

ANNUAL REPORT

Covering Period: 06/2002-6/2003

**Submitted to the Office of the Science Advisor
U.S. Agency for International Development**

AGRICULTURAL POTENTIAL OF INDIGENOUS WATER HARVESTING SYSTEMS IN THE KARAKUM DESERT

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Project Number: CA21-031

Grant number:

A.I.D. Grant Project Officer:

Project Duration: 05/2002-05/2005

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Section I

A. EXECUTIVE SUMMARY

The overall regional goals of the proposed research are to:

- upgrade the agricultural productivity of marginal lands in Central Asia, thus improving the living standards of the local population
- decrease the danger of further land degradation and desertification
- decrease the volume of water pumped from the rivers which flow into the Aral Sea.

These goals can only be met by rationally utilizing the locally available water resources. Water harvesting on takyr is an indigenous technique that the desert dwellers were forced to abandon during the soviet era, and that we are proposing to adapt to the present needs within the framework of the present project. Takyr can be imagined as being islands of clay in a sea of sand. Due to the low permeability of the clayey surfaces, rainfall cannot be absorbed by the soil and runoff is generated. In this project we propose to test the use of trenches filled with sand to collect the runoff. Within these trenches we propose to grow trees (*Haloxylon aphyllum*) that could provide the local inhabitants with firewood and/or fodder for their animals. It is not possible to over-emphasize the central importance of these two items for a semi-nomadic population. The water requirement of these trees is not precisely known, and the objective of one of the field trials being presently carried out is to obtain this information that together with that obtained from the runoff trials will allow to optimize their distribution and estimate the productivity per unit area. We will estimate the area covered by takyr using remotely sensed data, and will be therefore able to estimate the potential contribution of this technique to the agricultural output of the marginal areas of Turkmenistan.

B. RESEARCH OBJECTIVES

B1. Overall Aim and Specific Objectives

Takyr have been exploited for rainwater harvesting in the past. However, it is unclear whether the practice remains socially and economically feasible, how much runoff would be actually available for irrigation and the yields that could be attained. The overall goal of the proposed research is to assess the agricultural potential of the Central Asian takyr and thereby:

- upgrade the agricultural productivity of marginal lands in Central Asia, thus improving the living standards of the local population
- decrease the danger of further land degradation and desertification
- reduce the volume of water pumped from the rivers which flow into the Aral Sea.

The specific objectives of the project are to:

1. determine soil surface characteristics of takyr;
2. quantify rainfall/runoff characteristics of plots of different lengths within takyr;
3. assess the efficiency of an innovative water harvesting layout for shrub and tree production;
4. use remote sensing techniques to estimate the total area occupied by takyr in Turkmenistan
5. evaluate the present status of the surfaces of selected takyr and their runoff potential
6. evaluate the social and economic impact of large scale water harvesting, formulate recommendations (based on 1-5) and
7. disseminate them among interested organizations in Central Asia.

B2. RESEARCH ACCOMPLISHMENTS

Objective 1. Determine soil surface characteristics of takyr.

A person for carrying out the necessary measurements has been selected. Geographer A.Veyisov will be trained in Israel as from the beginning of October 2003 in the use of the falling head infiltrometer and tension infiltrometer. He will take with him undisturbed soil samples from the upper layers of various takyrs. The samples will be analyzed using the Scanning Electron Microscope of BGU.

Upon his return to Turkmenistan he will carry out field measurements with instruments supplied by the Israeli team. Presently Mr.Veyisov is conducting a literature survey.

Objective 2. Quantify rainfall/runoff characteristics of plots of different length within representative takyrs.

At the Karrykul Research Station the reconstruction of runoff plots with a lengths of respectively 100, 55, 30, and 15 was completed. Concrete tanks with gutters for runoff collection for each of the four plots were repaired. An agro-meteorological station with a data-loggers to measure rainfall and other relevant parameters, and pressure transducers with data-loggers to record pressure changes in the tanks (runoff intensity) were installed during the previous dry season. The data of nine recorded runoff events (two of them caused by snow) had been sent to the project coordinator for further analysis.

M. Kakabaev has been employed by this project as a Technician from the beginning of the program. He takes care of maintenance and cleaning of runoff plots (removal of vegetation and sand), pumping water from the tanks, guarding, etc.

Objective 3. Assess the efficiency of an innovative water harvesting layout for tree production.

An irrigation trial is being carrying out in the Bakhardok area (30km to North-East from Karrykul Research Station) where water for irrigation is available. Twenty four one-year old

seedlings of *Haloxylon aphyllum* were planted on March 26, with a distance of 6m between seedlings (four rows with six trees in each row). The thickness of the takyr layer is about 30-40 cm and the depth of the pit (diameter: 0.5 m) in which the seedlings were planted was therefore set at 0.5 m. The experimental plot is surrounded with a double row of fast growing desert shrubs *Salsola richteri* planted in order to minimize advection. According to the research plan we imposed four water treatments (six replicates) that are 100, 75, 50 and 25 % of the maximum expected evaporation rate in the area. Height and diameters of crown are monitored on a monthly basis (Table 1).

K.Baisahatov is employed as a technician in charge of irrigation and additional technical aspects.

Objective 4. To use remote sensing techniques to estimate the total area of takyrts in the Karakum Desert and to classify takyrts according to their surface characteristics.

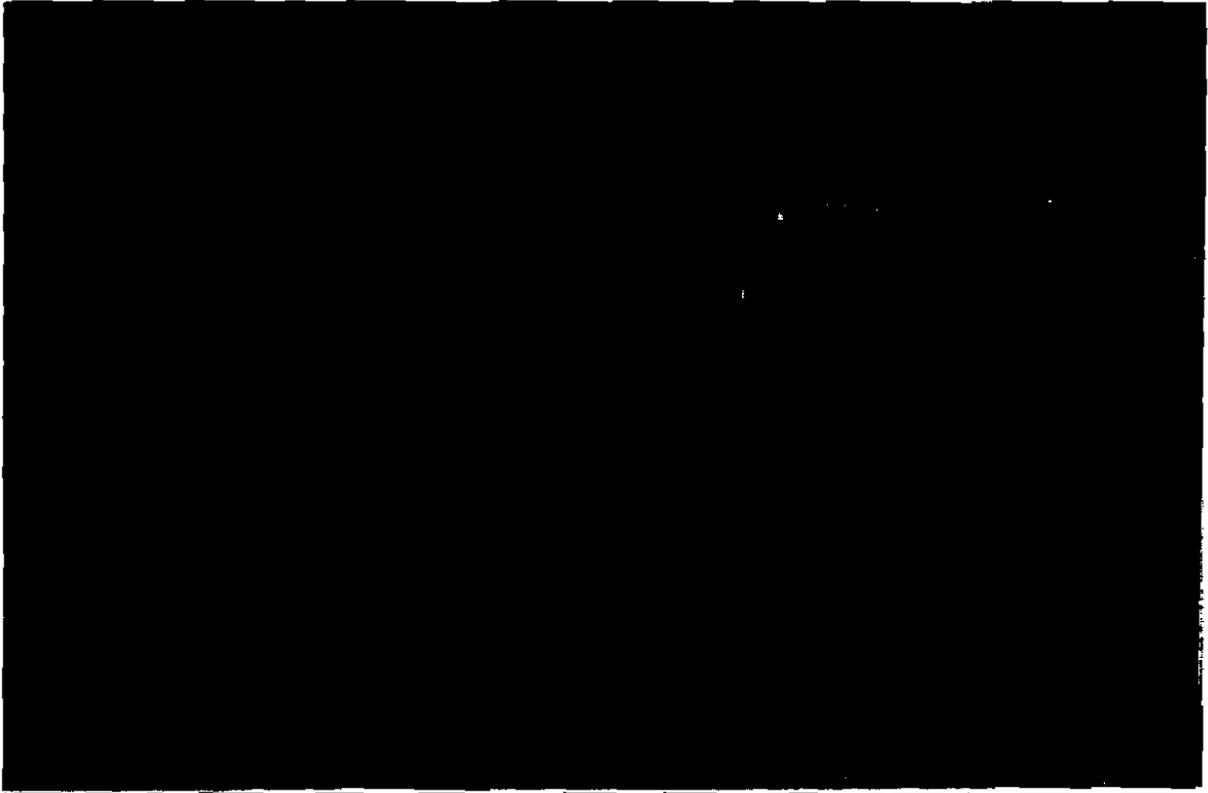
During the visit of Dr.L.Orlovsky to Turkmenistan from 04.04.03 to 17.04.03, a field expedition to the Karrykul Research Station was conducted. We visited a number of takyrts and solonchaks close to the station in order to determine their present status (degradation rate). Discussions took place concerning available source data to compile a base for this objective. In order to map the distribution of takyrts and estimate their area, images (additional to the existing ones) will be needed in order to cover the whole country.

Objective 5. To determine the social and economic preconditions and prospect of large-scale takyr agriculture.

During the visit of Dr. Mamedov to Israel a report titled "Economic Aspects of Takyr use in Turkmenistan" composed by A.Ataev and B.Mamedov, was presented to Dr.M.Schwarz. The National Institute of Deserts, Flora and Fauna subcontracted the Nature Protection Society of Turkmenistan to carry out the social surveys needed to complete this part of the objective.

Table 1. Tree development and growth.

№ of tree	Irr.rate,%E	Height, m			Crown diameter, m		
		april	may	june	april	may	june
1	100	0.55	0.64		0.54	0.76	
2	75	0.65	0.70		0.70	0.87	
3	50	0.65	0.70		0.59	0.74	
4	25	0.60	0.65		0.59	0.67	
5	50	0.65	0.67		0.62	0.80	
6	25	0.67	0.71		0.58	0.66	
7	100	0.63	0.67		0.51	0.62	
8	75	0.60	0.65		0.50	0.56	
9	25	0.69	0.77		0.62	0.76	
10	100	0.73	0.75		0.48	0.63	
11	75	0.69	0.72		0.53	0.62	
12	50	0.69	0.72		0.58	0.80	
13	75	0.62	0.69		0.50	0.57	
14	50	0.53	0.61		0.54	0.63	
15	25	0.69	0.70		0.63	0.69	
16	100	0.43	0.43		0.33	0.35	
17	100	0.70	0.72		0.63	0.69	
18	75	0.78	0.81		0.58	0.67	
19	50	0.59	0.65		0.47	0.59	
20	25	0.62	0.63		0.50	0.58	
21	50	0.76	0.78		0.63	0.67	
22	25	0.59	0.61		0.46	0.49	
23	100	0.68	0.71		0.54	0.62	
24	75	0.45	0.46		0.55	0.67	



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Photo: Irrigation trial in Central Karakum. The double row of shrubs for wind protection can be seen in the foreground and the buildings of the station in the background. The rows of Haloxylon are clearly visible.

C. SCIENTIFIC IMPACT OF COLLABORATION

The instrumentation that has been purchased and installed in the field attracted the interest of a large number of Turkmenistan scientists. The meteorological data obtained at the site is relevant to other research groups and will be an important factor in enhancing the interactions between the various research groups active in the area. The joint data analysis that is being carried out presently together with the future training of young scientists will undoubtedly affect a wide circle of Turkmen researchers.

D. DESCRIPTION OF PROJECT IMPACT

This research will be an addition to the Presidential Program "Assessment of desert forest-rangeland resources and elaborate technologies of their improvement". This opportunity will be used to disseminate the results of the project among interested national level organizations through the High Council for Science and Technology of Turkmenistan.

E. STRENGTHENING OF DEVELOPING COUNTRY INSTITUTIONS

The training of members of the National Institute of the Deserts, Flora and Fauna of Turkmenistan in the latest technologies of soil water content monitoring, remote sensing and socio-economic analysis will undoubtedly strengthen the research capabilities of the Institute.

F. FUTURE WORK

Work in the field will continue as planned. The collection of data for the socio-economic part of the project will depend on the outcome of the actions we request AID to undertake as detailed in Section II.

Section II

A. MANAGEMENT ISSUES

The rejection of the visa request (details in Annex J) may force us to change our original research design, as we will not be able to collect the required data by ourselves. Our only alternative will then be to rely on a combination of data collected by a locally hired social scientist and the official publications on related topics (agricultural outputs and costs, market price and marketing set-ups, etc.). We are well aware that this is not an ideal procedure but unless visas are secured for Dr. Schwartz and his student, we have no other option.

B BUDGET

For the second year of the project we propose some changes in the budget. Since part of the meteorological equipment is already available, these funds should be used to purchase some of the following:

Electrical conductivity meter, desktop computer and a digital camera.

C SPECIAL CONCERNS

No special concerns

D COLLABORATION, TRAVEL, TRAINING AND PUBLICATIONS

Dr. Batyr Mamedov (Turkmenistan) visited J. Blaustein Institute for Desert Research in January 16-29, 2003 for discussion of future activities. He was trained to work with the falling head infiltrometer and tension infiltrometer (devices purchased for his team).

Dr. Leah Orlovsky (Israel) visited Turkmenistan during April 2003. She visited the Central Karakum Field Station in Karrykul (runoff harvesting plots).

Mr. Atamurad Veyisov, postgraduate student from Turkmenistan, will visit J. Blaustein Institute for Desert Research during October 2003 –January 2004 .

E REQUEST FOR AMERICAN EMBASSY TEL AVIV OR A.I.D. ACTIONS

Dr. Batyr Mamedov, requested visas for Dr. Schwartz and a student through the normal channels. The Ministry of Foreign Affairs of Turkmenistan rejected his request without stating specific reasons. Unfortunately there is no pertinent written material in our possession. We request AID's assistance in securing entry visas to Turkmenistan for Dr. Schwartz and his student.