LIVESTOCK DEVELOPMENT AND RANGELAND CONSERVATION TOOLS FOR CENTRAL ASIA

NARRATIVE SUMMARY

In the 1990's, market changes and privatization caused imbalances and dramatic reductions of agricultural stocks, production and productivity in Central Asian Republics (CAR). Central Asia represents a large region in the center of the Eurasian continent that encompasses the territories of Turkmenistan, Uzbekistan, Kazakhstan, Tajikistan and Kyrgyzstan. Rangelands occupy nearly 80% of the territory and provide the main source of forage for livestock. Sustainability of extensive production and human nutritional welfare were negatively impacted by socio-economic changes immediately following independence. Division of state and collective herds into smaller private units caused erosion of animal stocks that started in the early 1990's and is in contrast with the long-term increase of livestock population in the region. The decline in livestock numbers can be attributed to the deterioration of the terms of trade for producers. Lack of winter forages, collapse of marketing networks and poor maintenance of livestock water wells have resulted in hand-harvesting of range plants for feed and fuel and concentration of livestock around populated areas and active wells. In spite of declining livestock numbers, rangeland degradation is accelerating near surface water and populated areas. Rangelands of CAR may constitute a significant part of the "missing sink" that attenuates the increase in atmospheric carbon dioxide. Additionally, restoration of degraded lands may constitute a source of carbon credits for the region. Thus, this project addresses the immediate need to improve welfare of small landowners, to prevent further deterioration of rangelands, and to document their role as carbon sinks.

This research is divided into two modules – GIS/Basic Resources and Range Forage and Carbon Flux; and is supported by two components – Animal Production and Socio-Economics. We take an integrated multidisciplinary approach to improve the welfare of herders that involves not only on-farm solution of technical aspects, but also the assessment of alternatives and policy instruments to support them. Alternatives are evaluated from the point of view of sustainability, impacts on the global carbon budget, and economic profits. Models incorporating ecological and policy scenarios are used to explore the regional impacts of various technical alternatives.

The original plan for the 2000-2001 year included:

1. Augmentation and refinement of regional GIS for Turkmenistan (TK) and Uzbekistan (UZ);
2. Creation and distribution of a spatial tool for each country;
3. Begin regional estimates of C balance in rangelands;
4. Begin cartographic modeling of livestock sector in Kazakhstan;
5. Continued measurements and modeling of carbon dioxide flux in rangelands;
6. Reduction of CO_2 data and development of CO_2 flux models;

7. Installation of 2 eddy covariance systems (EC) for roving measurements of CO_2 fluxes in various ecosystems and under different management practices, conduct roving measurements;
8. Hold 2nd CO_2 Network meeting and conduct regional training on supplemental training and troubleshooting for the BR system;
9. Integrate CO_2 flux and satellite data, process and integrate historical data with recent CO_2 flux and satellite data;
10. Develop technical capacity of Kazak scientist in image processing;
11. Analyze and summarize information on primary and secondary productivity of rangelands for sheep;
12. Establishment of forage laboratory in Samarkand State University and training of scientists;
13. Conduct laboratory assessment of nutritive properties of predominant range vegetation types in target zones;
14. Evaluate existing maps of sampling sites and conduct inventory of literature data;
15. Quantitative assessment of the causes of livestock reduction and prediction of future stock levels utilizing developed model;
16. Model the interaction of livestock, pasture, and the regional economy using a bio-economic approach;
17. Model the behavior of producers that determine the stocking level mainly by controlling the sales and purchases of animals;
18. Calibrate models for regions in Uzbekistan with available data;
19. Dissemination of results to the government and producers.

Most of these proposed activities were conducted as reported below, with slight departures from the original plans.

Research

GIS and Basic Resources Module

Problem statements and approaches. The GIS and Basic Resources module is designed to serve as the basis for regional application and modeling of research results. The main activities of this component are the creation of a GIS for KZ, TK, and UZ. Information is used for direct dissemination and as a basis for the other modules and components. During the fourth year of the project we proposed to augment the regional GIS, create and distribute a spatial tool for UZ and TK, begin regional estimates of C balance in rangelands (integration with CO_2 component), and begin cartographic modeling of the livestock sector in Kazakhstan (integration with the SE component).

Augmentation and refinement of the databases will emphasize meteorological and remote sensing data. The creation and distribution of a spatial tool will be subcontracted to the Blackland Research and Extension Center. Integration with other components was done to build, synthesize and calibrate spatial models, to validate these models against ground truth data, and to use these models to test alternative scenarios and predict the outcome of management actions. Existing models will be extrapolated to Central Asian vegetation types and then integrated in the GIS over the spatial extent of the region to produce landscape-level estimates of total carbon flux.

Progress. Remote sensing data were acquired by the Range Forage and Carbon Flux module group. It includes 1998 June - July AVHRR, 1999 June - Aug AVHRR NDVI, and 2000 Jan – Dec AVHRR NDVI. Additional images include SPOT Vegetation 2000 – copyrighted, Landsat7 TM data (30 m) for 1999 for Shortandy and the Shetskii Raion, Kazakhstan, and 2000 MODIS image for the fall (500 m).

Daily meteorological data were acquired for KZ, TK, and UZ for 1999, 2000, and Jan-Jul 2001. In order to develop the relationships between production and rainfall, precipitation data was obtained from 21 climatic stations, interpolated across a 1200 km band in Southern Kazakhstan and corresponding forage types were extracted from the vegetation layer for analyses. This is a preliminary step in developing a cartographic model to provide estimates of the impact of alternative livestock management strategies on rangelands net primary production.

Country Almanacs (Almanac Characterization Tool or ACT) for Turkmenistan and Uzbekistan are under construction by the TAMUS Blackland Research and Extension Center. The ACT is an integrated spatial information system designed for agriculture and natural resource management. The ACT software is complemented by the construction of a foundation database for each geographical region. The foundation data accompanying the ACT include climate, meteorological, infrastructure, population, topographic, and where available, census and other economic and social data. The ACT's analytical and visualization tools enable the rapid characterization of areas within the target geographic regions. The beta version was produced in April 2001 and with the correction of some deficiencies the final version is scheduled for distribution in December 2001. Once the Almanacs are complete, training will be conducted in Central Asia.

GIS data produced in Uzbekistan included layers for political districts, soil types, and vegetation types. These are being rubber-sheeted to overlay existing data layers.

Departures from the original plan were minimal. Delays in receipt of carbon data have delayed the augmentation of the regional GIS database. There were delays in completing the forage map, which continues to be edited and cleaned.

Range Forage and Carbon Flux Module

Problem statements and approaches. The main objectives of the Range Forage and Carbon Flux module are to: 1) quantify annual net primary production (ANPP) on representative Central Asian rangelands and 2) assess the role of Central Asian rangelands in the global carbon budget. Accurate estimates of ANPP from these rangelands will provide important information on carrying capacity to sustain livestock production in the region and are important for evaluating whether Central Asian rangelands are net sources or sinks for atmospheric CO_2. Our studies in Central Asia will provide data necessary to quantitatively assess the role of Central Asian rangelands in the global carbon budget.

The Central Asian Region is dominated by vast rangelands, and we hypothesize that these extensive rangelands may constitute a significant portion of the "missing sink" that attenuates the increase in global atmospheric CO_2. The capacity of rangelands to sequester atmospheric CO_2 could be increased with better rangeland management practices, thereby improving the welfare of small landowners and, if acceptable treaties and protocols can be developed, possibly providing opportunities for trading "carbon credits". Daily and seasonal carbon balances of rangeland ecosystems are measured with a Bowen ratio (BR) technique that calculates net CO_2 exchange between a terrestrial surface (including soil and vegetation) and the atmosphere. The net CO_2 exchange between rangeland ecosystems and the atmosphere was monitored continuously during the growing season in the following study sites in Central Asia:

• Shortandy site – This represents the 'typical steppe', which consists of the vast area of the true steppe spreading from the lowlands of the northern Black Sea through the southern parts of the Russian Plains to the steppes of northern Kazakhstan. This site is located in the field experimental station of the Barayev Kazakh Research Institute of Grain Farming, near the town of Shortandy, about 60 km NNE of Astana, Kazakhstan, (51°40' N, 71°00'E, 367 m a.s.l.)

• Karnap site – This represents the 'sagebrush-ephemeroidal' arid rangelands of the foothills of Central Asia. This site is located in the territory of the agricultural enterprise "Razzok Jahangirov", 150 km NWW from Samarkand Uzbekistan (40°N, 65°30'E, 310 m a.s.l.).

• Karrykul site – This represents the 'shrub sandy desert', which includes the majority of the rangelands of Turkmenistan (26 million ha). This site is located in the southern part of the Central Karakum Desert, 80 km to the north of Ashkhabad, Turkmenistan (38°36'N, 58°24'E, 90 m a.s.l.). The site is part of the Karrykul Research Station of the National Institute of Deserts, Flora and Fauna of the Ministry of Nature of Turkmenistan.

Progress. The CO_2 flux data collected during the 2001 growing season are being processed and analyzed to develop predictive models for carbon flux and aboveground net primary production in three major types of rangelands that cover significant areas of Central Asia. At each BR site, micrometeorological variables were measured and averaged every 20 minutes, and CO_2 fluxes were calculated for each 20-minute period. Data were stored electronically and sent via electronic mail to the USA, where data quality assurance procedures were performed. These micrometeorological variables will be used for each CO_2 flux site to develop mathematical models to estimate daytime CO_2 flux, night-time respiration, and daily net CO_2 fluxes. The daily net CO_2 fluxes will be integrated to estimate the net carbon balance for the entire growing season. A full technical report of the CO_2 flux module is being prepared and will be completed in March 2002.

In Kazakhstan, we are using two eddy covariance (EC) systems to obtain roving CO_2 flux measurements in various rangeland ecosystems. The main objective of these measurements is to assess the variability of CO_2 fluxes across different vegetation types such as: 1) abandoned lands – previously cultivated lands for wheat production and left uncultivated for the past several years; 2) revegetated lands – those that are currently being used to grow crested wheatgrass (*Agropyron* spp.) for hay production; and 3) virgin lands – pristine, uncultivated lands where native vegetation grows. These types of land cover are representative of the majority of the agricultural land area of northern Kazakhstan, with exception of areas currently being used for wheat production. Twelve sites (3 vegetation types x 4 replicates) were identified for the roving EC measurements within the experiment station of the Barayev Kazakh Research Institute for Grain Farming near the town of Shortandy. We are comparing typical rangelands, with improved pasturelands and abandoned croplands, in a statistically valid design with replicates. The EC measurement systems are being used for this effort because they are state-of-the-art instruments for the task. Our approach is innovative because it uses the two EC systems as roving, instead of stationary units. Results from these roving measurements will be used for precise scaling-up of local CO_2 flux measurements to the landscape or regional level. Furthermore, efforts are being undertaken to measure the winter CO_2 fluxes in rangelands of northern Kazakhstan. This will allow us to estimate the rangeland ecosystem's carbon balance on an annual basis.

Scientists (Drs. Larry Tieszen, Bruce Wylie, and Bradley Reed) at the Earth Resources Observation Systems (EROS) Data Center (EDC) have the task of spatially and temporally extrapolating the CO_2 fluxes measured with the BR systems in rangelands of Central Asia. They have assessed the ability of remotely-sensed data (AVHRR NDVI) to estimate CO_2 fluxes measured at the ground level using data obtained from a sagebrush steppe ecosystem at Dubois, Idaho. A fairly strong relationship between daytime CO_2 flux and NDVI has been found, and a manuscript, "Calibration of remotely sensed coarse resolution NDVI to CO_2 fluxes in a sagebrush steppe ecosystem," is currently in-review for publication. Thus, the above-mentioned roving EC CO_2 flux measurements in Kazakhstan will be useful in improving and streamlining our efforts to apply AVHRR NDVI data in scaling-up the local CO_2 fluxes to the landscape or regional levels.

Regression tree algorithms were developed using spatial and temporal data sets for the Central Asian CO_2 flux study sites. These data included net ecosystem exchange (NEE), night-time respiration, daytime CO_2 flux, and photosynthetically active radiation (PAR). The PAR and NEE algorithms were implemented spatially for the area from June 1 to August 10; four 10-day composite periods. These algorithms relied on coarse spatial estimates of precipitation, which agreed well with precipitation measured at the BR systems. However, the effect of the coarse resolution data set is evident in the resulting 10-day NEE maps. Only NDVI, precipitation, PAR, day of year were used because there were only three CO_2 flux monitoring sites (1998-1999). Thus, other spatial variables like DEM, ecoregions, soil texture, etc. were not used.

Departures from the original plan were minimal. Project funds for EDC were depleted as of the end of August. Dr. Wylie's time on this project was reduced because funds were used to pay for SPOT VEGETATION and Dr. Glimanov's modeling efforts. These expenditures were appropriate and, have been and will be relevant in future research.

Project funds allocated to Dr. Tagir Gilmanov were used to generate daytime respiration estimates from daytime CO_2 fluxes. This will allow quantification of the components of NEE (NEE = gross primary production (GPP) – respiration). Daytime respiration estimates were consistent with night-time respiration and with values published in the literature. We will continue this analysis on other sites and years for the 2002 activities. Smoothed NDVI data were sent to Dr. Gilmanov to assess if relationships were stronger with NDVI and GPP or NEE.

Further information about the collaboration with the EROS Data Center can be found at http://edcsnw3.cr.usgs.gov/ip/index.html.

Animal Production Component

Problem statements and approaches. The Animal Production Module pursues two major objectives: (1) determine the production potential of the semi-arid and arid regions of Uzbekistan and Turkmenistan for sheep production, thereby facilitating the design of appropriate development programs for the livestock sector; (2) create modern planning capabilities in the host countries by establishing laboratories, provide training to host country scientists, and develop computer-based maps of production and development potential. Activities comprise research on diet composition of sheep, determination of nutritional quality of range and its dynamics throughout the forage year, parameterization of a mathematical model of sheep production for the determination of potential production levels as determined by the ecological characteristics of the natural pastures, and development of computerized maps to facilitate decision making in livestock development and range conservation.

Our project will produce data essential for an improved match between animal genotype and environmental resources in Central Asia. This is the basis for long-term sustainable production. The methods that will be developed in our project are highly relevant for extensive sheep production systems in the United States. The host countries will benefit by acquiring appropriate planning and analysis tools that will help them address the grave environmental problems of livestock production on Central Asian rangelands.

Progress

Animal Experiments. One of the main objectives to the module is to determine diet selection of small ruminants on natural rangelands in Uzbekistan. Field research began in May with an experiment on digestibility of Alhagi pseudoalhagi,(camelthorn, Fabaceae) the major winter forage supplement for small ruminants in Uzbekistan. In the months before, facilities were constructed to conduct these experiments. The first diet selection field experiment began in August, when a group of experimental animals was inserted with Captec slow release devices. Both animal field experiments were completed successfully. An import permit was obtained for the United States for the plant samples in October. Import of animal samples is more difficult, and has not been fully approved yet. The next experiment on forage digestibility using the metabolism crates constructed in the project will begin in December.

Range condition Monitoring. Three expeditions covering a total of more than 3,000 miles to six ecological sites for the establishment of range condition monitoring sites were conducted in August. On all sites, extensive range inventory measurements were conducted for the assessment of mid-grazing season forage resources. On all sites, an exhaustive collection of plants was performed. In the laboratory in Samarkand, complete biomass measurements were performed. Plant samples are scheduled to be imported into the US in November for analysis of their nutritional properties. The second expedition to the monitoring sites is currently underway. Each year, all sites will be inventoried four times, from the end of March to the beginning of November. Statistical analysis of the inventory data is currently under way.

Animal Production Models. Work on the re-programming of the SR-CRSP sheep, goat and beef production systems models began in November of 2000. Work is performed in collaboration with Lahey Computer Systems, Inc. LCS is the world's premier supplier of FORTAN compilers. The CEO of this company, Thomas M. Lahey, accepts selected re-programming and porting projects. We established a contract with LCS for programming services required by the IFAD funded project. To date, we have completed Phase I and part of Phase II of this project. The sheep and goat, and the beef models are functional now. Due to the very large number of software problems encountered in the existing code, the re-programming component of the project is currently 2 months behind schedule. We have begun to compile data for the parameterization of the models for Central Asian production conditions. We have limited data on genotypic and phenotypic animal parameters. The most serious data deficiency is the paucity of data on forage and diet quality of animals in grazing systems in Central Asia. Further, data collected on mortality and morbidity of sheep and goats in Kazakhstan and Uzbekistan do not seem to be trustworthy. Our Uzbek collaborator is currently working on a forage quality data set, and collecting additional information on mortality data. The next step, Phase II of the programming will start shortly. This phase includes the reprogramming of the database structure of the model and the design of a user-friendly interface for all the models.

Socio-Economic Component

Problem statements and approaches.

Livestock sector in Kazakstan

In 2000-2001 we continued our search for factors that affected and still affect livestock production in Kazakhstan and Uzbekistan. Between 1990 and 1998, Kazakstan lost 73% of its sheep and goat population and 59% of its cattle population. In 1999, the sheep, goat and cattle populations began increasing for the first time since the collapse of the Soviet system. After a review of the existing literature, we conducted field interviews and farm surveys. We identified the following causal factors.

Explanations for the decline:

• The end of the Soviet Union led to dramatic changes in the economic environment in Kazakhstan.

• Lower output prices and higher input prices, as a result of price liberalization, sharply reduced the profitability of livestock production and led to liquidation of livestock capital.

• Privatization of former state and collective farms and distribution of their assets to member workers resulted in the creation of numerous smallholder farms who lack both physical and human capital needed for optimal livestock production.

• Government support, such as price supports, input and credit subsidies, and investment in infrastructure, disappeared altogether.

• Livestock, especially sheep, were used as a means of exchange – animals were bartered away for production and consumption goods during a severe economic downturn when employment and financial credit were unavailable to many farmers.

Explanations for the recent increase in livestock output:

• Relative prices have stabilized and farmers have adjusted output levels accordingly.

• Producers are learning how the new market-oriented system works.

• Smallholders, working within their family, have fewer coordination problems than large farms.

• Smallholders have lower average unit costs than large farms have. Large farms have much higher overhead costs.

Our research has now moved on to the stage where we are starting to analyze how these factors have affected livestock production. We want to explore the mechanism in which the identified causal factors affect livestock production, and assess the relative importance of each factor. Among the factors listed above, we especially focus on the price changes and farm privatization. In analyzing the impact of rapid price changes, we take into consideration of the importance of price expectations in transition economies and livestock production. The identification of the causal parameters will allow us to suggest policy measures that will aid the Kazakhstani livestock sector achieve a new equilibrium level.

Progress. During October 2000 – July 2001, we constructed a dynamic optimization model of population dynamics for sheep. Under the price level for 1998, the model predicted the steady-state level population of 18 million head (the sheep and goat population was 35 million in 1990 and 10 million in 2000). The figure may be an underestimation if the output price recovers further and an overestimation if the forage availability restricts the growth of livestock population (the model does not yet take this into account). The use of average productivity may not be appropriate since the breed composition has changed considerably and meat-type sheep are currently preferred to wool-type breeds. The model parameters will be updated and replaced, and the model structure will be improved. Range resource availability will be incorporated in the model as well.

During August-September 2001, M. Kobayashi conducted interviews with local scientists and producers to identify the factors potentially responsible for the dynamics of the livestock sector. We collected farm level data in association with the Farm Monitoring Project funded by IFAD/ICARDA. The data will be used to improve the productivity parameters in the mathematical programming model above. Finally, we collected published statistics on livestock production and prices, which are going to be statistically analyzed to test whether the factors identified significantly affect livestock production in Kazakhstan.

Since livestock is a capital asset that provides future production as well as immediate output, it is relevant and important to explore how producers saw the industry's future in order to understand the path the livestock industry has taken. For example, when output price falls, producers will reduce their herd/flock size if they believe that the price will continue to be lower. On the other hand, if they believe that the price decline is only a temporary change, they will maintain their herd/flock size (holding other things constant).

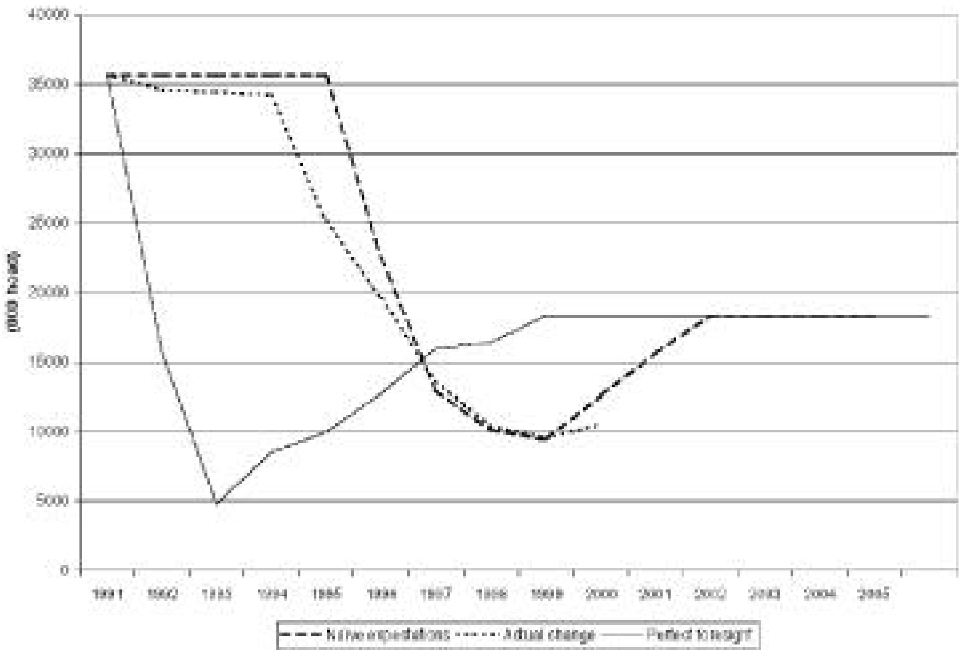
To analyze the importance of price expectations in dynamic problem of livestock production, we constructed a dynamic optimization model for the national sheep flock, and implemented several simulation exercises. Assuming constant meat and wool productivity, birth and mortality rates, and given the levels of current and (expected) future prices, the model calculates the optimal slaughter each year, and hence the time path for the optimal national flock size.

Using the model, we calculated the transition path of sheep population from the 1990 level under two different price expectation formation schemes. Figure 1 shows the following:

- With perfect foresight, the decline in sheep and goat population would have been even larger (because producers would have sold their livestock when the output prices were the highest), but the recovery would have been sooner.
- With naïve price expectations, where forecasts are based only on the current price and the expectation is that the current price will last), the simulated transition path looks close to the actual one.

As seen in Figure 1, the optimal paths differ greatly depending on the producers' view of the future. In the early years of transition, when the economy was extremely uncertain, it is unlikely that the producers had a clear understanding of supply and demand situations of the industry so they could correctly predict the future prices. Indeed, our simulation results show that the optimal path under the assumption of naïve price expectations looks much closer to the actual path than under the assumption of perfect foresight. The results also draw attention to the importance of knowing actual expectations among producers in order to predict where the sector is going. This enables us to form effective policies that will help the sector to achieve a desirable equilibrium. At the same time, the model can be used to analyze the

Figure 1. Simulation of transition path of sheep and goat population under different price expectations formulation schemes.



impacts of having more accurate price forecasts on the welfare of producers and consumers.

Given these results and considerations, our next questions are:

- How did the producers form price expectations?
- What information did they use to predict future prices when the economy was extremely uncertain?
- Did the expectations change during the course of transition?

We will explore these questions by estimating the proportions of producers with different expectation formations and the change in the proportions over time. Once we better understand the expectation formations in Kazakhstan, we will construct a simulation model for range-based livestock producers.

Survey in Uzbekistan

Results of the survey conducted in Uzbekistan in 2000 were analyzed and a MS thesis (J. Seigies) produced based on these results. This study focused on the comparison of forage availability and livestock production practices by smallholders between regions within Uzbekistan and between UZ and KZ. The comparison between countries reflects the interesting fact that although overall country statistics reflect major differences in the evolution of total livestock populations, the trends observed in household production and tenure are similar. Comparisons among regions in Uzbekistan reveal, not unexpectedly, that the more vulnerable regions, such as Karakalpakstan and the semiarid Plains are also the ones that experience the least availability and highest cost of feed for livestock. The vast majority of household livestock holdings were for the purpose of milk production and as a means of saving. These results are very similar to what was observed in Kazakstan.

Dissemination of results

The PI and other members of the research team visited government and farmers institutions in Kazakhstan and Uzbekistan. Host country scientists were briefed and consulted on the progress and plans of the project. We continued to distribute the Russian version of the GL-CRSP newsletter to villages that were surveyed in 1998, and will include those visited in 2000 in the future.

Several articles were published in Ruminations. Two MS thesis were produced in this reporting period. These publications will be available through regular library services and through the internet.

A major dissemination effort was completed in collaboration with ILRI. Several local scientists wrote technical chapters for a handbook for small producers in Kazakstan. The book was edited by Dr. N. Malmakov and printed in Russian. Several hundred copies of the book were distributed freely to small producers. A Kazak version is under development. The handbook has also been translated to English to facilitate interaction with the English-speaking scientific community.

Gender

Data from this project will provide information that will benefit both the male and female portions of the general population in the region. Results from the project will hopefully encourage women in host countries to become involved in further research that will enhance rangeland primary productivity, develop the livestock sector, and affect regional policies.

This project has continued to support women at all levels: as direct beneficiaries of the research results, as employees to support regional activities (Sidelnikova, Khosmukhamedova, Mamedova, Raushan, Kernshakaya), as collaborating scientists (Karibayeva, Shabanova, Soyunova, Lebed, Gaziantz, Young), as graduate students (Olmstead, Kobayashi, Toderich), and as student assistants (Darmina, Maze).

Policy

Important linkages developed in the past and reported last year continued to operate. This year, we successfully concentrated in furthering our connections with scientists and government institutions in Uzbekistan.

Although Kazakhstan is ahead of the other two countries in terms of reforms, it still does not have well-developed agricultural policies. Local researchers are trying hard to construct such policies. The development of additional objective information at both the aggregate market and also the individual farmer level – and policy analysis that could be based on such information - would be extremely useful for future agricultural policy making. According to a report by the World Bank, the government of Kazakhstan recently initiated a farm restructuring program which seeks, by applying bankruptcy laws to insolvent former collective and state farms, removal of their debt burden and a more efficient management. If the program is successfully implemented, it will promote restructuring of the sector by introducing more competitive forces into the market. By identifying the constraining factors to the restructuring of the livestock sector, our study will complement the government's efforts and possibly augment their effectiveness.

One of the aspects of our research that has attracted the most interest from policy-makers has been the study of Central Asian rangelands as potential carbon sinks. We envision that the database collected from the CO_2 flux monitoring sites in Central Asia will serve as the foundation for the development of a technological package to identify, evaluate, and monitor "carbon credits". Regional scientists, international collaborators, and policy-makers are just beginning to seriously consider agricultural ecosystems as potential sites for mitigation of climate change. We informed regional scientists and policy-makers about these possibilities, and have obtained significant leveraged funding to create a regional network for carbon flux measurement and modeling. Our continued work in this area will enhance the regional human capacity so that participating countries can rely on their own scientists for the expected future negotiations and measurements that will be necessary in deciding issues related to carbon crediting. One of the main goals of this network is to enhance the regional human capacity so the participating countries can rely on their own scientists for the expected future negotiations and measurements that will be necessary. This aspect of our project received very strong (moral) support from the Central Asia USAID Mission. Outputs from the CO_2 module will help define the role that the expansive rangeland areas of Central Asia play in the global carbon balance; the magnitude of carbon sequestration and, therefore, the potential importance of carbon credits for Central Asian republics; and the best management practices to secure maximum carbon sequestration, support sustainability, and maintain or restore ecosystem integrity.

Besides the scientific relevance of this project, the CO_2 module will result in capacity building that will include explicit training in biophysical interpretations of remotely sensed data. This will involve high-resolution image interpretation and analysis as well as the extraction of changes in temporal responses derived from coarse-resolution AVHRR data. We will provide our in-country colleagues both the data and algorithms concerning the examination of AVHRR-derived vegetation indices and other metrics to track phenological changes and to relate them to biomass production and CO_2 flux magnitude and dynamics. We hope to quantify the spatial extents of these changes and their underlying climatic- and weather-related causes.

In Uzbekistan, the surveys were designed in collaboration with and carried out by personnel from the Uzbek Research Institute of Market Reform, a branch of the Uzbek governmental system charged with investigating and recommending reforms to the current market system. Four of the five members of the livestock division of the Institute directly participated in the surveys. The results of the surveys will ultimately be analyzed in collaboration with the Institute and recommendations will be jointly developed for presentation to policy makers.

Outreach

The problem of quantifying the magnitude of CO_2 flux and assessing the carbon sequestration potential in principal rangelands of Central Asia were acknowledged to be of prime importance by administrators at a number of key governmental, research and management institutions in Kazakhstan, Uzbekistan and Turkmenistan, including ministries of the environment/nature conservation, academies of sciences and leading agricultural, land management, and rangeland research institutes. During visits to the region in spring 1997 and 1998, the institutions interested in receiving the data and modeling results from the CO_2 flux subproject included: Kazakhstan (Ministry of Science; Academy of Science; National Academic Center for Agrarian Research;

Ministry of Agriculture), Turkmenistan (Academy of Sciences; Regional Center for Prevention of Desertification; Ministry of Natural Resources and Environmental Protection; Research and Production Center of Ecological Monitoring), and Uzbekistan (Ministry of Agriculture, Institute of Karakul Sheep Breeding). The extension approach adopted in the CO_2 flux module will be based upon: 1) informing the target institutions and individuals about the results of the CO_2 flux evaluations at the three monitoring stations; 2) sharing quantitative models to predict CO_2 flux rates as functions of environmental factors and management decisions; and 3) discussing with the target institutions the resultant maps of CO_2 flux rate and estimated carbon sequestration potentials derived from combining flux models with the GIS of basic ecological resources of the Central Asian states.

A research collaboration between LDRCT and World Bank-Global Environmental Facility (WB-GEF) has been established in a demonstration project to assess and quantify the rates of carbon sequestration in various ecosystems such as good-condition rangelands, degraded rangelands, abandoned croplands, and rehabilitated rangelands. The proposed target site for this demonstration project is the Shetsky Raion in Kazakhstan. Thus, the data collected from the CO_2 module of the LDRCT project will provide key baseline information that will be helpful in establishing the research and rehabilitation activities of the WB-GEF project, which will be implemented in 2002.

Developmental Impact

Quantifying the magnitude and distribution of CO_2 fluxes in the principal rangeland types of Central Asia has direct relevance to understanding the regional status of terrestrial ecosystems. We hypothesize that the capacity of rangelands to sequester carbon could be improved through scientifically based management decisions. For example, the 30-year study of carbon balance of the chernozem soils in northern Kazakhstan conducted at the Barayev Institute of Grain Farming (Shortandy, Kazakhstan) indicated a 25 to 30 percent reduction of humus reserves due to cultivation. Transformation of a portion of these lands, especially in the region of marginal agriculture in northern and central Kazakhstan, into managed pastures will result in an accumulation of a significant reserve of soil carbon. However, in some parts of the region marginal cropping areas, such as desertified steppes and semi-desert rangelands in the foothill zone of Uzbekistan, are being broken out for wheat cultivation.

Determination of the potential effect of these processes on the carbon balance of the soils (where presumably a substantial loss of soil organic matter occurs through accelerated wind and water erosion of light-textured, loess soils) will help in making wise decisions regarding the management of foothill ecosystems. Similarly in Turkmenistan the desert shrub rangelands are being over-exploited by year-round grazing. Data concerning the seasonal dynamics of ecosystem productivity from continuous CO_2 flux measurements will provide important information necessary to make rational decisions in managing these fragile ecosystems.

The CO_2 flux module has maintained close collaboration with the USDA-ARS Rangeland CO_2 Flux Network, including the sharing of data processing algorithms. Results of the research on Central Asian rangelands are being used to compare with flux measurements and inter-validate the flux models derived from the steppe and semi-desert rangelands of the western U.S.A. The CO_2 flux module also cooperated with the International Center for Agricultural Research in Dry Areas (ICARDA), which contributed expertise, equipment, and resources to the establishment of the CO_2 flux station in Uzbekistan.

Leverage Funds and Linked Projects

Scientists at the USDA-ARS and Utah State University (USU) in Logan, UT (Drs. Douglas Johnson and Nicanor Saliendra) are participating in the LDRCT CO_2 flux module. The USDA and USU salaries and benefits support for Dr. Johnson (10% time) and Dr. Saliendra (50% time) on CRSP-related activities are estimated at $42,000. Additionally, the CO_2 flux module has benefited considerably by significant in-kind support from the USDA-ICARDA project. This includes support to purchase and install two Bowen ratio systems at the Karnap site in Uzbekistan, fencing and security guards to secure the CO_2 monitoring site, a refurbished vehicle for travel to and from the study site, and portable shelter at Karnap for research and security personnel. Support from the USDA-ICARDA project for CRSP-related research in Central Asia is estimated to be about $60,000.

The CO_2 flux module and the GIS module obtained funding from ALO and UC-Davis for the "Enhancement of Human Capacity for a network of CO2 flux studies in Central Asian Rangelands" project. This project resulted in the training of regional scientists and enhancement of the regional human capacity for gaining expertise in the measurement and modeling of carbon fluxes. This grant is completely complementary with LDRCT, and included more than $90,000 in funding and $110,000 of in-kind matching funds from UC-Davis and regional institutions. The first phase of the ALO project was completed in April 2000 when six Central Asian scientists spent about four months of training at Utah State University and UC-Davis. The second phase of this project was completed in March 2001 when a regional meeting was held in Samarkand, Uzbekistan, and a workshop on the CO_2 flux measurements and data processing was conducted through field trips at the Karnap site near Samarkand. Interaction with GIS counterparts in Turkmenistan and Uzbekistan have contributed to the productivity and assured sustainability of the GIS/CO2 activities now being developed in the region.

The CO2 flux module also leveraged significant funds from the Environmental Office at USAID to purchase the two Eddy Covariance Systems and implement the roving CO_2 measurements ($100,000).

Funds were also leveraged with the efforts of the scientists at the EDC to scale-up the CO_2 flux measurements to the landscape or regional levels using AVHRR NDVI data. The USGS at EDC supported the project with $60,000 in-house SIR funds.

Funding from IFAD continued to support the farm monitoring and alternative forage activities of the LDRCT and from ILRI to produce a farm manual and conduct an assessment of rangeland quality in Kazakhstan.

Efforts to leverage funds through a project considered by the International Atomic Energy Agency are under way to complement the Animal production component. Dr Pittroff is advising a proposal by the Republic of Uzbekistan for a large laboratory infrastructure and training program to the International Atomic Energy Agency in Vienna. During the 2001 visit, negotiations to further establish a collaborative structure of Uzbek institutions benefiting from this proposal were conducted. Coordination problems were resolved during a consulting visit of Dr Pittroff in Vienna. A proposal is in progress and will be submitted in December 2001. The proposal is closely coordinated with the technical advisory group of IAEA in Vienna and has excellent chances of success.

Upon invitation by Dr Gustave Gintzburger, CIRAD (formerly ICARDA), Dr. Pittroff visited CIRAD to consult with CIRAD scientists about a possible collaboration between the animal production component and a CIRAD-CSIRO initiative in Central Asia.

Training

Degree Training

Karen Olmstead, MS, 2001, Biology and Agricultural Engineering, A Simple Model of Rangeland Productivity in Southern Idaho Using Landsat Images, University of California, Davis. (50% for 3 months)

Adam Wolf, MS, 2001, International Agricultural Development, Modeling the Farm Landscape in North Kazakhstan; University of California, Davis.

Morgan Doran, MS, 2001, International Agricultural Development, Mulberry Foliage as a Protein Supplement for Ruminant Livestock: Agronomic and Nutritional Properties, University of California, Davis.

Joern Seigies, MS, 2001, International Agricultural Development, Constraints to Smallholder Livestock Development in Uzbekistan, University of California, Davis.

Mimako Kobayashi, PhD, 2003, Agricultural Resource Economics, Livestock Production in a Transition Economy: The Case of Kazakhstan, University of California, Davis.

Short Term Training

Alexander Nikolaenko, from the Institute of Ecology and Sustainable Development, Almaty, Kazakhstan

Three Month Training (March-June 2001) at the EROS Data Center. Mr. Nikolaenko was a quick learner and applied the techniques to process data for the project. He was trained on using classification trees to develop land cover data set. This encompassed selecting training points, building decision trees, and applying them to spatial data. He developed preliminary land cover maps for three ETM+ scenes, one associated with each flux tower location. He was also trained on the use of GPS-laptop real time linkage software (OziExplorer) that allowed real time viewing in the field of digital imagery (ETM+ or land cover). This technique was used by Mr. Nikolaenko to collect more than 150 land cover ground validated points for each of the three scenes. The project covered his travel costs to the three CO_2 flux study sites in Central Asia. His training also included a trip to the Shetsky and Shortandy areas at Kazakhstan on June 20-July 1, 2001 to use the OziExplorer software that linked real-time GPS information with digital images. Mr. Nikolaenko also processed AVHRR NDVI time series data for the project for 1999 and 1998. He processed the spatial daily estimates of precipitation, minimum temperature and maximum temperature into 10 composite periods similar to the NDVI data and the daily net CO_2 flux data. Finally, he provided useful GIS data sets and information including the Kazakhstan Forage Production Map.

The Uzbek collaborator, Dr. Mardonov, spent 6 weeks in the United States between April and June. He was trained in range nutrition methods, use of Captec slow release devices and took part in several intensive sampling periods in ruminant nutrition experiments on the Hopland Field Station of the University of California.

During the 4 week stay of Dr. Pittroff in Uzbekistan, he trained Dr. Mardonov's staff in database management and basic data analysis.

Collaborators from three Central Asian republics participated in a meeting and workshop dealing with CO_2 flux measurements and data processing. For the period of 28 February-14 March 2001, Dr. Saliendra traveled to Uzbekistan and provided on-site training on the installation and troubleshooting of the CO_2-Bowen ratio instrumentation at the Karnap site near Samarkand. Additionally, processing and quality assurance of the CO_2 flux data were discussed. Participants in the training included Kanat Akshalov (KZ), Muhamet Durikov (TK), Mukhtor Nasyrov (UZ), Bakhtijor Mardonov (UZ), and Tolib Mukimov (UZ).

Workshop:

CO_2 Flux Measurements in Central Asia, 9 March 2001, Institute of Karakul Sheep Breeding and Desert Ecology, Samarkand

A scientific meeting was held following the training to present and discuss the results of the CO2 flux measurements obtained during the last three years, 1998-2000. The CO2 participants also presented the results of their 1998-2000 CO2 flux measurements. The workshop was attended by representatives from the Government of Uzbekistan, ICARDA, and Samarkand State University including:

Mekhlis Suleimenov, Liaison Officer ICARDA, Tashkent, Uzbekistan

D. Khodjaev, Chairman, Dept. of Plant Physiology and Microbiology, Samarkand State University

S. U. Usupov, Director GeneralInstitute of Karakul Sheep Breeding and Desert Ecology

Shrinkulov, Chairman Samarkand Branch of Academy of Science

M. M. Makhmudov, Rangeland Ecologist, Institute of Karakul Sheep Breeding and Desert Ecology

K. N. Toderich, Head of Department, Desert Ecology Research, Samarkand Branch of Academy of Science

A. Abdusattarov, Dept. of Foreign Relations, Uzbekistan Ministry of Agriculture and Water Resources

O. Rakhmatullaev, Professor, Samarkand State University

During his trip to Shortandy, Kazakhstan on May 9-June 22, 2001, Dr. Saliendra trained Adam Wolf and Dr. Kanat Akshalov on the installation, troubleshooting, and data collection and processing using two state-of-the-art eddy covariance (EC) CO_2 flux measurement systems. These two EC systems were moved about every three days to measure CO_2 fluxes for two days at each study site. For the period June 23-October 1, 2001, Mr. Wolf and Dr. Akshalov conducted four cycles of roving EC measurements involving 12 sites (3 ecosystems x 4 replicates) identified near the beginning of the 2001 growing season.

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Publications

Doran, Morgan P. 2001. Mulberry foliage as an alternative feed for ruminant livestock. MS Thesis, University of California, Davis.

Malmakov, N. ed. Smallholders' Manual, Almaty, Bastau Press 2001. 195pp.

Seigies, Joern. 2001. Regional Differences in Livestock Feed Availability in Uzbekistan. MS Thesis, University of California, Davis.

Wolf, L. Adam. 2001. landscape patterns of soil organic matter, snow, and severity of wind erosion in North Kazakstan. MS Thesis, University of California, Davis.

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Increased Lamb Production from Kazakh Finewool Flocks

Narrative Summary

Sheep numbers have decreased markedly in the past 10 years in Kazakhstan and other Central Asian countries. In the past 10 years, privatized farmers have sold sheep for much needed cash, bartered them for food and other supplies, or consumed them for food. The decline in sheep numbers also was accelerated by low world wool prices. Three prolific breeds of sheep (Kazakh Prolific, U.S. Polypay, and U.S. Rambouillet with the FecB gene for high litter size) are being investigated for their ability to improve lamb production from Finewool sheep flocks in Kazakhstan and Kyrgyzstan. Crossbred Prolific Breed x Kazakh Finewool ewes gave birth to .32 to .44 more lambs per ewe lambing than Kazakh Finewool ewes. In addition, the crossbred lambs had growth rates as high or higher than either Kazakh Finewool or Kyrgyz Finewool lambs. It appears that crossing of finewool breeds in Central Asia with certain prolific breeds that should have moderate to good adaptability to the environmental conditions in the area should result in increased levels of lamb production. Improved buffers in diluents for freezing of ram semen appear to increase the survival of ram sperm in frozen-thawed samples. This technology will allow the increased use of frozen semen from superior rams throughout Central Asia through artificial insemination. One example is the use of frozen-thawed semen from prolific breed crossbred rams in Kazakhstan to inseminate ewes in Kyrgyzstan in 2000 and Uzbekistan in 2001.

Research

Problem Statement. Sheep numbers in Kazakhstan and other Central Asian countries have been in a free-fall since they became independent states. In Kazakhstan, sheep numbers have decreased from approximately 30 million head in 1990 prior to independence to 9.8 million head in 2000. Low profitability of the sheep sector has been one reason for the drastic decrease in sheep numbers. After World War II, the local coarse-wooled meat sheep of Kazakhstan were largely replaced with Finewool sheep of Merino-type in order to provide raw wool for the Russian textile industry. The Kazakh Finewool was a new breed developed in the 1950's and 1960's for its wool production. Economic collapse in Russia and a glut of wool on the world market selling at very low prices has left Kazakhstan with few markets and unprofitable prices for its fine wool. Therefore, there has been little economic incentive to maintain sheep numbers.

A second reason for the recent decrease in sheep numbers is due to the privatization of agriculture. When sheep were privatized in the early 1990's, they were the major liquid assets of many farmers and were sold or bartered in order to obtain other agricultural inputs and household necessities. Farm families also consumed many sheep as food. Still today, many of the large cooperative or joint-venture farms pay their members and farm workers with sheep because money is in short supply. The liquidation of the national breeding flock has resulted in a large supply of sheep meat at reasonable prices available in the market place. However, this cannot continue because the decrease in breeding sheep numbers will eventually result in a shortage of sheep meat in the market place.

Since Finewool sheep have low reproductive rates (approximately 1.25 lambs born per ewe lambing), increases in population numbers are slow. An increase in the number of lambs raised per ewe in Finewool flocks can result in an increase in the number of replacement females produced in order to help rebuild national flock numbers as well as an increase in the amount of lamb meat produced per ewe. With a higher reproductive rate, fewer ewes are required to produce the same amount of lamb meat. This results in less feed required to produce a kg. of lamb meat and less pressure on range lands and other feed resources.

Studies aimed at improving ram semen freezing procedures and artificial insemination techniques have also been conducted with the goal of improved conception rates from artificial insemination with frozen-thawed semen.

Activity One: Improved genetics for lamb production (Medeubekov, Kasymov, Malmakov, Thomas, Gottfredson)

Progress. *Comparison of sheep sired by Polypay, Rambouillet, Kazakh Prolific, and Kazakh Finewool rams for lamb meat production under scientific supervision.*

Materials and Methods. In collaboration with the Center for Sheep Selection and Genetics (CSSG) of the Kazakh Scientific Research Technological Institute of Sheep Breeding (KSRTISB) near Almaty, Kazakhstan, a study was initiated in October 1997 to evaluate the effectiveness of prolific Kazakh and U.S. breeds of sheep to increase lamb production of Kazakh Finewool flocks through an increase in the number of lambs born per ewe. Prolific breeds used in the study were Kazakh Prolific , U.S. Polypay, and U.S. Rambouillet. The Kazakh Prolific was developed by crossing Kazakh Finewool with the prolific breed of Finnish Landrace. The Polypay is a four-breed cross containing equal parts of the breeds of Finnish Landrace, Dorset (a meat breed), Rambouillet (a wool breed), and Targhee (a wool breed). The Rambouillet is the major finewool breed in the U.S., and the particular Rambouillet used in this project are from a flock where the FecB gene for increased ovulation rate is present. All two-way cross ewes resulting from these matings should have a greater prolificacy than the Kazakh Finewool ewes, but the Rambouillet crosses should have comparable fleeces to the Kazakh Finewool whereas the Kazakh Prolific and Polypay crosses should have poorer fleeces.

Semen was collected and frozen from Polypay and Rambouillet rams at the University of Wisconsin-Madison in the autumns of 1997, 1998, and 1999 and shipped to CSSG. Semen was collected from Kazakh Finewool and Kazakh Prolific rams at CSSG during the same years. In the autumns and winters of 1997 and 1998, Kazakh Finewool ewes at the cooperative farm, Aksengerskoe, were inseminated with semen from the four breeds of rams. Semen from Kazakh Prolific rams also was used on Kazakh Prolific ewes to produce purebred lambs. Aksengerskoe is located near KSRTISB and has a long history of involvement with the institute. Prior to privatization of farms in Kazakhstan, the large flocks used in the genetics' program of KSRTISB were located at Aksengerskoe. Many of the breeding flocks of the institute still remain at Aksengerskoe even though the farm is no longer under any government obligation to maintain the flocks. The lambs born in 1998 and 1999 at Aksengerskoe were trekked to the traditional mountain pastures owned by the cooperative near the border with Kyrgyzstan for summer grazing. The lambs were weaned and weighed on the mountain in August at three to four months of age. Ewes and lambs were trekked back to Aksengerskoe farm in September. Lambs were moved to KSRTISB, fed in pens, and weighed at monthly intervals through approximately one year of age, after which they returned to Aksengerskoe. In the autumn of 1999, semen from the four breeds of rams was used on the cooperative farm Koktalsky (Koktal National Breeding Center) near the city of Taldy-Korgan in Panfilov Region of Almaty Oblast that also has a long history of cooperation with KSRTISB. The lambs born from these matings in 2000 spent the summer on the mountain pastures of the farm near the border with China in southeastern Kazakhstan.

The ewes born in 1998 and 1999 were mated in the autumns and winters of 1999 and 2000, respectively, and lambed for either their first or second time in the springs of 2000 and 2001.

Ewe Reproduction. Experimental ewes were inseminated in November 2000 and lambed in April 2001. The number of lambs born per ewe lambing were: Rambouillet x Kazakh Finewool = 1.61 (n = 12), Polypay x Kazakh Finewool = 1.52 (n = 5), Kazakh Prolific = 1.64 (n = 14), and Kazakh Finewool = 1.20 (n = 14). The small number of ewes with reproductive data indicate that the prolific-breed crossbreds and the Kazakh Prolific are much more prolific than the traditional finewool ewes found in Kazakhstan and give birth to 32 to 44 more lambs per 100 ewes lambing.

Progress. *Evaluation of prolific sheep genotypes in other commercial environments (on-farm trials). (Medeubekov, Kasymov, Malmakov, Thomas, Gottfredson)*

Materials and Methods. Even though the experimental sheep have been raised on two private farms, each farm still has major involvement and oversight of the staff at KSRTISB. In order to evaluate these breeds under more commercial conditions, prolific crossbred rams born in 1998 at Aksengerskoe were mated to ewes on three commercial farms in Almaty Oblast in the autumn of 1999.

Results. On the "Turan" peasant farm in Iliisk Region of Almaty Oblast, which practices year-round pasturing of the Kazakh Meat-Wool (KMW) breed, two crossbred rams (one Rambouillet x KF and one Polypay x KMW) and normal KMW rams were used for breeding in 1999. Performance of the lambs born in 2000 is presented in Table 1. The 1/4 Rambouillet and the 1/4 Polypay lambs had greater birth weights and growth rates than the KMW lambs.

Six of the "better" prolific-cross ram lambs and 36 of the "better' ewe lambs were retained for breeding and evaluated at approximately one year of age for body and fleece weight (Table 2).

Table 1. Birth and weaning weights of lambs born at Turan Farm, Almaty Oblast

Breeding of lamb	Sex	No.	Birth wt, kg	4-mo wt, kg	Daily gain, g
(Rambouillet x KF) x KMW	Ram	15	4.9±0.19	38.4±0.69	279
	Ewe	19	4.7±0.19	35.7±0.73	258
(Polypay x KMW) x KMW	Ram	26	4.9±0.15	38.9±0.97	283
	Ewe	25	4.8±0.17	36.7±0.94	266
KMW	Ram	17	4.4±0.04	34.1±0.94	248
	Ewe	15	4.1±0.04	32.5±0.86	236

Table 2. Yearling body and fleece weights of selected lambs at Turan Farm, Almaty Oblast

Breeding of lamb	Sex	No.	Yearling wt, kg	Fleece wt, kg
	Ram	3	72.3	6.4
(Rambouillet x KF) x KMW	Ewe	12	56.7	4.9
	Ram	3	78.1	6.1
(Polypay x KMW) x KMW	Ewe	14	58.0	5.0
KMW	Ewe	10	57.4	4.8

the retained ewe lambs will be evaluated for reproductive performance in subsequent years.

Progress. *Extension of the Prolific Sheep work beyond Kazakhstan to Kyrgyzstan. (Malmakov, Azhibekov, Abdurasulov)*

Materials and Methods. Frozen semen from Rambouillet x Kazakh Fine-Wooled (KaF), Polypay x KaF, Kazakh Prolific x KaF crossbred rams and Kazakh Prolific rams was frozen at the Kazakh Sheep Breeding Institute and shipped to Kyrgyz Research Institute of Animal Husbandry in October 2000. Semen was frozen in the form of 0.12-0.15 ml pellets using New Zealand Tris-based diluent.

In November-December of 2000, Kyrgyz Finewool (KyF) ewes belonging to “Alamedin” farm, Alamedin Raion, Chu Oblast were artificially inseminated with frozen semen shipped from Kazakhstan.

A control group of ewes was mated with KyF rams. At lambing time in April-May of 2001, all lambs were identified, ear tagged and tattooed.

Records were taken on date of birth, sex, birth weight, litter size and type of birth coat. Lambs will be raised with their dams on natural pastures until 4 to 4.5 months of age when they will be weaned and weighed.

Sheep of KyF breed have a hard constitution, large body size, well-developed skeleton and good conformation. Their wool is dense, and the fleece is well closed. Ewes usually have wool fiber diameter of 60-64 count, whereas rams have fiber diameter of 58-60 count; staple length is of 7 cm and higher. Prolificacy is 1.2 to 1.3 lambs born per lambing. In spring 2001, the KyF ewes used in this study had a mean body weight of 55.8 kg with the range from 40 to 63 kg and a mean fleece weight of 3.7 kg.

Results. Among 112 ewes inseminated with frozen semen from the prolific cross rams from Kazakhstan, 66 (58.9%) lambed to the insemination and delivered 72 lambs (Table 3). Of the 30 ewes inseminated with semen from KyF rams, 20 ewes lambed, and they delivered 23 lambs. A total of 95 lambs were born from 86 ewes (1.10 lamb per ewe lambing).

One-quarter Polypay and 1/4 Rambouillet crossbred lambs were slightly heavier at birth (4.8 and 4.4 kg, respectively) than 1/4 Kazakh Prolific or KyF lambs (4.09 and 4.11, respectively) (Table 4), and the breed groups had similar ranks for one-month weights.

Linear body measurements reflected differences in body weights. Polypay and Rambouillet crosses had slightly greater measurements than Kazakh Prolific crosses and straightbred KyF lambs. (Table 5).

Table 3. Reproductive performance of Kyrgyz Finewool ewes inseminated with frozen semen

Item	n	Breed of sire			
		Polypay x KaF	Ramb x KaF	KaP x KaF & KP	KyF
Number of ewes inseminated (mated) and present at lambing time	142	59	18	35	30
Number of ewes lambed: n%	86	40	10	16	20
Number of lambs born	60.6	67.8	55.6	45.7	66.7
	95	44	10	18	23
Prolificacy	1.10	1.1	1.0	1.13	1.15

Table 4. Live body weight of lambs at birth and at 1 month of age.

Breed	n	Body weight at birth, kg		Body weight at 1 mo of age, kg		Daily gain, g
		Mean	S.E.	Mean	S.E.	
1/4 Polypay	40	4.8	0.19	16.8	0.6	400
1/4 Rambouillet	9	4.43	0.18	16.8	0.4	412
1/4 or 1/2 Kazakh Prolific	16	4.09	0.03	16.2	0.4	404
Kyrgyz Finewool	20	4.11	0.03	16.3	0.4	406

Table 5. Linear body measurements (cm) of the crossbred and control lambs

	1/4 Polypay		1/4 Rambouillet		1/2 or 1/4 Kazakh Prolific		Kyrgyz Finewool	
	at birth	at 1 mo	at birth	at 1 mo	at birth	at 1 mo	at birth	at 1 mo
Height at withers	39.3	53.5	38.3	52.0	37.3	50.0	38.6	51.5
Height at rump	40.0	54.6	39.8	53.8	38.3	51.8	39.9	52.8
Slanting body length	31.9	51.4	31.5	50.4	31.0	48.4	31.6	49.4
Chest depth	17.5	33.5	17.4	32.5	17.3	30.5	17.5	31.8
Chest girth	39.2	64.4	39.0	60.0	38.7	50.3	39.2	59.8
Metacarpus girth	6.1	8.5	6.0	8.0	5.8	6.8	6.0	7.3

Activity Two: Development of Improved Ram Semen Freezing Diluents. (Malmakov, Gottfredson)

Diluents containing tris (hydroxymethyl) amino-methane (Tris) as the main component have been examined for storage of semen from the bull, boar and ram (reviewed by Salamon and Maxell, 1995). However, Tris has poor buffering capacity below pH 7.5 (Good et al., 1966), and more research is required, particularly on those buffers with efficient hydrogen ion buffering capacity in the "sperm tolerant" range of 6.5-7.5 (e.g., N-Tris(hydroxymethyl)-methylaminoethane-sulfonic acid (TES) and N-2-hydroxyethylpiperazine-N'-2-ethanesulfonic acid (HEPES) (Good et al. 1966) and 3-(N-morpholino) propanesulphonic acid (MOPS) (Upreti et al., 1991)).

In 1998-99 we compared a New Zealand Tris-based diluent with a sucrose-EDTA-based diluent developed by Soviet scientists. The laboratory comparison revealed that the New Zealand diluent provided the best cryoprotection for ram semen (Malmakov et al., 1999). A field trial conducted in 1999-2000 in Koktal farm, Almaty Oblast also suggested that semen frozen in the New Zealand diluent had slightly greater fertilizing capacity than semen frozen in the sucrose-based diluent (Table 6).

We studied biological buffers available in the Sigma Chemical Catalogue and found that a buffer with desirable buffering capacity is a Bis-Tris buffer (bis[2-Hydroxyethil]iminotris[hydromethil]methane;2-bis[2-Hydroxyethil]amino-2-[hydromethil]-1,3-propanediol) with a desirable pH range of 5.8 to 7.2. We used this Bis-Tris buffer from Sigma Chemicals Co (B9754) in a preliminary ram semen freezing experiment. The Bis-Tris buffer improved post-thaw motility of ram semen when it was added to the sucrose-EDTA-based diluent (Malmakov et al., 1999).

Because the New Zealand diluent showed the best laboratory and field results, we decided to attempt to further improve the New Zealand diluent and gave up, for the present time, improvement of the sucrose-based diluent. We studied the effect on post-thaw motility of ram semen of substitution of the Bis-Tris buffer for the Tris buffer in the New Zealand diluent. Concentrations of 200, 240, 280 and 320 mM of Bis-Tris also were compared. Semen was collected from two Kazakh fat-rumped rams with the aid of an artificial vagina and evaluated under microscope. Good quality ejaculates were pooled and divided onto five portions and diluted with the respective diluents (Table 7).

The pH of all tested diluents was adjusted to 6.7 by the addition of citric acid. Diluted semen was equilibrated at room temperature for 15 to 20 minutes, placed into 0.25 ml mini-straws; then mini-straws were placed in a small box (like a jacket to prevent cold shock) and chilled in the fridge at 2 to 3°C for 1.5 to 2 hours. Straws with semen were frozen in the liquid

Table 6. Fertility of Kazakh Finewool ewes inseminated with Kargaly semen frozen in sucrose-based and Tris-based (New Zealand) diluents (Koktal farm, Almaty oblast – 1999-2000)

	Diluent	
	Sucrose-based	Tris-based (New Zealand)
Number of ewes inseminated	27	28
Number of ewes lambed	12	15
Fertility %	44.4	53.6
Number of lambs born		
Total	12	17
Males	7	5
Females	6	11

Table 7. Composition of the compared diluents.

Components	Tris-based diluent	Bis-Tris-based diluents – Concentration of Bis-Tris			
	280 mM	200 mM	240 mM	280 mM	320 mM
Tris, g	3.39	-	-	-	-
Bis-Tris, g	-	4.184	5.02	5.86	6.695
Glucose, g	0.467	0.467	0.467	0.467	0.467
Citric Acid, g	1.8	0.682	0.810	0.9	1.08
Sucrose, g	2.15	2.15	2.15	2.15	2.15
Sulfanilamide, g	0.3	0.3	0.3	0.3	0.3
Egg Yolk, ml	14	14	14	14	14
Glycerol, ml	4.3	4.3	4.3	4.3	4.3
Added water up to:	81.7 ml	81.7 ml	81.7 ml	81.7 ml	81.7 ml
pH	6.7	6.7	6.7	6.7	6.7

nitrogen vapor in the MVE 20 LN tank for 3 minutes with an emersion speed of 1 cm/15 sec starting from a height of 7 cm above the liquid nitrogen surface.

Results. Just after thawing, motility of frozen-thawed semen was significantly higher (P=0.032) when concentration of the Bis-Tris buffer was equal to 240 mM (Table 8). After 2 hours of incubation at 37°C, motility was still significantly higher in the semen frozen with the diluent with 240 mM of Bis-Tris (P=0.016).

This experiment showed that replacement of the 280 mM Tris buffer in the New Zealand diluent with 240 mM of Bis-Tris buffer increased significantly (P<0.05) motility of the frozen-thawed ram semen. In our case, post-thaw motility increased by 5% (50.8% vs 45.8%).

Table 8. Motility of thawed and incubated ram semen frozen in Tris-based and Bis-Tris-based diluents (20 observations)

Semen motility, %:	**Tris-based diluent conc. of Tris= 280 mM**	**Bis-Tris-based diluents, conc. of Bis-Tris: 200 mM**	**240 mM**	**280 mM**	**320mM**
Just diluted	76.5±1.50	75.8±1.51	75.6±1.59	75.6±1.59	74.5±2.08
Chilled	79.0±.69	78.5±.90	78.5±1.03	79.5±.34	78.8±.71
Frozen-thawed:					
Just after thawing	45.8±1.82 [b]	48.5±1.36 [a,b]	50.8±1.32 [a]	49.3±1.42 [a,b]	48.0±1.33 [a,b]
Incubated for 2 h	44.3±1.75	47.5±1.47	49.8±1.33	47.8±1.38	46.3±1.77
Incubated for 4 h	40.5±1.58	43.5±1.54	44.3±1.86	43.5±1.71	39.8±2.63
Incubated for 6 h	33.3±2.09 [a]	35.0±2.29 [a]	35.6±3.05 [a]	33.0±3.07 [a]	24.9±3.41 [b]
Incubated for 8 h	23.2±3.40	31.3±3.01	33.8±2.74	26.4±3.16	20.9±2.82

[a,b] Means within a row with no superscripts in common are different (*P* < .05).

References

Good N.E., Winget G.D., Winter W., Connoly T.N., Izawa S., and Singh R.M.M. (1966). Hydrogen ion buffers for biological research. Biochemistry 5, 467-77.

Malmakov N.I., Asilbekova G.K., Kasymov K.T. and Gootwine E. Increasing motility in frozen-thawed ram semen and improvement of the buffering capacity of freezing media with Bis-Tris buffer. Vestnik selskohozaistvennoi nauki Kazakhstana 1999, 5: 130-137.

Maxwell W.M.C. and Salamon S. Liquid storage of ram semen: a review. (1993). Reprod. Fert. Dev., 5, 613-38.

Salamon S. and Maxwell W.M.C. (1995a) Frozen storage of ram semen I. Processing, freezing, thawing and fertility after cervical insemination. Anim. Reprod. Sci. 37: 185-249.

Salamon S. and Maxwell W.M.C. (1995b) Frozen storage of ram semen II. Causes of low fertility after cervical insemination and methods of improvement. Anim. Reprod. Sci. 38: 1-36.

Upreti G.C., Oliver J., Munday R., and Smith JF. (1991). Development of a ram semen diluent (RSD-1) for maintaining spermatozoal motility. Proc. Aust. Soc. Reprod. Biol., 23rd Ann.

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Gender

This project does not target or preferentially benefit one gender or age group over another.

Policy

The in-country scientists have communicated the existence and results of this project to government officials in both Kazakhstan and Kyrgyzstan.

Outreach

Results of the project have been presented to the farming population through a field day in both Kazakhstan and Kyrgyzstan. The evaluation of prolific breeds on a peasant farm in Kazakhstan also brings the results of the project directly to the farm population.

Developmental Impact

This project attempts to increase lamb production so Kazakhstan and other Central Asian countries can increase their sheep numbers and increase their lamb meat production at the same time, while improving the efficiency with which range and feed resources are used. Thus the project has a positive effect on economic development at the same time that it has a positive impact on the environment and promotes agricultural sustainability.

Results of this experiment have direct application in the U.S. Much of the sheep industry of the Western and Southwestern U.S. is based on the production of finewool sheep. Due to low world wool prices and loss of a government subsidy on wool in 1995, wool sheep production is unprofitable, and U.S. sheep numbers are falling. U.S. sheep producers in the range states need to switch their emphasis from wool to lamb production, and increased prolificacy of the flocks is one way for them to increase lamb meat production.

Other Contributions

The purpose of this project is to increase lamb production from finewool sheep flocks in Central Asia so that farmers have more efficient and profitable sheep production systems and citizens have more lamb meat available for home consumption of or export.

Leveraged Funds and Linked Projects

This project plus the UC-Davis GL-CRSP project in Central Asia are partners with ICARDA and ILRI in the IFAD project "Integrated Feed and Livestock Production in the Steppes of Central Asia" for a three-year period starting on October 1, 1999. The project is funded for $1.5 million, and the GL-CRSP will receive $250,000. Our project activities are closely coordinated with Luis Iniguez, ICARDA coordinator of the IFAD project.

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