated that this implies a substantial further tax of somewhere between 30-60% depending on the assumed equilibrium exchange rate. This calculation is in fact quite conservative considering that payments are sometimes delayed as much as 6 months, during which time the official exchange rate may have changed. It was impossible to verify, but if the previous official exchange rate of 55 is used since that was the rate prevailing when the cotton was contracted for export, the implied tax would be proportionately larger.

A further problem is the fact that payments are made in the form of bank transfers and not in cash. Currently, there is a 40% premium on cash transactions, so this constitutes a further implicit tax on farmers.

If we put all of these factors together farmers are receiving less that 30% and possibly less than 20% of the true value of their cotton <u>even when they are receiving the supposedly free market prices</u> for part of their crop.

However, this is not the end of the story. It was widely reported that in those cases where producers failed to meet their target amounts, **all** of their crop was subject to state procurement at the state price. It was reported in Karakalpakstan that most producers in fact failed to achieve their targets and so were subjected to this problem. All in all, it is apparent that the supposed liberalization of the cotton market has had virtually no real effect on many farms and that in spite of any policy initiatives to the contrary, cotton farmers are still subject to state control to much the same extent as they have always been.

There is one caveat to this conclusion - Normally, cotton under state order is processed by the gin but no credit is given to the producing unit for byproducts such as seed and lint, nor are they returned to the producer. Since the value of these products is apparently included in the procurement price for "free" cotton,

there will be some additional benefit at the farm level.

However, the overall picture is clear: there is substantial taxation of cotton, and the benefits of this taxation accrue almost exclusively to the central government and not to the Republic or oblast. At the farm level, cotton is a losing proposition, while gins do not appear to be making excess profits, and are in terms of the revenue flow only a collection point from which exports are made, with the revenue going to the central government.

Though state orders are slated to be phased out in 1998, it remains uncertain whether this means that farmers will be permitted to grow any crop they choose, or that only state order prices will be phased out but producers will still be required to produce planned quantities.

Marketing and Pricing of Other Crops

Horticultural and meat products are both free of state planning and can be grown and marketed at uncontrolled prices. Horticultural products in particular and livestock to some extent are therefore produced largely on private plots. Local markets had ample supplies of a wide variety of fruits and vegetables, as well as meat, and many of these were reported to originate in other parts of Uzbekistan, such as Samarkand, making it clear that interregional trade in these commodities is not a problem.

Rice and wheat are treated differently. As noted above, each of these commodities is produced according to state planning directives. While other sources have maintained that rice has been liberalized, (See, e.g. the Uzbekistan Agricultural Baseline Survey), the state grain milling enterprise was unequivocal in stating that farmers were required to produce planned amounts. The plan target for each producing unit is divided in two parts. The first part is sold to the state at a fixed price, while the second part is provided at an "agreed" price negotiated between the seller and the state enterprise which mills the grain (Uzklebprodukt). Any farm which satisfies both the fixed price plan and the agreed price plan may then keep any excess to dispose of as they see fit - i.e. it may be used for own consumption, shipped to other regions, or exported from the country.

No wheat has ever been sold at the "agreed" price in Karakalpakstan, implying that achievement of planned amounts has never exceeded 50% since wheat was first planted by state order in 1993. (See Table 17 for these prices for the current year. The various grades of wheat are distinguished by gluten content.) Last year, only 5% of republic requirements were satisfied with local production, with the remainder imported from abroad. While a

substantial amount of this wheat came from Kazakhstan last year, only a negligible amount came from this source in the current year, having been replaced from a variety of sources.

The republic is almost self sufficient in flour milling capacity, with a reported 500 tons/day produced out of a required 550 tons/day. This production comes from 4 mills (one in Takhitashi, two in Nukus, and one in Kungrad) with a theoretical capacity of 730 tons/day. The resulting flour deficit is filled with imports from a variety of sources. Flour prices are also set by the government (See Table 17). Bread prices are also controlled, and the current price of 15 soum for a 600 gram loaf (approximately $US 0.10 at the current parallel exchange rate) is quite low compared to world prices of flour and wheat.

In the case of rice, production plans are usually fulfilled and some farms have on occasion exceeded both the amounts planned at the fixed price and that at the agreed price, and so have qualified for license to ship the rice out of the republic. The price paid to farmers in the last harvest for unmilled rice was 18.5 soums/kg, while the agreed price was typically about 2-3 soums higher. Table 18 shows the structure of costs for rice processing. Last year, 24,752 tons were processed, most of this, (23,243 tons, rice classified as second grade.

Independent milling of both rice and wheat is permitted, with farmers allowed both to operate mills if they choose, or to take their crop to private companies to be processed if they choose. However, exports from the republic are not permitted unless, as noted above, the plan has been fulfilled. It was reported that independent milling of rice is commonplace, while that of wheat is not, giving the state an effective monopoly on processing of wheat.

Animal feed is also produced by the grain processing company, and is all sold at market prices. (Approximately 4-5 soum/kilo for cattle feed). There is some variation in this price both due to market factors and due to the varying composition of the feed, which is a mixture of milling residues and mineral and vitamin additives. It was reported that these additives were previously purchased from other parts of the FSU but are now produced in Uzbekistan. Unfortunately, the plant which produces them in Fergana, itself uses imported inputs and so has had output shortfalls which have affected production of feed in Karakalpakstan.

Input Supplies

Seeds

Cotton seed is provided by retention of 25% of seeds produced by gins while the remainder is crushed for oil. As noted above, there is an effort underway to improve seed production and certification through production by independent companies. This effort should be strongly supported to enable the multiplication of certified quality seed as needed by the producers.

Conversations with cotton breeders indicated that improved varieties are available (e.g. Chimbai 40 in Karakalpakstan, and Khorezm 126 in Khorezm as noted above) but that multiplication and distribution is a major bottleneck. However, plant varieties are released to the Ministry of Agriculture and Water, which then evaluates them according to a hierarchy of criteria. It wasreported in Khorezm that these, which amount to state ordered plant breeding objectives were, (in order of importance):

1. verticillium wilt resistance

2. fiber yield

3. early opening

4. fiber strength

It is notable that the only attribute related to quality ranks fourth and last in importance. General breeding targets in Karakalpakstan are increased yield, drought resistance, salt tolerance and disease resistance.

The current cotton improvement project (see above) will go far toward addressing problems in cotton seed multiplication and distribution. Implementation has been somewhat delayed, but the project is expected to be completed by the end of the year 2000.

For other crops a substantial share of requirements are satisfied by retention of own production, with the balance provided from state sources. This is particularly true in the case of wheat and rice. Horticultural crops rely to a significant extent on private suppliers, in line with their predominance in household plots.

For rice and wheat there is no apparent systematic seed supply system. Most of the producers interviewed relied at least to some extent on retaining a portion of their crop for seed. Vegetable and fruit seeds are freely available in the local markets, though these were clearly not certified or regulated in any way.

Machinery

A state enterprize, Uzselkhoztekhnika, is responsible for supplying and servicing tractors and other agricultural equipment. The current state of affairs is quite poor in many cases, with tractor fleets of 10 years of age or more. (See Table 19) In addition, there are significant problems with adequate maintenance and availability of spare parts. Table 20 shows figures for the current agricultural vehicle fleet in Khorezm, where it can be seen that less than 25% of tractors were actually functional.

The move over the past two years toward provision of machine services from centralized tractor parks is an unfortunate recreation of a soviet style institutional structure that has proven to be suboptimal in all other contexts where it has been implemented. If, as is the case in Uzbekistan, operators are employees of the machinery company, they lack incentives and knowledge to do the best possible job on any particular field. In addition there are inevitable coordination problems as the question of who gets priority on use of the machines is decided by administrators who are not familiar with individual farm level conditions and who are employees of the state.

The recent purchase of large Case tractors with a capacity four times greater than previously used machines is a move toward large scale, expensive equipment that is not suited for smallholder use. However, if these machines do in fact prove able to ameliorate the problem of a hard pan through deeper ploughing than smaller machines can accomplish, then they may well be worthwhile but it will be necessary for the government to achieve extremely high levels of machine use to make the fleet a viable economic proposition.

Given the fact that there is a justifiable agronomic rationale for deep ploughing together with the fact that no single farmer or collective could possible afford to buy one, it seems reasonable to continue to allow them to operate, unsubsidized, as independent service contractors. (Currently, they operate on a contract basis but receive both implicit and explicit subsidies.) However, there is no economic rationale, and much negative experience, with machine tractor stations for smaller tractors. Further purchases of these by the central government do not seem justifiable and those that are already owned by the state could be sold off to private sector farmers as demanded.

It is interesting to note that virtually every independent farmer interviewed in the course of this mission either had, or was planning to get, his own tractor and other machinery. The desire for independence from centralized supply of machine services was near universal, underscoring the need for availability of tractors on the appropriate scale for these smallholders. Liberalization of imports of both new and used equipment could go far toward meeting

this demand.

Fertilizers and other Agrochemicals

Both Khorezm and Karakalpakstan are areas in which soil is washed annually (or more than once annually) in order to leach out salts. This, together with frequent applications of irrigation water, means that fertilizers are also leached out of the soil and so must be applied at higher rates than would normally be the case. Researchers in Khorezm reported that plants actually use only around 45% of the amounts applied, thus justifying the high application rates recommended in the region.

Fertilizers and agro-chemicals are supplied by a state enterprise, Uzchemservis. This company exists primarily to service the needs of the collective sector, but will also sell to independent farmers if supplies are available. While domestic production capacity exists, there has been insufficient supply in recent years. Imports of a formula containing N=23 and P=23 produced in Kazakhstan have satisfied some of the demand, while former potash imports from Russia have been reduced to nil or a very low level until this year when 21,000 tons were delivered. (It was reported that farmers are often reluctant to use potassium since though it is a necessary nutrient, it is also a salt (KCl).)

Prices are relatively high, both because of withdrawal of subsidies but also because of the need to transport supplies by rail through Turkmenistan. It was reported that Turkmenistan is imposing transit charges amounting to 25-30% of the final price. However, prices are still tied to the official exchange rate and so contain an implicit subsidy depending on the extent to which this diverges from the equilibrium rate.

Use of other chemicals is down by more than half over the past two years, in part due to higher prices but also due to problems with availability. Pesticides are imported from Germany, while domestically manufactured defoliants are unavailable because the factory lacks required imports to make them. It should be noted, however, that some of these chemicals are used primarily in conjunction with machine harvest. Growth regulators cause cotton plants to switch from vegetative growth to boll production and so result in fields where all plants are ready for harvest at the same time. Defoliants strip plants of leaves prior to machine picking so as to reduce the trash content of seed cotton. Neither of these are necessary if labor intensive methods are used instead of mechanical ones.

Uzchemservis is plagued by problems of non-payment by farmers who in turn are plagued by problems of non-payment for their crops. Thus there is a cascade effect of arrears, which in the end causes the system to default to one of physical planning since supplies

are given to farmers without requiring a down payment.

It was reported that there exist deposits of bentonite within Karakalpakstan, and that the ore contains 4-5% potassium along with a variety of micronutrients. It was reported that it is feasible to mine up to 200,000 tons/year but that the necessary equipment is not available. Field trials with fertilizer from this source have been performed and it was possible to achieve a yield of 3.5 tons/ha. with cotton.

Given past problems with fertilizer supply and distribution, there is a good case to be made for immediate withdrawal of the state from fertilizer distribution and marketing, an end to explicit or implicit subsidies, and encouragement of private sector companies in this area. The state company could continue to operate as a wholesale supplier from depots in Nukus and Urgench, open to all suppliers and in competition with any private sector suppliers who wish to operate.

Extension

Currently, technical information is disseminated via agronomists located within each kolkhoz. However, it is not necessary for most farmers to be aware of these developments as their job requires fulfilling tasks designed by the administrators of the collective on which they are working.

This situation will change if there is true land tenure reform resulting in smaller production units with real independence. These farmers will need extension advice on a wide variety of issues which were previously resolved at higher levels. It would be possible to achieve such a system relatively quickly by instituting a retraining program for kolkhoz level agronomists and placing them in the Association of Private Farmers, which is already geared toward giving private sector advice and which in Khorezm already finances itself in part through per hectare levies on independent farmers. (This could not be verified in Karakalpakstan, and may be a feature which was inherited when it was merged with the Association of Smallholders.) It may be useful to rotate these workers to other raions so as to avoid the appearance of the continuation of previous administrative relationships. Organization of an extension system on a raion basis rather than by kolkhoz would also help in this regard.

In addition, regular radio programs presenting technological and market information would be extremely useful. Many farmers are completely unaware of general market conditions, prices, etc. and can be made aware of other useful information in this way at a relatively low cost.

Farm Budgets and Crop Choice

Crop budgets for the three most important crops, cotton, rice and wheat, were calculated and are presented in Chabot & Kyle, 1997 (Crop Budgets for Western Uzbekistan, Cornell Department of Agriculture, Resource and Managerial Economics Working Paper No. 97-12). Most of the information used to construct these budgets was collected during field visits in May and June of 1997 and was supplemented with various other sources as identified in the notes contained in the appendix.

Overall, Khorezm enjoys relatively better conditions, and consequently has higher yields for each crop than does Karakalpakstan. It is for this reason that the profitability of farming is substantially higher in Khorezm. This situation is even more pronounced due to the operation of the state order system, which imposes substantial financial penalties for non-fulfillment of the state order amounts. For this reason, Karakalpakstan, which failed to planned amounts for cotton, and which has remarkably low yields for wheat, showed negative financial returns for these crops.

The crop budgets make it clear that cotton is always economically viable in both regions and is the preferred crop under fully liberalized conditions as depicted in scenario D. This result is quite robust, and comes through clearly in virtually any manipulation of the figures in any of the crop budgets. It is in strong contrast to the current financial return, which is negative in Karakalpakstan, and quite low in Khorezm. In fact, the financial return in Karakalpakstan was negative in all scenarios except that which postulated a 30% yield increase.

Rice as currently grown is the most attractive crop in financial terms, but generates negative economic returns once the value of water is included in costs. It should be noted that water use here has been assumed to be 35,000 m3/hectare, the average usage reported by SANIIRI. If it is instead assumed to be 50,000 m3, as has been reported in some instances, rice is no longer financially viable under any circumstances which include payments for water.

Wheat is a losing proposition for farmers in both Karakalpakstan and in Khorezm. It remains the least preferred crop under all conditions and is not capable of generating a profit for farmers in Karakalpakstan even under the most optimistic of assumptions. It fares somewhat better in Khorezm, since yields there are half again as large as the (somewhat optimistic) assumption of 1.2 tons/hectare in Karakalpakstan.

In summary, it is clear that cotton is the economically preferred crop in the Aral Sea region, and that under liberalized conditions would be chosen by farmers facing realistic input and output prices. The current widespread enthusiasm for rice cultivation is apparently largely due to the fact that water is free. Rice would be likely to be grown in the Amu Darya delta and in Khorezm under liberalized conditions, but to a lesser extent than is currently the case. Wheat would not be grown at all by profit motivated farmers. It can be imported from Kazakhstan much more cheaply than it can be grown under current conditions in the Aral Sea region.

A final note is in order regarding water pricing, since this is perhaps the most contentious issue regarding liberalization of the agricultural sector in Uzbekistan. In order to allow a reasonable evaluation of the importance of water pricing in each of the cases presented, a final item was included labelled `Return to Water'. This item shows what price would have to be charged for water in order for the crop concerned to just break even. It can be seen that the returns to water are quite high in many cases, but that its value in production of wheat is in fact negative under many conditions.

Tables

Table 1. Khorezm - Agricultural Production in 1995 and 1996 (tons)						
	Total		Kolkhoz		Private Farms	
	1995	1996	1995	1996	1995	1996
Cotton	304,694	290,042	304,694	290,042	--	--
Grains	202,762	249,925	179,605	217,716	23,157	32,209
Wheat	44,853	63,181	38,231	53,553	6,622	9,628
Rice	124,425	172,546	113,925	155,606	10,500	16,940
Corn	28,476	9,898	26,456	7,343	2,020	2,555
Potatoes	27,559	27,998	4,889	3,348	22,670	24,650
Vegetables	140,120	144,092	43,829	41,400	96,291	102,692
Melons	42,645	42,838	14,785	12,678	27,860	30,160
Fruits	35,862	36,589	12,833	12,074	23,029	24,515
Grapes	11,568	8,344	6,543	3,308	5,025	5,036

Source: Goscomprognostat

Table 2. Karakalpakstan: Agricultural Production, 1995-1996 (tons		
	1995	1996
Wheat	34,056	20,532
Rice	141,912	201,562
Cotton	288,223	203,921
Potatoes	4,778	10,759
Vegetables	66,238	77,191
Fruit	4,171	4,541
Grapes	568	1,616

Source: Goscomprognostat

Table 3. Khorezm: Planted Area - 1996 (hectares)	
Wheat	28,847
Rice	44,561
Seed Corn	1,898
Other Grain	583
Cotton	100,967
Sunflower	44
Other Industrial	41
Potatoes	535
Vegetables	2,658
Melons	1,398
Fodder Crops	31,963

Source: Goscomprognostat

Table 4. Karakalpakstan: Planted Area 1996 (hectares)	
Wheat	33,927
Rice	100,288
Other Grains	10,635
Cotton	146,611
Potatoes	2,025
Vegetables	8,231
Melons	7,250
Fruit	2,739
Grapes	345

Source: Goscomprognostat

Table 5. Kaakalpakstan: Returns on Cotton Producing Kolkhozes, 1995-96

	1995	1996
	%	%
Turfbul	-26.6	-45.8
Beruni	-36.4	-49.6
Ellikalla	-29.1	-45.7
Amu Darya	-8.1	-40.9
Khodzeli	-6.0	-46.4
Shurmana	-11.9	-51.3
Kanlykul	-19.8	-42.5
Kungrad	-23.0	-31.1
Kegeili	+2.2	-58.4
Chimbai	-8.1	-43.7
Karauzyak	-22.6	-51.6
Tahtakupir	-36.3	-37.9
Bozatau	-3.7	-36.2
Total	-18.00	-44.7

Source: Ministry of Agriculture and Water

Table 6. Khorezm: Livestock Production 1995-96

	Total		of which: Private Plots	
	1995	1996	1995	1996
Cows	167,347	171,999	132,841	137,038
Pigs	12,494	7,418	726	831
Sheep and Goats	174,959	180,636	131,403	142,740
Horses	2,435	3,292	1,218	2,062
Camels	82	82	13	16
Rabbits	6,395	5,575	5,938	5,451
Poultry	1,540,250	1,365,380	540,000	560,000

Source: Goscomprognostat

Table 7. Karakalpakstan: Livestock Breeding, 1994-95

	1994		1995	
	Total	of which private plots	Total	of which private plots
Cows, bulls, calves	403,080	267,694	386,508	265,671
Sheep and Goats	487,156	219,574	485,819	219,584
Horses	18,214	7,449	18,127	7,867
Camels	4,913	2,242	4,997	2,334
Poultry	572,706	386,514	575,295	382,841

Source: Goscomprognostat

Table 8. Khorezm: Dekhan Farms by Type

	Number of Farms			
	Total	Crops	Livestock	Fish
1996	956	289	667	9
1997	1044	409	596	23

Source: Ministry of Agriculture and Water

Table 9. Average Yield of Specific Crops by Region (tons/hectare)						
	Fergana Region	Central Region	Southern Region	Desert Region	Aral Sea Region	Total
Cotton	3.0	2.5	3.4	3.5	2.0	2.8
Wheat (irrigated)	3.2	3.0	2.8	1.9	2.3	2.9
Rice	2.9	2.6	2.1	1.0	1.9	2.2
Alfalfa (irrigated)	12.5	10.6	11.3	15.4	10.1	11.8
Watermelon (irrigated)	16.2	13.1	13.2	13.3	12.3	13.7
Melon	16.5	9.1	11.2	9.2	6.9	8.7
Tomato	24.5	19.5	18.0	9.5	8.7	16.8

Source: Uzbekistan Agricultural Baseline Survey, July 1996.

Table 10. Change in Land Area of Main Farms 1990-1996 by Region						
	Fergana Region	Central Region	Southern Region	Desert Region	Aral Sea Region	Total
Land Under Central Administration, 1990	5,923	3,623	13,883	168,017	6,819	26,217
Land Under Central Administration, 1996	4,837	3,295	13,237	160,347	5,931	24,701
% Change in Land Area Under Central Administration	18%	-9%	-5%	-5%	-4%	-5%
Total Area of Main Farms in 1996	6,114	3,862	14,168	166,500	6,423	26,163
Land Under Central Administration as a % of Main Farms in 1996	79%	85%	93%	96%	92%	94%

Source: Uzbekistan Agricultural Baseline Survey, July 1996.

Table 11. Uzbekistan: Length of Canal System						
	Length of farm irrigation canals					
State/Oblast	Earth canal (%)	Concrete lined (%)	Piped (%)	Total (km)	Specifi-cation (m/ha)	Farm network efficiency (%)
UZBEKISTAN	79	19	2	167,335	39.6	0.74
Karakal'n	99	1	0	19,674	39.2	0.63
Andijan	79	17	4	10,580	37.5	0.69
Bukhara	86	14	0	15,063	57.1	0.66
Djizak	13	79	8	7,859	27.3	0.87
Kashkadarya	57	3	4	19,058	38.9	0.83
Navoi	87	13	0	4,702	38.9	0.69
Namangan	89	8	3	9,432	34.5	0.78
Samarkand	89	1	1	17,118	46.4	0.73
Surkanarya	45	54	1	8,123	25.8	0.73
Syrdarya	51	47	2	6,553	21.9	0.84
Tashkent	85	11	4	12,291	30.7	0.73
Fergana	94	6	0	24,884	70.0	0.70
Khorezm	99	1	0	12,018	45.9	0.65

Source: TACIS: WARMAP Project Vol. 4

Table 12. Uzbekistan: Types of Irrigation (percent of total)									
State/ Oblast	Surface								
	Furrow				Basin	Wild Flood	Sprink -ler	Drip	Total
	temp. canal	pipe- lines	irrig. acc	total					
	-irrigated area as percent of total-								
UZBEKISTAN	59	8	0	67	29	4	0	0	100
Karakal'n	55	2	1	58	22	20	0	0	100
Andijan	74	4	0	78	20	1	0	0	100
Bukhara	65	8	1	73	26	0	0	0	100
Djizak	60	12	0	72	28	0	0	0	100
Kashkadarya	51	14	1	66	34	0	0	0	100
Navoi	63	5	0	67	32	0	0	0	100
Namangan	69	5	0	74	23	2	0	0	100
Samarkand	67	3	1	70	29	0	0	0	100
surchandarya	63	4	1	68	29	3	0	0	100
Syrdarya	39	32	0	70	27	3	0	0	100
Tashkent	66	4	0	70	26	3	1	0	100
Fergana	70	3	0	72	26	1	0	0	100
Khorzem	26	4	0	30	58	11	0	0	100

Source: TACIS: WARMAP Project Vol. 4

Table 13. Land Area in Amudarya Basin with High Watertable and Salinity, 1987-89

	Depth of watertable in m						Total	Percent of land with watertable			Wtd av. Depth
Region	<1	1-2	2-3	3-5	5-10	>10		<2m	<3m	<5m	<10m
	Land area in '000ha										
Tajikistan	12	71	147	40	201	119	590	14	39	46	4.6
Kyrgistan	0	0	0	0	0	27	27	0	0	0	0
Turkmenistan	22	587	825	407	179	205	2224	27	64	83	2.9
Uzbekistan	23	520	467	413	539	158	2121	26	48	67	3.9
Karakalpak	0	269	305	113	22	0	509	38	81	97	2.5
Total	57	1446	1,744	974	941	509	5671	27	57	74	3.4
	Degree of soil salinity*										
	non-	weak	mod-erate	severe	very severe	Total	Percent of land with salinity > than				
							mod-erate	severe	very severe		
	Land area in '000ha										
Tajikistan	482	66	42	0	0	590	7	0	0		
Kyrgista	27	0	0	0	0	27	0	0	0		
Turkmenistan	303	574	866	480	0	2224	61	22	0		
Uzbekistan	983	717	228	177	10	2116	20	9	0		
Karakalpak	156	211	275	65	2	709	48	9	0		
Total	1951	1569	1411	723	12	5666	38	13	0		

Source: TACIS - Warmap Project Vol. 4

- * Non Saline 21.0 me Na/100g soil
- Weak 1- 3
- Modern 3 - 6
- Severe 6 - 12
- Very Severe > 12

Table 14. Illustrative Water Requirements Under Alternative Cropping Patterns[a]

Crop	Indicative Water Requirement (m^3/ha)
Cotton	5 875
Wheat	3 870
Rice	13 290
Vegetable	7 460
Fodder	8 490
Orchards[(b)]	5 050/ 4 800

Source: Preparation Study of the Uzbekistan Drainage Project Phase I: Final Report, Jan. 1997.

Notes: a. Based on norms for "average" rainfall years and mean of norms for all RADU regions and excludes leaching requirements [Wichelns, 1994].

b. Patterns are used only to illustrate relationships between cropping pattern and water use and have not been derived to reflect projected patterns derived through agronomic considerations.

Table 15. Summary of Estimated Total Yearly Recurrent and Capital Cost for Different Non-Traditional Irrigation Systems

		Without water charge-total cost (US$ha/year)	With water change-total cost (US$/ha/year)	Difference (US$/ha/year)
1	Hydraulic centre pivot (Frigate)	224	317	93
2	Electric centre pivot	238	319	81
3	Linear move centre ditch	267	348	81
4	Raingun (electric)	505	598	93
5	Raingun (motorpump)	665	758	93
6	Sideroll (Volzhanka)	308	401	93
7	Tractor boom sprinkler (DDA 100 MA)	166	259	93
8	Drip irrigation - cotton	906	978	72
9	Drop irrigation - vegetables	793	865	72
10	Furrow irrigation - traditional	83	213	130
11	Furrow irrigation - improved management	83	183	100
12	Furrow irrigation - plastic sheets*	62	162	100
13	Furrow irrigation - siphons	96	196	100
14	Furrow irrigation - gated sleeve	101	194	93
15	Furrow irrigation - gated pipe	121	214	93
16	Furrow irrigation - surge irrigation	126	213	87
17	Furrow irrigation - cablegation	118	200	82

Source: WARMAP Project Phase 2 - Report: Non-Traditional Irrigation Methods, December 1996.

Table 16. Safe Storage of Seed Cotton

Moisture Content of Seed Cotton (Percent Wet Basis)	Days Storage
8 - 10	30
10 - 12	20
12 - 14	10
14 - 15	< 3

Source: World Bank Technical Paper No. 287, "Cotton Production Prospects for the Next Decade", 1996.

Table 17. Karakalpakstan: Fixed Wheat and Flour Prices as of November 1996

Wheat		
Grade	soum/ton	$US at Equilibrium Exchange Rate
1	18,038	$180
2	16,430	164
3	14,467	145
4	12,500	125
5	11,140	111
6	10,374	104
Flour		
1	27,500	275
2	19,801	198
3	18,244	182

Source: Uzkhlebproduct

Table 18. Karakalpakstan: Rice Processing Costs, 1996

(soum per ton)

	Cost of Production	Including 10% Profit Margin	Including Taxes
Best Grade	31,416	34,558	40,779
1st Grade	29,030	31,933	37,681
2nd Grade	27,336	30,070	35,483
Broken	9,791	10,771	12,710
For Flour	4,079	4,487	5,295

Table 19. Average Age of Farm Vehicles (years)							
		Fergana Region	Central Region	Southern Region	Desert Region	Aral Sea Region	Total
Trucks	Main	14	9	9	10	9	10
	Associated	12	6	9	9	8	9
Tractors (wheeled)	Main	13	9	13	10	8	11
	Associated	10	8	9	10	8	8
Tractors (tract)	Main	12	8	9	9	9	10
	Associated	12	7	9	10	9	9

Source: Uzbekistan Agricultural Baseline Survey

Table 20. Khorezm: Farm Machinery, 1996

	(number of units)
Tractors	11,019
of which: Currently Functioning	2,215
Trucks	3,161
Cotton Picking Machines	789

Source: Ministry of Agriculture and Water

Figures

Figures 1 and 2 from Final Report for the Preparation Study of the Uzbekistan Drainage Project.

Figures 3 and 4 from TACIS WARMAP project Volume 4.

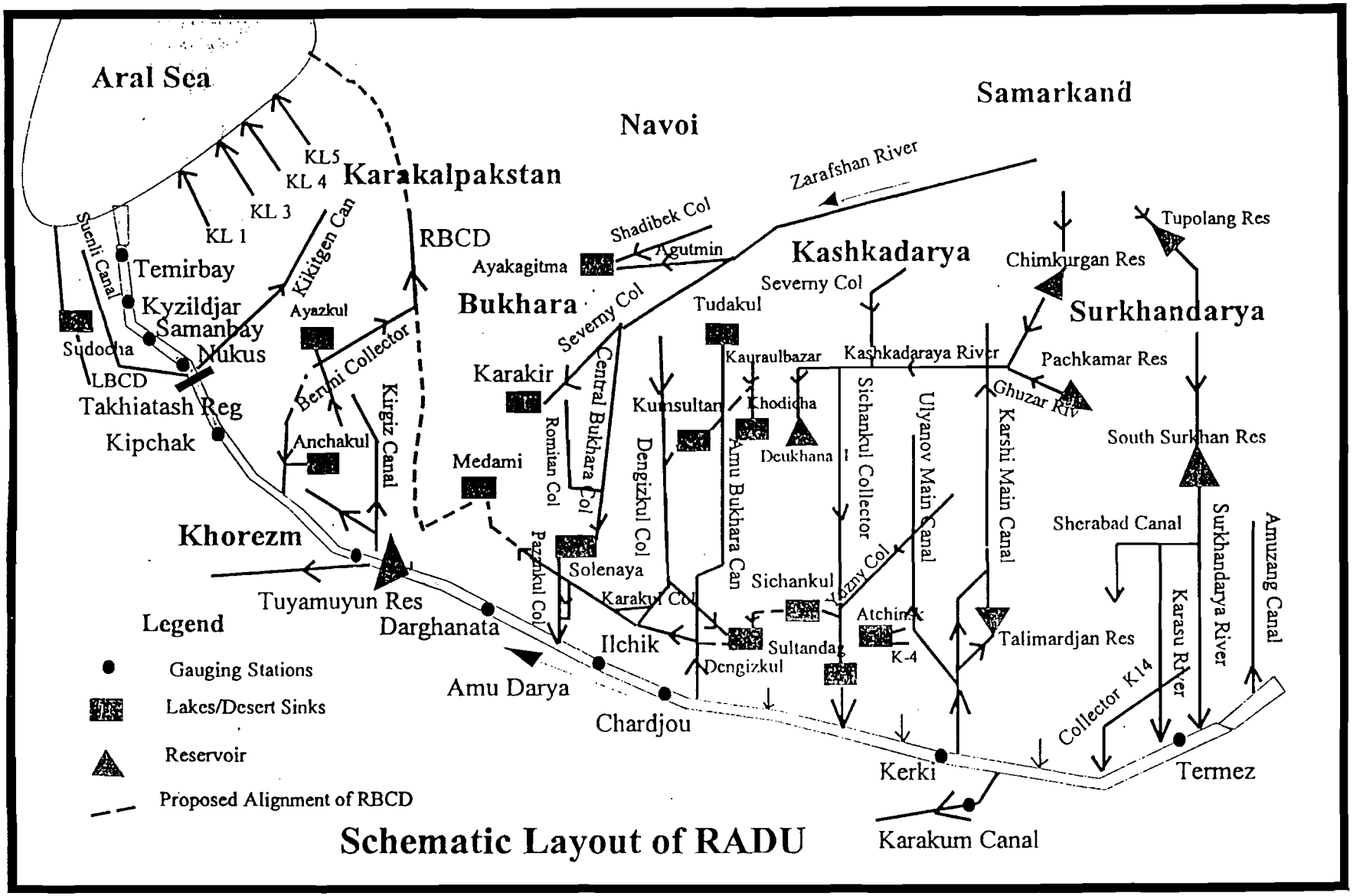
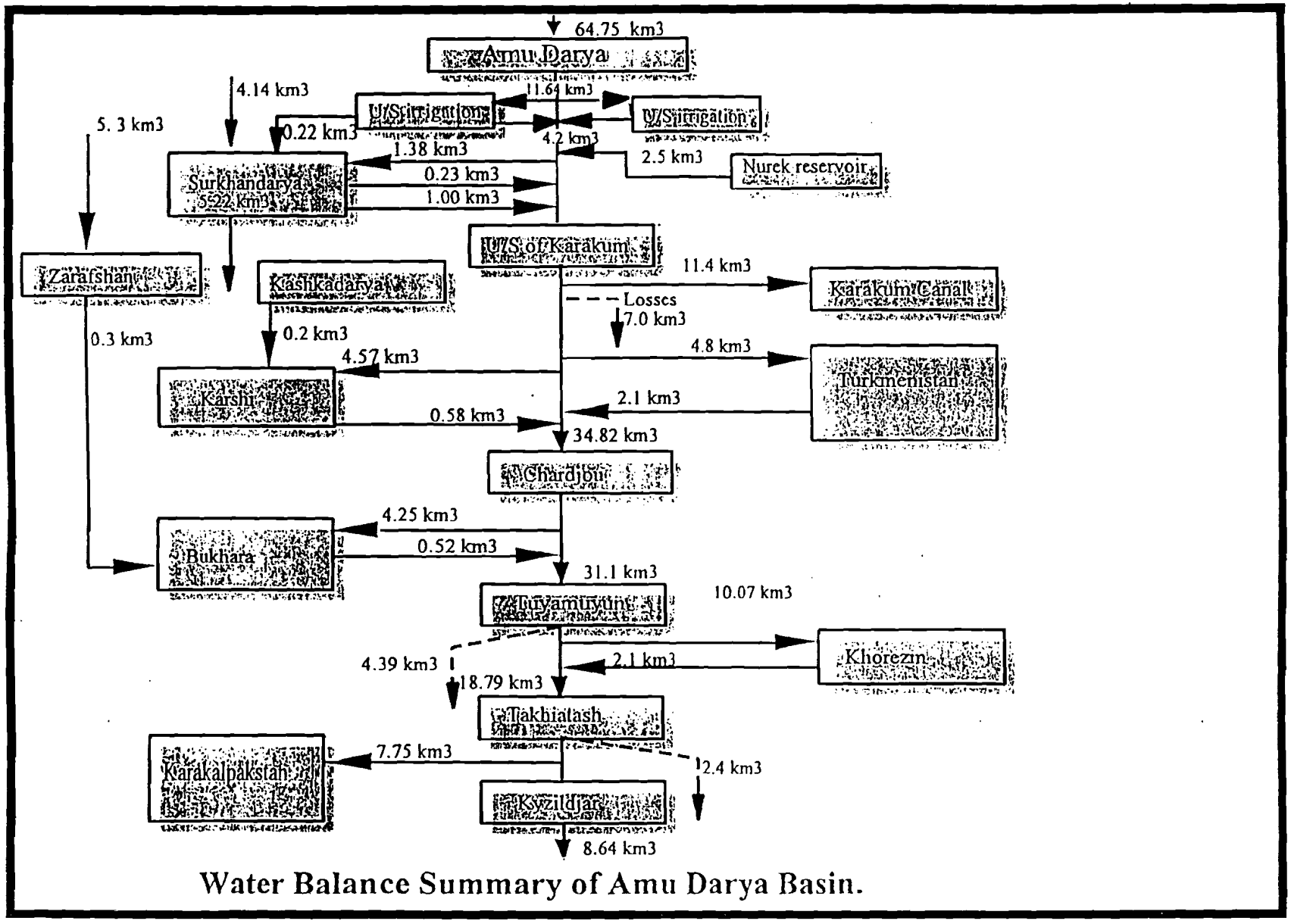


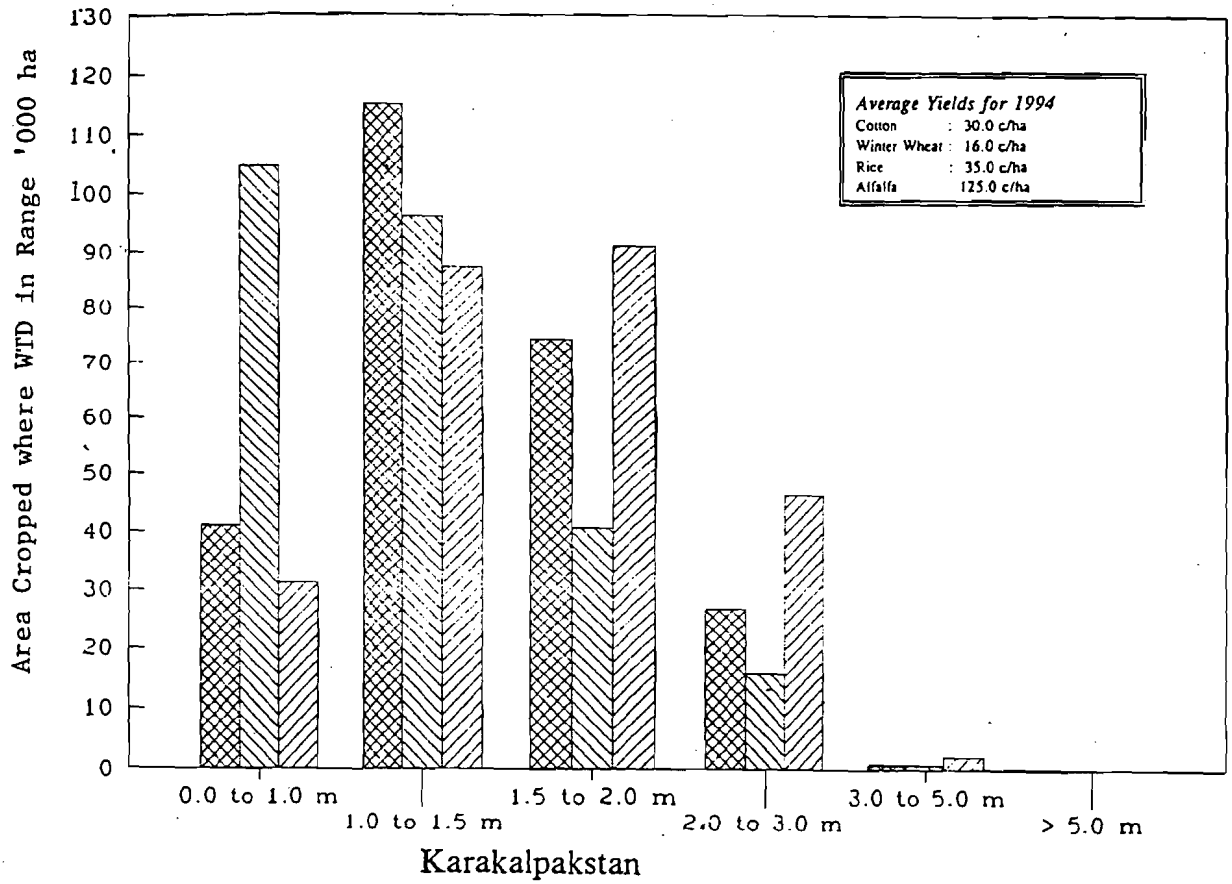
Figure 1
Schematic Layout of RADU



Water Balance Summary of Amu Darya Basin.

Figure 2
Water Balance Summary of Amu Darya Basin

Figure 3
Water Table Depth and Crop Yields
Karakalpakstan and Khorezm



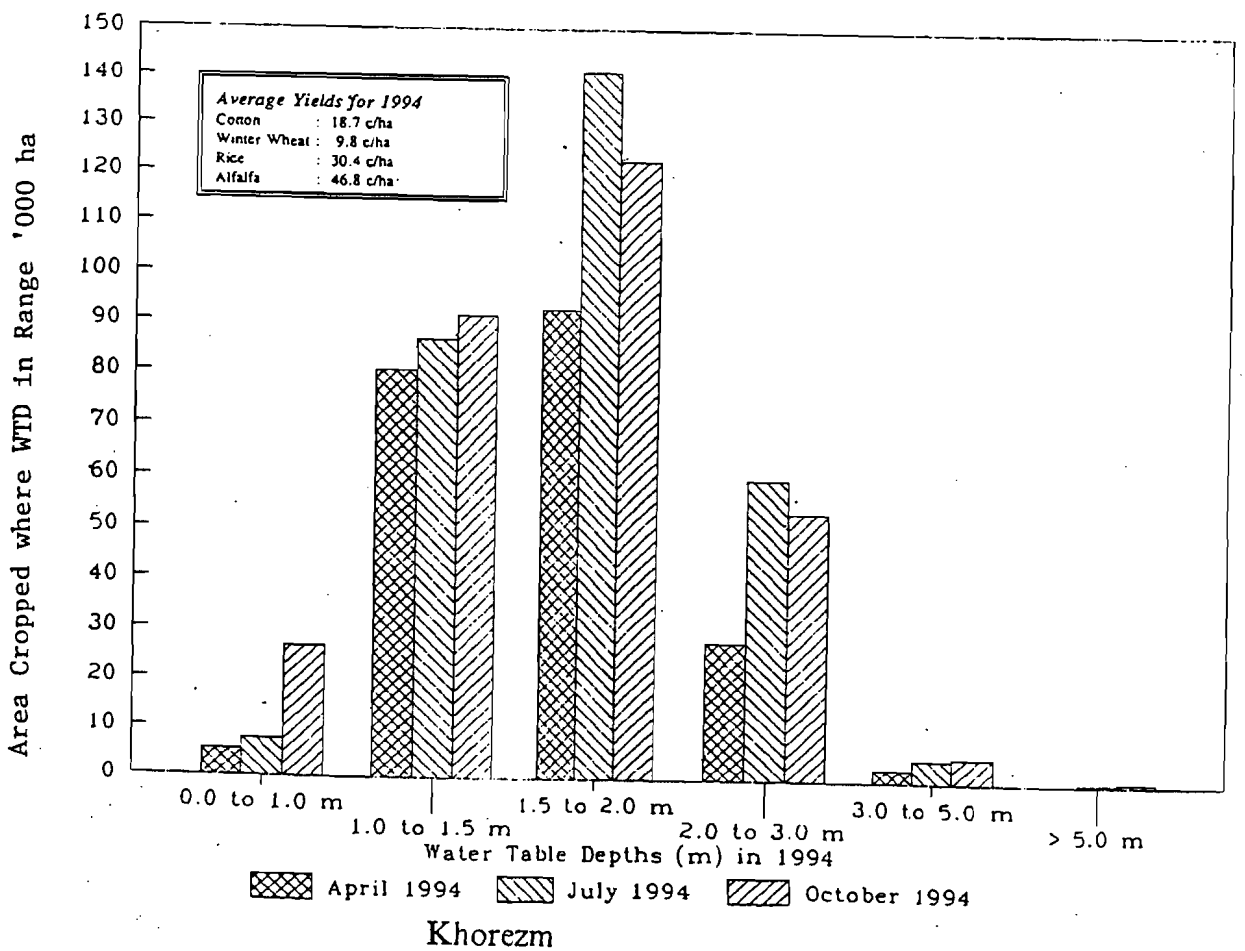
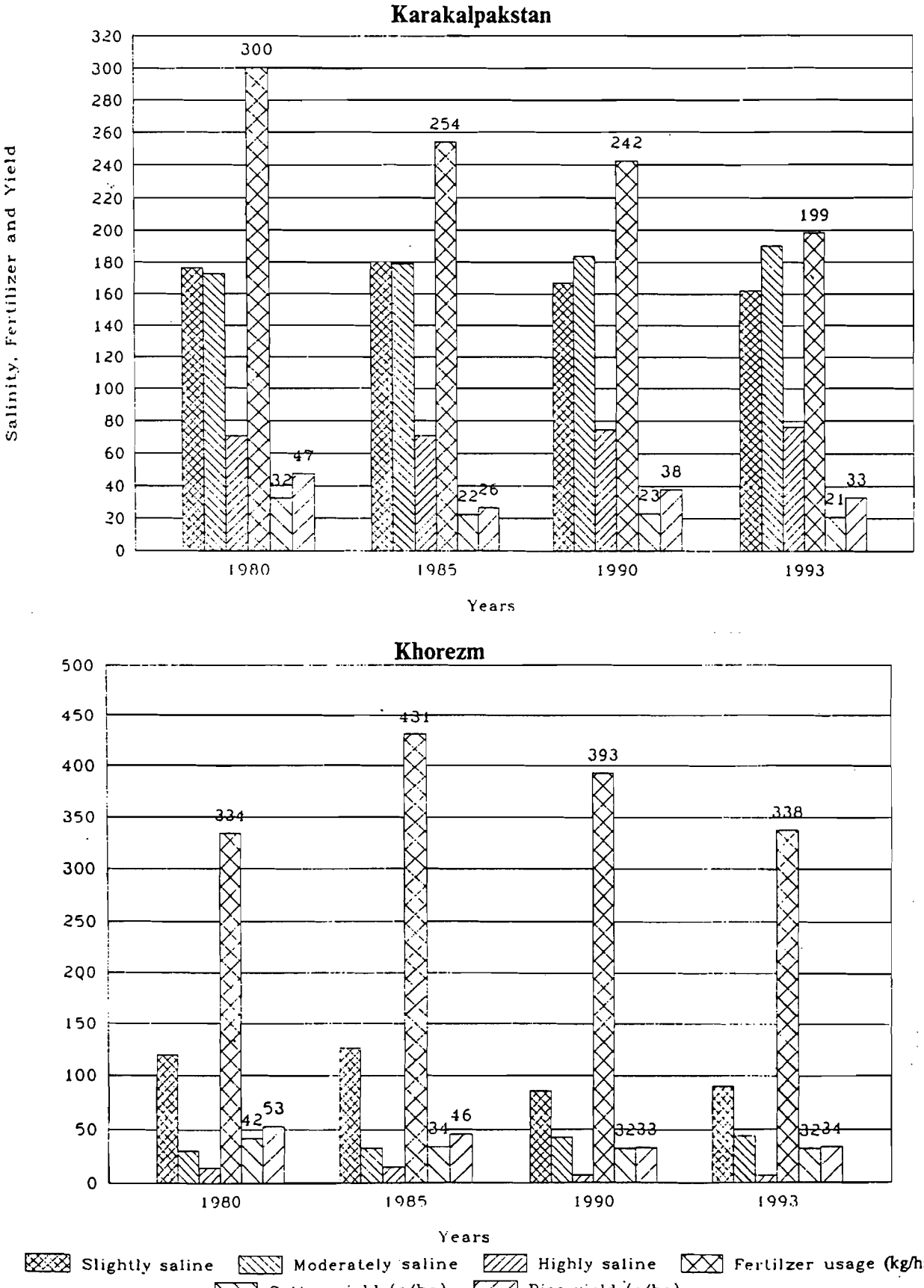
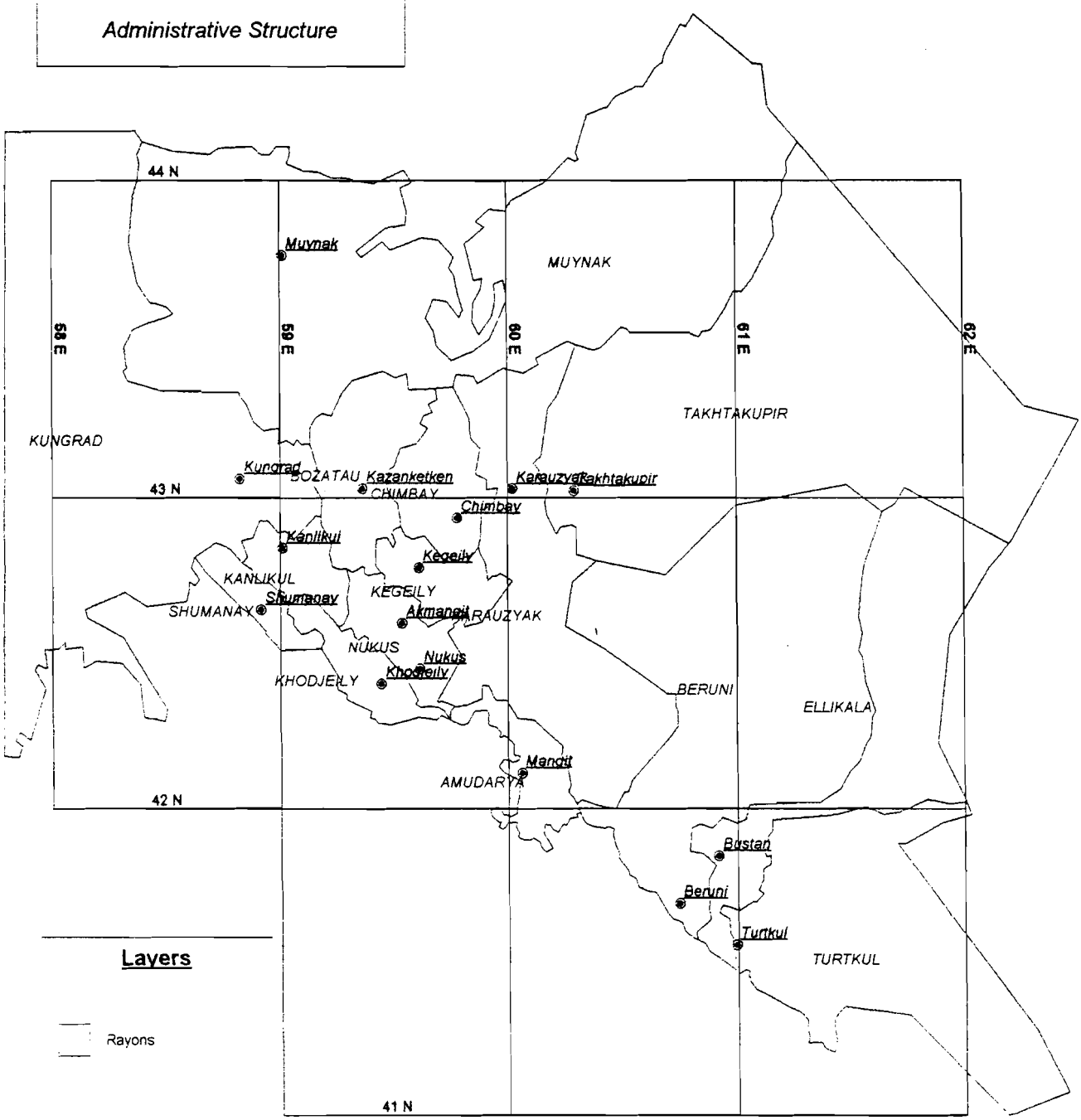


Figure 4
Soil Salinity, Fertilizer Use and Yield in Karakalpakstan and Khorezm



Karakalpakstan

Administrative Structure



Layers

Rayons

Raycenters

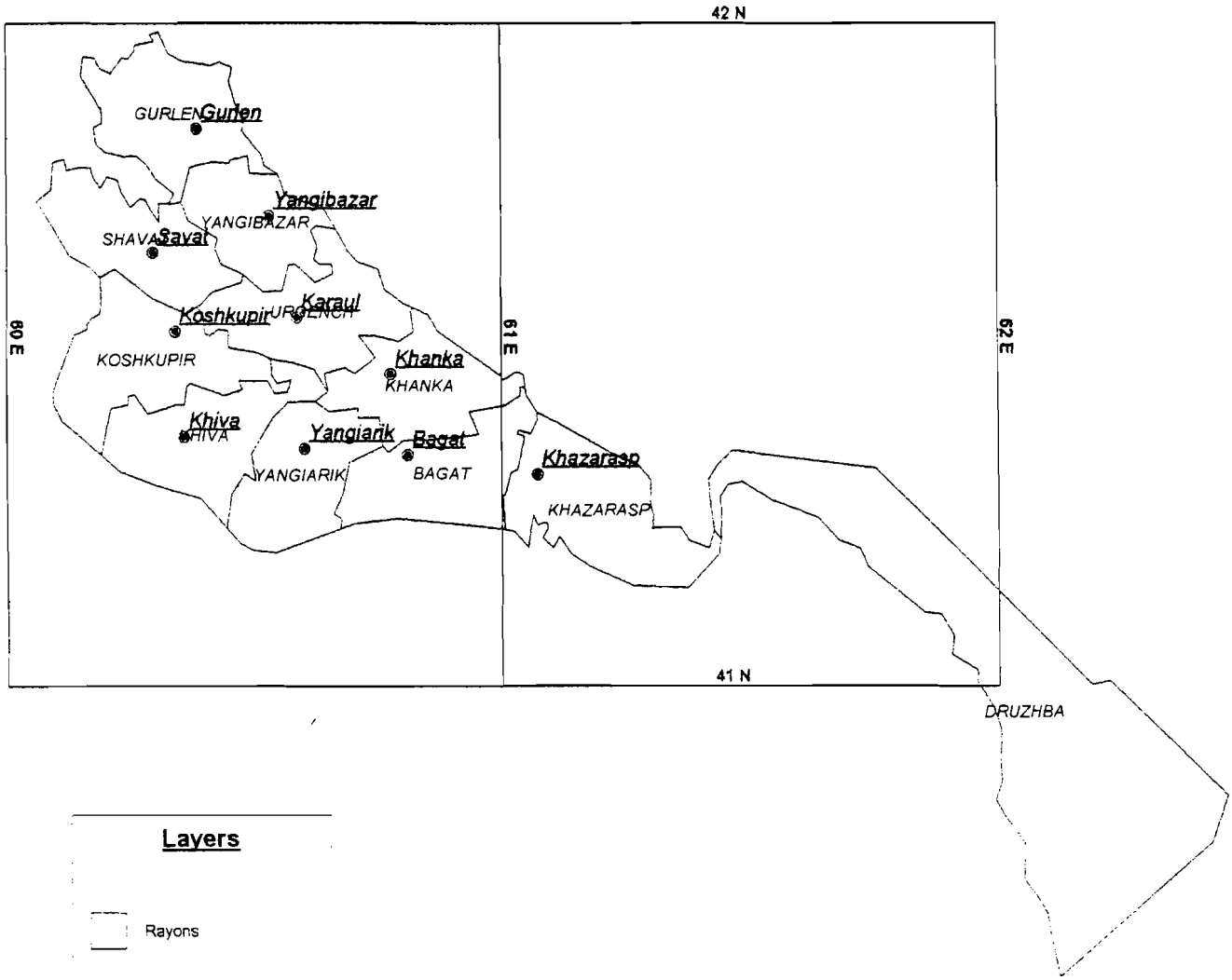
Grid 1degr

KM

0 20 40 60 80

Khorezm Oblast

Administrative Structure



Layers

Rayons

Raycenters

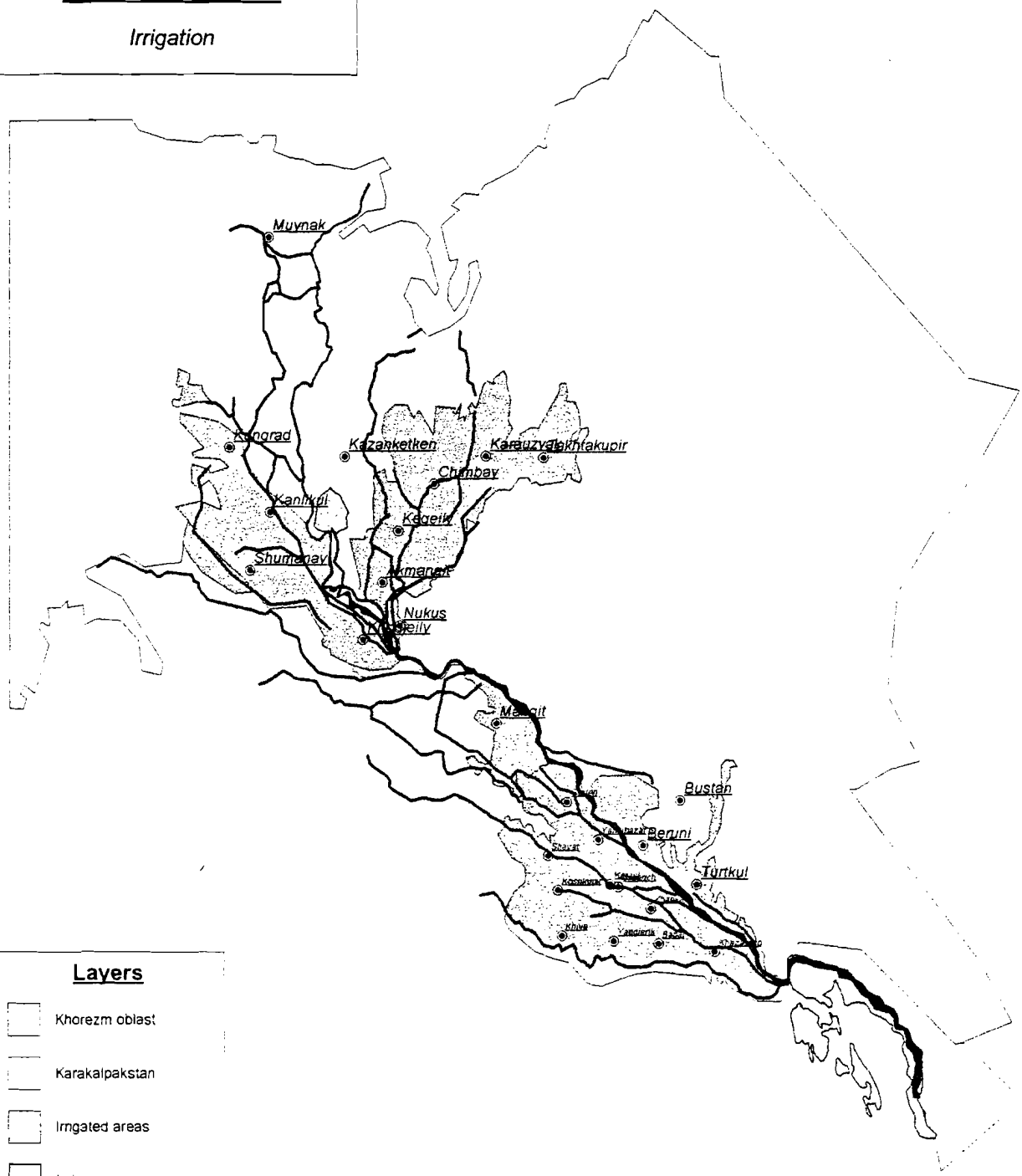
Grid 1 degree

KM

0 20 40 60 80

Aral Lake Zone

Irrigation



Layers

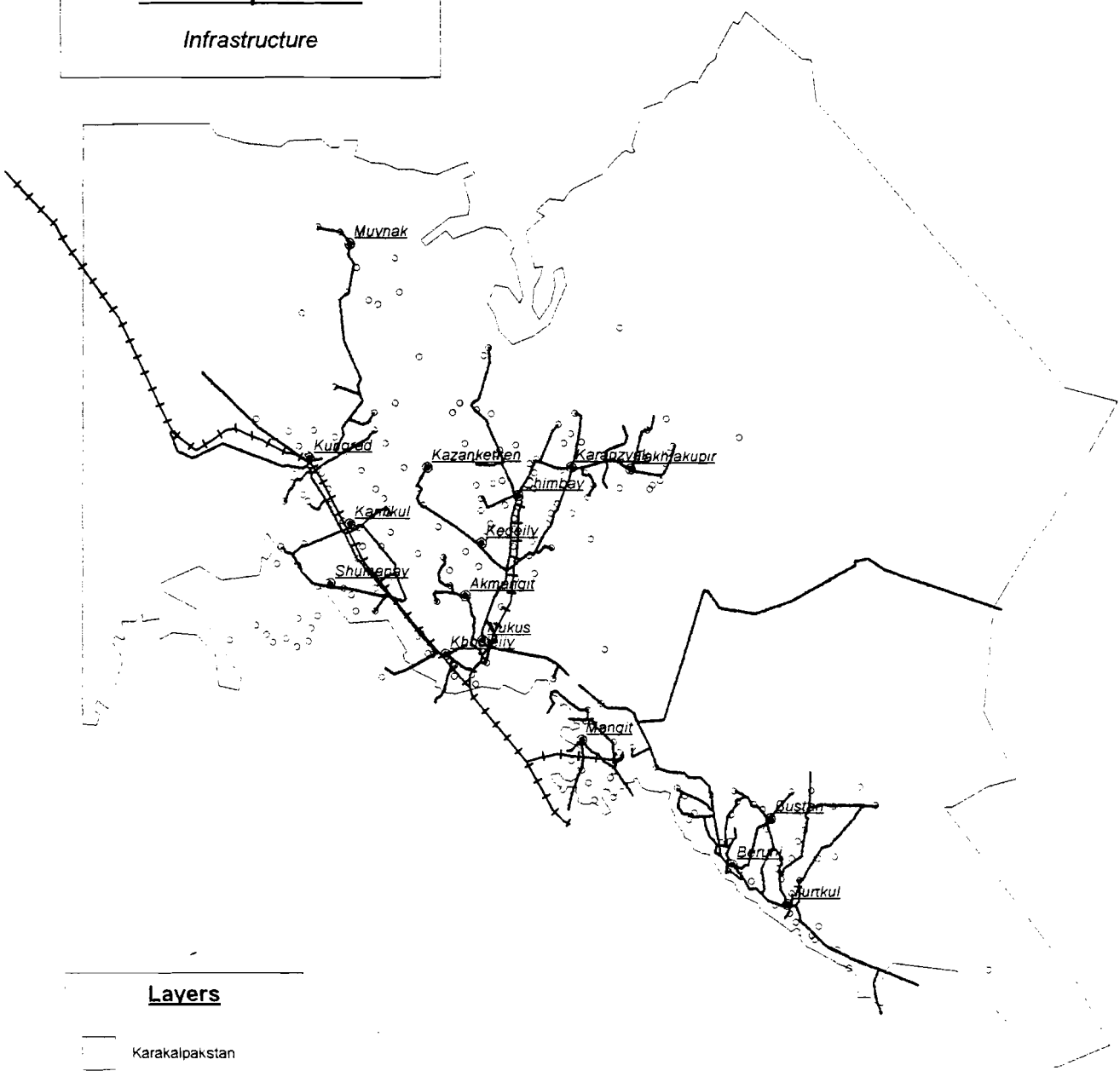
- Khorezm oblast
- Karakalpakstan
- Irrigated areas
- Lakes
- Amudarya
- Raycenters
- Main canals

KM

0 20 40 60 80 100

Karakalpakstan

Infrastructure



Layers

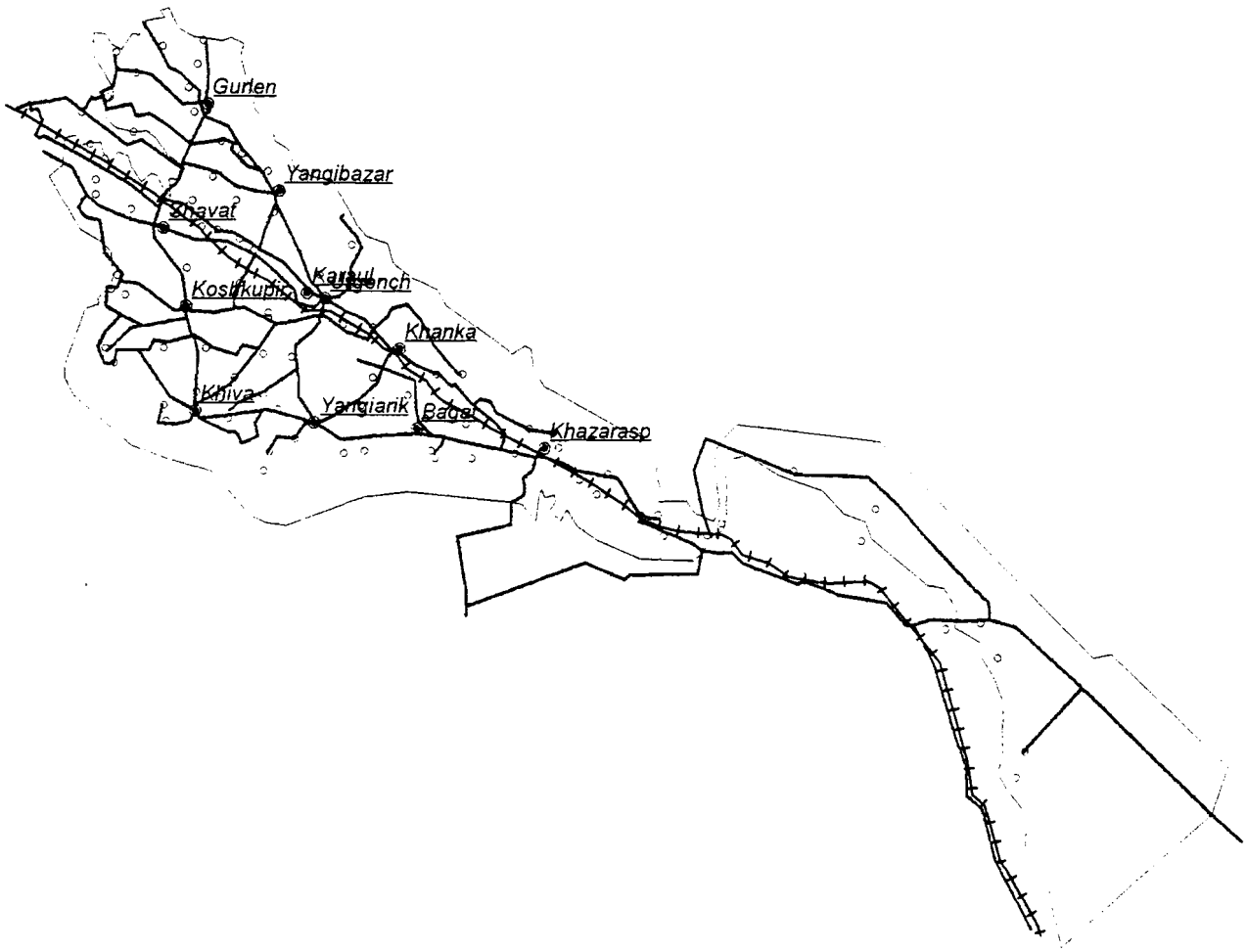
- Karakalpakstan
- Raycenters
- Settlements
- Main roads
- Railways

KM

0 20 40 60 80

Khorezm Oblast

Infrastructure



Layers

- Khorezm oblast
- Raycenters
- Settlements
- Main roads
- Railways

KM

0 20 40 60 80

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