1999-2000 GL-CRSP Annual Report

Lead Principal Investigator and Institution

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Title of Project: LDRCT

Livestock Development and Rangeland Conservation Tools for Central Asia

Narrative Summary

Recent 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. 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. 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 1999-00 year included:

1. creation of GIS of Turkmenistan (TK) and Uzbekistan (UZ), and expansion of the GIS for Kazakstan (KZ),

2. train regional scientists and technicians to perform all measurements and analysis necessary to conduct the carbon-flux studies and GIS modeling,
3. distribute GIS Tool for Kazakstan to Ministries and Academy of Sciences,
4. establish web site in UC Davis to distribute GIS Tool,
5. continued measurements and modeling of carbon dioxide flux in rangelands,
6. build predictive models for carbon flux and aboveground net primary production in three major types of rangelands of Central Asia as functions of meteorological, soil, vegetation, and livestock management factors.
7. document the role of rangelands as potential carbons sinks,
8. compare the carbon flux in a good condition rangeland vs. a paired field that was incorporated into agriculture as a result of policy for wheat self-sufficiency in UZ,
9. analyze results of surveys and modeling of livestock enterprises from KZ,
10. implement rural surveys of production systems in UZ,
11. compare characteristics of production units across countries and subregions.
12. use programming techniques to determine what options could promote expansion of smallholder production and forecast impacts on intensity of land use
13. parameterize and use of the Texas A&M sheep and goat simulation model to identify biological and economic factors that limit production and profitability of smallholder production units in Central Asia,
14. dissemination of results to the government and producers.

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

Research (by activity):

GIS and Basic Resources Module

Problem statements and approaches

The GIS and Basic Resources module serves 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 third year of the project we planned to expand the GIS for Kazakstan and Turkmenistan and start the compilation and digitization of data for Uzbekistan. Further, survey data was to be analyzed to test the relation between production system, and rangeland condition, as well as to determine productivity and production bottlenecks. CO_2 flux data, which would continue to be gathered in Kazakstan, Turkmenistan and Uzbekistan, were to be used to parameterize empirical range productivity models.

Progress

Departures from the original plan were minimal. First, it was determined that a more significant effort in training local scientists and technicians was necessary. Second, acquisition of maps and weather information in Turkmenistan and Uzbekistan were necessary.

Workshops and formal training in digitization were held in the United States with GL-CRSP and additional leveraged funds for six Central Asian colleagues. The group attended classes in basic GIS concepts and English, presented seminars, and presented project results at an international meeting. Application of new methods was practiced using the GIS programs available for digitization of maps and data manipulation. They also met with the Davis researchers to plan future work, which needs to be completed on the GIS. Each country developed a preliminary work plan for the next year. A meeting of the GIS and CO2 groups was held in Davis during the Winter to discuss potential to extrapolate CO2 data across the landscape.

Techniques for using remote sensing to model rangelands in Central Asia are being developed. A potentially valuable aspect of the GIS for Central Asia is the incorporation of remote sensing information into the database. There is relatively inexpensive data available from both the Landsat and weather satellite programs. This data could potentially be used in conjunction with ground-based soils and climate data to develop a vegetation growth model for the Central Asian rangelands. This model in turn could potentially be used as a basis for carbon sequestration estimations. However, before the data can be used in this way, a viable technique for combining the available information into a coherent model needs to be developed.

Since both remote sensing and ground-based data are more readily available for the United States, a small study was initiated at a rangeland site in Idaho. The site was selected due to the similarities to the Central Asian rangelands in both climate and vegetation. The study will look at the feasibility of using available remote sensing and climate data to model semi-arid rangelands and will also try to determine the minimal level of data needed to get valid vegetation estimations. The study is due to be completed by May, 2001.

Country Almanacs (ACT or Almanac Characterization Tools) 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 geographic region. The foundation data accompanying the ACT include climate, meteorological, infrastructure, soils, vegetation, 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. Once the almanacs are ready, dissemination and training will be conducted in both countries.

Range Forage and Carbon Flux module

Problem statements and approaches

The main objectives of this 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. We are using the BR method to measure net CO_2 exchange between rangeland ecosystems and the atmosphere 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 at 51°40' N, 71°00'E, 367 m a.s.l., 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, Kazakstan.
- 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 (40°N, 65°30'E, 310 m a.s.l.), Uzbekistan.
- 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 (38°36'N, 58°24'E, 90 m a.s.l.), Turkmenistan. 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

At each BR site, micrometeorological variables were measured and averaged every 20 minutes, and CO_2 fluxes were calculated for each 20-minute period during the 2000 growing season. Data were stored electronically and sent via electronic mail to the USA, where data quality assurance procedures were performed. The data is being processed and analyzed.

These micrometeorological variables will be used to develop mathematical models to estimate daytime CO_2 flux, nighttime 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. For each CO_2 flux study site, we will develop carbon flux models as functions of micrometeorological, soil, and vegetation factors. The model will allow us to estimate the annual net primary production (ANPP) at each study site, document the role of rangelands as potential carbon sinks, and assess the importance of Central Asian rangelands in the global carbon budget. The data then will be used to develop predictive models for carbon flux and aboveground net primary production in the three major types of rangelands that cover significant areas of Central Asia. A full technical report of the CO_2 flux module is being prepared and will be completed in January 2001.

In Uzbekistan we are also comparing CO_2 fluxes on a rangeland in good condition with those on a rangeland site just recently brought into cultivation as a result of the thrust for wheat self-sufficiency in Uzbekistan.

Activities during 1998-99 showed that further training of regional scientists and technicians to perform the carbon-flux studies and GIS modeling was necessary. Funding was then secured to bring six Central Asian scientists to the USA for training on CO_2 flux data collection, data processing and quality assurance, and modeling of CO_2 flux.

Departures from the original plan were minimal and expanded the project for the most part. Integration with the GIS module was enhanced through a meeting of participants from both modules.

Research on the potential for arable soils in North Kazakhstan to sequester CO_2 as soil organic carbon continued during 2000 as well (research conducted by A. Wolf). Data collected during the summer of 1999 continued to be analyzed. The scale of this research is the farm-landscape, which is on the order of kilometers and thousands of hectares. The research has three modules. The first module tests the hypothesis that soil organic carbon is determined by the effect topography has on factors that control soil genesis, e.g. moisture redistribution or wind erosion. The second module simulates the potential for cultivated soils to sequester soil carbon over time under different management scenarios, and located at different positions on the landscape. A third module uses economic optimality criteria to simulate what the profitability of different farming practices would be in different places across the farm landscape. With the second and third modules, we will examine the economic tradeoffs for farmers between grain production and carbon sequestration, in order to establish the opportunity cost for carbon sequestration in different landscape positions, e.g. in marginal soils versus superior soils. Our hypothesis is that land use changes (e.g. abandoning marginal fields) already taking place in North Kazakstan will both increase profitability for farmers and sequester carbon. Conversely we hypothesize that the opportunity cost of lost grain income in the soils with largest potential for carbon sequestration will be high. These estimates both of carbon sequestration and economic costs will give a first approximation to the amount of carbon which may be sequestered regionally, and the approximate value this carbon may have to farmers in the area.

Several steps of the research plan have been completed successfully. A digital elevation model (DEM) of the study area was digitized from 1:20,000 scale maps, using contour lines to generate a continuous surface of the study area. From this DEM, calculations using Arc INFO GIS estimated the elevation, slope, aspect, and curvature at each sample location. Scientists collaborating with this project at the Baraev Kazakh Institute for Grain Farming (KazNIIZKh) measured the late-winter snow distribution in the study area, and recorded each sample location with a GPS so these measurements could be incorporated within the GPS. Using variography, we estimated that the spatial continuity of snow was very wide, showing that samples several kilometers apart were still correlated. This information was used to interpolate the measure of snow in un-sampled locations of the study area. From this snow surface, we estimated the amount of snow at locations where we had sampled soil.

Radio-cesium content of soils is currently being measured, which will be used to model erosion. The detection facility was established in conjunction with the North Kazakh component of the LDRCT project in collaboration with the Crocker Nuclear Laboratory (CNL) at U.C. Davis. Although a full data set for the sample area is not yet complete, measurement is now active and ongoing and should be complete by January.

Soil measurements, snow, and topographical measures are being analyzed statistically to create a predictive model for the distribution of soil across the entire landscape. Spatial cross-correlography of the data has shown that measures of snow, soil organic matter, and elevation are correlated not only when they are in the same location, but also among nearby locations.

Path analysis of the available data (TOPOGRAPHY, SNOW, SOC, SON) reveals that topography strongly influences the distribution of snow on the landscape ($R^2 = 0.61$). The influence of topography and snow on SOC is more complicated. For subsurface soils, which are less altered by tillage and erosion than surface soils, snow has a strong positive relationship with SOC, and the effect of topography is mostly through its indirect effect on snow distribution. For surface soils, snow has nearly zero effect on observed SOC, but the remaining of topography on SOC is large. We interpret this initial result to indicate that topography may have a large indirect effect by means of erosion. Although the 44% R^2 value of this initial model to explain SOC is already fairly high given that a handful of variables explain the heterogeneity of soils across 20 kilometers, the quantification of erosion has the potential for explaining a much higher proportion of variance.

Regarding the second module of this research, simulation of SOC under alternative management scenarios across the landscape is in many ways contingent on having a model for how parameters vary across the landscape. Nonetheless, there is substantial progress in this experiment. The CENTURY soil organic matter simulation model was chosen, because it is widely known and respected, and published papers have shown that this model has simulated SOM dynamics in soils very near the study area with high accuracy ($R^2 = 0.98$). We have begun parameterizing the model for our study, using measurements from Module 1, as well as from historical data from long term rotation experiments conducted by KazNIIZKh within the study area, as well as soil samples collected from those experiments. Our goal is to parameterize the model to reproduce measured values for yield and SOC based on the rotations that have taken place for the last 20 years.

Animal Production Component

Problem statements and approaches

The major objectives of the Animal Production component include:

1. monitoring and modeling of animal production;
2. studying the value of mulberry foliage as a supplement for winter;
3. creating a practical manual for livestock producers;

4. determining the production potential of the semi-arid and arid regions of Kazakstan, Uzbekistan and Turkmenistan for sheep production, thereby facilitating the design of appropriate development programs for the livestock sector;
5. creating 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.

Research in this module is scheduled to begin in 2001.

This component was expanded during the 1999-2000 period with funding from IFAD and ILRI. IFAD funding is being used to consider alternative forages to create and implement integrated technical packages for increased livestock productivity. IFAD funding is specifically supporting development of a sheep production model, farm monitoring in Kazakstan, and assessment of alternative winter forages. ILRI funding is being used to determine the current pattern of rangeland condition as a function of the distance from villages and spatial pattern of use in order to provide detailed quantitative information upon which to base recommendations; and to produce a simple and brief forage management and animal feeding manual for smallholders of Kazakstan.

Progress

Modeling of animal production started with a complete and thorough revision and updating of existing Fortran code. Contracts were established to create a user-friendly interface that will dramatically expand the user base for the product. Development will continue by testing of model outputs based on characteristics of Central Asian livestock production. These programs will be used in all components of the Central Asian project.

Regarding monitoring of animal production, appropriate field sites for data collection were surveyed and selected. Arrangements with host country institutions and collaborators were finalized. The main objectives agreed upon with host-country collaborators of the farm monitoring effort were (1) to establish linkage between producers, Agricultural Research Institutions and Educational Institutions of the region in order to develop the capacity that would be able to identify and resolve agricultural problems; (2) to enhance livestock production through revealing major constraints, and development and dissemination of methods and technologies to remove these constraining factors; and (3) to provide training opportunities for regional students. Eight 3rd year students from Zoo-Engineering and Veterinary Faculty of the Kazakh State Agrarian University (KSAU) and two post-graduates from the Kazakh Research Sheep Breeding Institute (SBI) were selected to conduct monitoring of sheep farms. Each student is working with producers that fall into three different categories from the same community:

1. Productive cooperative (or other group farm, such as Limited Liability Company - LLC,- etc.) with more than 1000 sheep;
2. Smallholding with more than 80-100 sheep;
3. 2-3 households having 10-20 sheep.

Monitoring of rangeland and abandoned land forage production is well under way. With partial funding from ILRI, we conducted training of regional scientists in which vegetation measurements were demonstrated in the field. Sites were selected and rangeland condition and forage quality was determined in more than 10 locations in Northern and Southeastern Kazakstan. More detailed information about the farm and rangeland monitoring work is included in the Appendices.

Work on alternative forages has progressed well. In each country, Uzbekistan and Kazakstan, experiments have been prepared to address the use of mulberry foliage as a winter forage supplement for livestock. The first experiment has the objective to quantify the conservation of mulberry foliage, in terms of quantity and quality, when dried and stored as whole branches with leaves attached, and when leaves and branches are dried and chopped. The second experiment has the objective to compare the performance (live weight gain, wool production, and wool quality) of yearling rams fed rations consisting of varying concentrations of mulberry foliage in combination with grass hay and barley. Participants have been contracted, forage has been harvested and conserved, animals have been acquired and experimental sites have been prepared. In addition to the experiments in Central Asia, measurements of mulberry quality, productivity and feed value have continued in UC Davis, with the collaboration and partial funding from the Department of Animal Science. An experiment to measure basic and essential nutritional characteristics of mulberry is under way. A series of lambs receive treatments that differ in the proportion of mulberry foliage in the feed. By slaughtering the animals at the end of the experiment, we will be able to determine primary coefficients that describe the digestion and flow of nutrients in the gut. Of particular interest is that mulberry protein degradability will be determined. These experiments will yield basic data about mulberry, comparable to those found in feed tables. Such information will be instrumental for anyone to consider the potential use of mulberry as a profitable feed. A detailed research plan is attached as an Appendix.

A literature review of information on range management, forage and feed utilization, and animal husbandry was performed and local authors were contracted to write a manual for livestock producers of Kazakstan. Several chapters have been written and are being translated to English and Kazak with partial funding from the International Livestock Research Institute. More details are available in the Appendices.

Socio-Economic Component

Problem statements and approaches

Activities in the Socio-Economics component of the project focus on the analysis of marketing of livestock in Kazakstan and socio-economic surveys of production units in Uzbekistan. In Kazakstan, the question of spatial integration of livestock markets is addressed because it has many policy implications. Without marketing orders, support prices, subsidies, and any kind of policy measures, the only platform on which producers perform their activity is the marketplace.

Marketing in Kazakstan.

The economic transition from a centrally planned to a market economy is ideally characterized by two processes. First, resources are reallocated across sectors according to the price signals that reflect the balance between supply of and demand for the resources. Second, within each sector, economic agents, who are now endowed with clearly defined property rights and hence better incentives, improve their performance.

The agricultural sector of Soviet Kazakstan was composed of large centrally planned state and collective farms and small household plots, the latter accounting for 34% of vegetables, 54% of potatoes, 33% of meat, and 46% of milk produced in the republic in 1990. Following the liberalization and privatization implemented since independence, while rural residents continued agricultural production on their household plots, the preexisting large agricultural enterprises (former state and collective farms) declined. The number of peasant farms has increased exponentially during the last decade. These small farms have been created as individuals left the large agricultural enterprises, either by choice or by necessity when their enterprise failed. Livestock production has declined dramatically on the large farms, mainly due to a decline in their average size. Total livestock production on the peasant farms has been rising over time, but at a lower rate than their numerical growth, implying a decline in output per farm (except for the recent recovery in milk production). Total livestock output from household plots is roughly constant. Livestock output from small farms (peasant farms and household plots) now exceeds that from large enterprises, though the large enterprises have also now been privatized.

Activities of this component seek to identify the principal factors that underlie the decline in livestock production and the changes in the structure of production. We intend to identify the influence of distinct factors and, by predicting their future course, predict as well the condition of the livestock sector in the future. Key questions that we will ask include whether the economy and/or livestock sector overshot in terms of its initial adjustment during the transition. If so, there is greater reason to expect a recovery. In addition, we will model ongoing changes at the enterprise level to allow examination of changing productivity over time due to improvements in human capital (management and labor), capital deepening, and new technology. We will also analyze livestock policy with a goal of recommending improvements in the policy area.

We approach these questions by modeling livestock production at the producer level. Since efficient reallocation and restructuring depend on the producers' ability to freely make decisions regarding input utilization, output levels, and marketing, we focus on the constraints that limit this ability. Our theoretical model of a dynamic range-livestock producer incorporates credit constraints, management ability, and forage availability as potential causes of constraints, as well as the price relations that reflect the general viability of the operation. Our model predicts that when these constraints bind, they reduce the capital value of an animal, which explains the increased sale of animals given the present depressed output prices.

> Progress in year 2000 includes: (1) identification of the main driving factors in the livestock sector, (2) review of analytic and empirical economic models, (3) discussion with scientists in the AP module regarding possible cooperation in developing empirical livestock models, and (4) identification of data needed to implement the theoretical model. We believe that changes in price relationship (lower output prices and higher input prices) have been the main driving factors behind recent changes in livestock production. In addition to it, liquidity/credit constraints that producers face likely limit the development of the livestock sector. Our model has three components: (1) micro economics (decision making by producers), (2) animal biology, and (3) range resource availability. For the animal biology part, we are planning to use the data published in national statistics, as well as information that can be derived from the animal simulation models by the AP module. GIS data for range stock and forage growth model by the GIS module will be used for the range resource part of the model.

Survey in Uzbekistan.

This component directly complements the Animal Production module, which plans to describe the main animal production systems of Kazakstan, Uzbekistan and Turkmenistan and identify the main limitations to their productivity on the basis of informal and formal surveys. The evaluation of animal production systems in Uzbekistan is designed to identify and characterize typical animal production and grazing systems in the country's main ecological regions. Formal livestock production surveys will be carried out over a large sample of farms, producing data that will describe and quantify production systems and resources and determine overall productivity and production bottlenecks. The rural surveys will allow direct involvement of rural families to express their problems and concerns and propose solutions that they feel are necessary and feasible. The results of the surveys are intended to identify the role of animal agriculture in rural family welfare and test hypotheses about the main proximate and ultimate constraints to profitable and sustainable animal production. Based on the results of the formal surveys, several enterprises will be selected for intensive monitoring and application of new technological packages that address identified problems. Results will be presented to agencies and producers in a series of reports, brochures, and audio-visual media.

Formal livestock production surveys were conducted during July - September 2000. The field surveys were carried out by the Uzbek Research Institute of Market Reforms (URIMR) under the terms of the MOU with LDRCT dated 24 March 1999. URIMR scientists and technicians were trained in participatory rural appraisal methods and rural surveys and took part in field testing of the surveys prior to actual implementation. Training and coordination were provided by a locally based, international NGO (Counterpart International or NOVIB) in collaboration with Joint Development Associates International (JDA), an NGO based in Tashkent. The survey program was coordinated and monitored by Joern Seigies, a graduate student of the UC Davis International Agricultural Development program, who was located in Uzbekistan during the July – September period. Joern worked with JDA to ensure that the training of URIMR personnel was effectively conducted, that the survey instructions and sampling approach were adhered to, and that survey results were accurately entered into the database upon completion.

The survey forms were based on those used in Kazakstan in 1998 with modifications based on observations by the Kazakstan survey teams, results produced by the surveys, input from UCD advisors, Uzbek advisors and URIMR. Each household was requested to provide information on the number and type of livestock owned, the type and quantity of feed provided and the source of the feed, grazing patterns, the ultimate use of the livestock, the source of livestock water, and breeding schedules. Sampling methodology was similar to the Kazakstan approach also, utilizing four sequential stages across the country, *oblast*, *raion* and village levels. The first stage divided the country into appropriate ecological zones, the second stage selected *raions* in each *oblast* that have a minimum livestock/hectare density, the third stage selected villages within each *raion* that have both a minimum livestock/hectare density and a maximum population size, and the fourth stage selected households with a minimum livestock holding. The actual selection criteria was determined from the livestock and population data that was collected prior to the survey.

The surveys were designed to collect information that would provide a description of rural smallholder livestock production in the ecological regions with the highest livestock densities. Based on the literature surveys and initial input from URIMR, there are four ecological regions that support most of the country's livestock development:

1) the desert and semi-desert areas of Novoi, Samarkand and Bukhara provinces where rangeland grazing supports karakul sheep production, and holdings of 1-2 cattle and 5-500 sheep per family are expected, mostly on jointly owned or privately owned farms;

2) the foothill and mountainous pasture regions of the southern provinces that support primarily beef cattle and mutton/wool sheep and goats;

3) the Amu Darya River delta region of the southern Aral Sea basin in the Republic of Karakalpakstan that is grazed by beef cattle; and

4) the irrigated region of the Ferghana Valley in eastern Uzbekistan that supports dairy cattle, mutton/wool sheep and goat production and where typical holdings are 1 cattle and 5-10 sheep with higher potential due to high farming density.

Fifty surveys were performed in each of the four ecological regions for a total of 200 surveys. Training in PRA methods and rural household surveys was provided by JDA who was well versed in PRA methodology and experienced in carrying out household surveys in rural Uzbekistan. Sampling methodology was adjusted to accommodate logistical issues and bureaucratic constraints of the Uzbek government system. In each of the four ecological regions, it was not possible to determine livestock density at the *raion* level as government records were not available to our survey team. Therefore *raions* were selected based on high projected livestock densities by URIMR personnel and relative accessibility from the main population centers located within each ecological region. Villages within each *raion* were selected based on local anecdotal guidance towards villages with apparently high livestock densities. In each village, it was customary and apparently necessary to seek permission from the local administration to carry out the surveys. In most cases, local administrators made recommendations as to the households that should be surveyed based on livestock holdings and often accompanied the survey teams to the households.

Dissemination of results

The PI and other members of the research team visited government and farmers institutions in Kazakstan and Uzbekistan. Host country scientists were briefed and consulted on the progress and plans of the project. Host country team members participated in several policy venues this year:

1. The scientific meeting on "Problems of Stabilization and Development of agriculture in Kazakstan, Siberia and Mongolia" Almaty, Kazakstan 2000.

2. The scientific meeting "Geo-information system as a modern tool for the monitoring of Rangelands Ecosystems in Arid/Semi-arid Zones of Uzbekistan" Samarkand, Uzbekistan. During this meeting, the CO_2 network for Central Asia organized under this project was able to present the goals of the network and to receive input from attending institutions and agencies.

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.

The following articles were published in the popular press and included information and results from the present project:

1. ALO Grant Awarded for Training and Partnership Program in Central Asia. Ruminations Newsletter of the GLCRSP, Fall 1999, pages 2, 15.

2. Characteristics of Smallholder Livestock Production Systems, by E. Laca and A. Breuer. Ruminations Newsletter of the GLCRSP, Fall 1999, page 3.

3. Carbon Sequestration, What's It All About? by M. Kleinschmit. Center For Rural Affairs Newsletter, April 2000, pages 3-4.
4. Global Warming: Prognoses and Solutions, by K. Akshalov. Vesti, Shortandy, Kazakstan, 24 June 2000, page 2.
5. Second Steering Committee Meeting of the IFAD-Supported Project "Integrated Feed and Livestock Production in the Steppes of Central Asia. CAC News, July-September 2000, page 9.
6. Central Asian Scientists in US for Training. Ruminations Newsletter of the GLCRSP, Winter 2000, pages 4-5.
7. Global Livestock CRSP Links Universities and Institutes Addressing Livestock-Related Problems in Central Asia. Ruminations Newsletter of the GLCRSP, Fall 2000, page 2.
8. Values of Mulberry Foliage Subject of LDRCT Study, by M. Doran. Ruminations Newsletter of the GLCRSP, Fall 2000, pages 7, 9.

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.

During the Uzbek survey, interviews were conducted with household members who were home at the time of the survey. Male members of the household were interviewed mainly, although women were interviewed in their absence. The responses by the women were as consistent as those by the men and the best combination was to have both available.

This project has continued to support women at all levels: as direct beneficiaries of the research results, as employees to support regional activities (Sidelnikova, Nabat, Raushan, Lydia), as collaborating scientists (Abouva, Karbayeba, Shabanova, Kerven, Soyunova, Lebed, Gaziantz), as graduate students (Breuer, Carpenter, Olmstead, Kobayashi), 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 Kazakstan 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 sectoral restructuring 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. In our analysis of results, we are gravitating towards a spatial analysis of limitations to livestock development and economic growth; a point well illustrated by the analysis of market integration. This type of analysis should allow optimization of development funds and of policy design.

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 Kazakstan, 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.

Recent developments indicated a possible collaboration between LDRCT and World Bank-Global Environmental Facility (WB-GEF) in establishing 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 CO2 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.

During the Uzbek surveys, Joern Seigies had a number of formal and informal discussions/collaborations with local economists and other government agency staff regarding economics issues and policy.

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 Kazakstan conducted at the Barayev Institute of Grain Farming (Shortandy, Kazakstan) 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 Kazakstan, 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.

Livestock production has been an important source of income, and livestock products have been an important source of food throughout the history of Kazakstan. Moreover, livestock has been an important asset for grazers and farmers. However, importance of livestock seems to have declined sharply. Our analysis shows that value of livestock changes as the economic environment changes. Our economic model suggests that producers are likely to place less value to their livestock because of high cost of production, the lack of special knowledge about livestock production, or uncertainty about future.

The animal production component will produce data essential for an improved match between animal genotype and environmental resources in Central Asia - 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.

Degradation of rangeland is one of Kazakstan's most urgent problems. Since livestock prices are low and transport costs are high, it is usually unprofitable to produce livestock in geographic locations that are from major urban centers (except for subsistence production). Since land is generally held in some type of communal property framework, a large proportion of Kazakstan's livestock are now found within a fairly short distance of urban areas, and the livestock range in this region is degraded. In contrast, potentially productive ranges farther distant from urban areas are underutilized and not degraded. Our analysis will provide some understanding regarding how, with expected changes in input (including transportation prices) and output prices, a growing proportion of Kazakstan's rangeland can be economically and sustainably exploited.

Large agricultural enterprises and specifically the large state farms that previously accounted for the bulk of Kazakstan's agricultural output have largely broken down. Many of their assets have been distributed or sold to previous workers, or simply consumed in the case of livestock. As a result, a large number of individual farmers have come into existence, though most of these farmers possess little capital (livestock, machinery) and few are skilled in farming. Few at all have prior experience with how to work within an economic market framework. It seems unlikely that large state enterprises provide a future for the agricultural sector. Issues of management expertise, trust, access to capital, and the like are very difficult. While individual farmers (as opposed to large enterprises) have a great potential to increase agricultural production, great efforts are needed to create a more positive framework within which these farmers and their farms can develop profitably and efficiently. Our analysis is focusing on the effort to better understand the strategies currently being followed by smaller farmers, the constraints that they face in achieving higher productivity and efficiency, and developing helpful policy recommendations. Part of this analysis will focus on the conversion of common or state land to individual use, whether by sale or lease. Our analysis, focusing on individual farmers, will fill such gaps in the knowledge of the behavior of small farmers, which would lead to direct improvement of government infrastructure and policy and, indirectly, the welfare of independent farmers.

Other Contributions

This year we organized and funded a meeting in Salt Lake City to organize the effort for a proposal from the World Bank to the GEF. The proposal - Dryland Management Project - is supervised by Dr. Jitendra Srivastava, Senior Agriculturist of the WB. The meeting took place on 8 August 2000 and was attended by S. Christiansen, D. Johnson, N, Saliendra, L. Tieszen, T. Gilmanov, and E. Laca. In addition to the funding of this meeting, it is estimated that the LDRCT group has contributed 60-80 hours of senior scientist time. Several draft budgets and documents were produced by LDRCT member and delivered to the WB group towards this proposal. We consider that these activities had a significant cost to the LDRCT, but we understand they are activities that directly address our global goals of providing technical assistance to donors and policy makers for the improvement of rural welfare through development of livestock production.

E. Laca conducted a week-long training seminar in Mexico for members of the Project PLAN during 29 Aug-4 Sep 2000. Twelve faculty, scientists, and students participated in the seminar, including PLAN members from Ecuador and Bolivia. This seminar focused on the measurements of livestock impacts on rangelands, but included one session to exchange ideas and schemes between PLAN and LDRCT. The seminar was funded by a grant from UC-MEXUS to L. Sánchez and E. Laca.

Leverage Funds and Linked Projects

Scientists at the USDA-ARS in Logan, UT (Drs. Douglas Johnson and Nicanor Saliendra) are collaborating in the joint sheep/rangeland project in Central Asia with scientists at ICARDA (Drs. Luis Iñiguez, and Musthapa Bounejmate). The CO2 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 CO2 monitoring site, a refurbished vehicle for travel to and from the study site, and portable shelter at Karnap for research and security personnel. Salary support for two Uzbek field scientists was provided through the USDA-ICARDA project. Support from the USDA-ICARDA project for CRSP-related research in Central Asia is estimated to be about $60,000. Additionally, USDA salary and benefit support for Dr. Johnson (10% time) on CRSP-related activities is estimated to be another $12,000. Thus, a total of about $72,000 has been leveraged through interaction with the USDA-ICARDA project.

The project obtained leveraged funds from ALO and UC-Davis to train regional scientists and enhance 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.

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

Efforts to leverage funds through a project considered by the International Atomic Energy Agency are under way to complement the Animal Production component.

Training

Degree Training

Abigail Breuer, MS, 2000, Agronomy and Range Sciences, Patterns of Rangeland Use in the Dry Steppe, Semi-Desert and Foothill Regions of Kazakstan, University of California, Davis.

Mary Carpenter, MS, 2000, International Agricultural Development, Linking Livestock Production to Human Nutrition the Dry Steppe, Semi-Desert and Foothill Regions of Kazakstan, University of California, Davis.

Karen Olmstead, MS, 2001, Biology and Agricultural Engineering, A Simple Model of Rangeland Productivity in Southern Idaho Using Landsat Images, University of California, Davis.

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

Short Term Training

Training: CO_2 data collection and analysis, GIS tools.

> Sessions on the collection, processing, quality assurance, and modeling of CO_2 flux data; Facilities of the USDA-ARS Forage and Range Laboratory located on the campus of the Utah State University, Logan, Utah. 30 November – 31 December 2000.
>
> Sessions on the techniques and protocols for developing GIS tools; Department of Agronomy and Range Science, University of California-Davis. 3 January-31 March 2000.
>
> Six collaborators from three Central Asian republics participated.

Name/Country	Attendance	Location	Subject
Kanat Akshalov	1-23 Dec. 1999	Logan, UT	CO_2 flux
Shortandy, Kazakstan	3-30 Jan. 2000	Davis, CA	GIS
Alexander Nikolaenko	1-23 Dec. 1999	Logan, UT	CO_2 flux
Almaty, Kazakstan	3 Jan.-31 Mar. 2000	Davis, CA	GIS

Moukhamet Dourikov Ashkhabad, Turkmenistan	1-23 Dec. 1999 3 Jan.-2 Mar. 2000	Logan, UT Davis, CA	CO_2 flux GIS
Valerii Nikolaev Ashkhabad, Turkmenistan	1-23 Dec. 1999 3 Jan.-31 Mar. 2000	Logan, UT Davis, CA	CO_2 flux GIS
Mukhtor Nasyrov Samarkand, Uzbekistan	1-23 Dec. 1999 3 Jan.-1 Mar. 2000	Logan, UT Davis, CA	CO_2 flux GIS
Bakhtijor Mardonov Samarkand, Uzbekistan	1-23 Dec. 1999 3 Jan.-29 Mar. 2000	Logan, UT Davis, CA	CO_2 flux GIS

Upon return to their countries, the participants used the materials they gained from their training in classrooms and laboratories at their institutions. To date, 354 additional persons have been trained under this project.

Workshop: CO_2 and GIS integration. UC Davis 21-22 January 2000. Scientists from Kazakstan, Turkmenistan, Uzbekistan, and the U.S.A. met to discuss and plan the integration of the CO2 flux and GIS modules. About 15 participants represented various institutions including the Kazakhstan National Academic Center of Agricultural Sciences, Turkmenistan National Institute of Deserts, Flora and Fauna, Samarkand State University, Uzbekistan Academy of Sciences, South Dakota State University, Utah State University, USDA-ARS, and UC-Davis participated.

Workshop: Participatory Rural Appraisal training. Tashkent, Uzbekistan. Staff of the Uzbek Economic Research Center were trained in survey techniques.

Workshop: Rangeland Vegetation measurements, Shortandi, Kazakstan, July 2, 2000. E. Laca conducted a one-day seminar and field training for five scientists and technicians.

Collaborating Personnel

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Publications

In progress

Abstracts and Presentations

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Pittroff, W. and Mardonov, B. An Integrated Approach to the Determination of Rangeland Productivity for Sheep Production. Presented at the 70th Anniversary Conference of the Karakul Research Institute, September 2000.

Wolf, L.A. How Flat is the Kazak Steppe? Modeling the farm landscape. Poster presentation at the 2000 Annual Meeting of the Global Livestock Collaborative Research Support Program. Autlan de Navarro, Jalisco, Mexico. March 2000.

Kobayashi, M. Small-scale agricultural production in post-Soviet Kazakhstan: Implications to spatial marketing of live animals. Presented at the 2000 Annual Meeting of the Global Livestock Collaborative Research Support Program. Autlan de Navarro, Jalisco, Mexico. March 2000.

Mardonov, B., Nikolaenko, A., Nikolaev, V. Geographical Information System for Central Asia. Presented at the 2000 Annual Meeting of the Global Livestock Collaborative Research Support Program. Autlan de Navarro, Jalisco, Mexico. March 2000.

Comments

Appendix 1: Evaluation of accomplishments

Degree to which planned activities were completed.

Approximately 80% of the original plan. Additional activities not originally planned were added.

Number of people who attended presentation of results or requested information.

Approximately 50.

Number of popular press articles that refer to this project.

Approximately 10.

Number of scientific publications resulting from this work.

Two theses, three abstracts, two articles (submitted).

Number of students and trainees supported or involved in this project.

Twenty one(Breuer, Carpenter, Wolf, Doran, Olmstead, Darmina, Seigies, Maze, Kobayashi, 2 UCD student assistants, 10 Kazak students).

Number of women supported or involved in this project.

Seventeen (Breuer, Carpenter, Olmstead, Nash, Darmina, Shabanova, Karibayeba, Kerven, Soyunova, Mamedova, Kernshaskaya, Sidelnikova, Lebed, Sidelnikova, Dimeeva, Stokova, Maze).

Number of regional policy-makers informed of our results and their assessment of the impact of the information.

To be determined.

Appendix 2: Mulberry foliage as an alternative feed for ruminant livestock in Central Asia.

Mulberry foliage as an alternative feed for ruminant livestock in Central Asia: Project Description and Procedures

Conducted by the Department of Agronomy and Range Science at the University of California, Davis in collaboration with the Uzbekistan Livestock Institute in Tashkent.

Overview of Project

Objective

The overall objective is to determine an appropriate method of conserving mulberry foliage for feeding ruminant livestock during the winter in Central Asia.

Specific objectives:

1. Quantify the conservation of mulberry foliage, in terms of quantity and quality, when dried and ensiled with a mix of meadow grasses and forbs.
2. Compare the performance (live weight gain, wool production, and wool quality) of yearling rams fed rations consisting of ensiled and dried mulberry foliage in combination with meadow grasses and forbs.

Experimental Design

The conservation experiment will compare three methods of preserving mulberry foliage: 1) air dry branches (with leaves attached) to be stacked and stored under shelter for winter feeding, 2) chop or mill air dried branches and leaves to pass through a _” screen and store for winter feeding, and 3) chop and ensile leaves and branches with freshly cut meadow grasses and forbs. The three preservation methods will be evaluated on the difference in quantity and quality of forage from time of the harvest in the summer of 2000, to the time of use in January 2001. Quantity losses will be measured by the weight difference of harvested forage and amount of forage fed from February to April 2001. Quality will be measured by determining the fiber content (NDF and ADF) and crude protein of forages at the time of harvest, immediately after preservation, and in January 2001.

In early February, a feeding trial will begin in which the performance of sheep consuming the three rations, plus a control ration, will be measured. The feeding trial will consist of 36 10-month rams that will be randomly divided and fed the formulated rations for a minimum of eight weeks. There will be three groups of three rams assigned to each one of the four rations. The experimental design will be a completely randomized design with 3 replications; each replication consisting of a group of 3 rams in a common pen. The performance of the sheep will be based on the change in live animal weight during the feeding trial, and on the quantity and quality of the wool. Feed, feed refusals, and feces will be collected at fifteen-day intervals during the feeding trial and analyzed for fiber components and protein.

Description of forage rations

The feed ingredients for four rations must be prepared and stored during the months of July and August 2000. Three of the four rations will be treatment rations consisting of grass (hay and silage), mulberry foliage, and barley. The forth ration is the control and will consist of grass hay and barley. Descriptions of each ration, including ingredients and their approximate quantities, are given below:

Ration 1: Grass hay, whole mulberry branches, and barley.

Ingredient	Fresh weight (kg)	As-fed weight (kg)	Dry Matter wt. (kg)	% of ration
Grass hay	--	1045	940	52
Mulberry foliage	2400	665	600	33
Barley	--	307	270	14

Ration 2: Chopped grass hay, chopped mulberry braches, and barley.

Ingredient	Fresh weight (kg)	As-fed weight (kg)	Dry Matter wt. (kg)	% of ration
Grass hay	--	1045	940	52
Mulberry foliage	2400	665	600	33
Barley	--	307	270	14

Ration 3: Silage consisting of freshly chopped grass and mulberry branches.

Ingredient	Fresh weight (kg)	As-fed weight (kg)	Dry Matter wt. (kg)	% of ration
Fresh Grass	4700	2850	940	52
Mulberry foliage	2400	1820	600	33
Barley	--	307	270	14

Control Ration: Grass hay and barley; includes amount for 10-day pre-trial rations.

Ingredient	Fresh weight (kg)	As-fed weight (kg)	Dry Matter wt. (kg)	% of ration
Grass hay	--	2500	2250	85
Mulberry foliage	--	0	0	0
Barley	--	445	390	15

The minimum amounts of each ingredient that must be purchased for the experiment are listed in the following table:

	Grass hay (kg)	Fresh mulberry foliage (kg)	Fresh grass (kg)	Barley (kg)
Ration 1	1045	2400	0	270
Ration 2	1045	2400	0	270
Ration 3	0	2400	4700	270
Control Ration	2500	0	0	390
Total	**4590**	**7200**	**4700**	**1200**

Forage Harvesting and Preparation

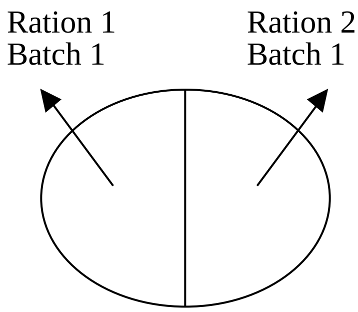
Before preparing forages, storage sites must first be clean from debris.

Mulberry Harvesting Procedure

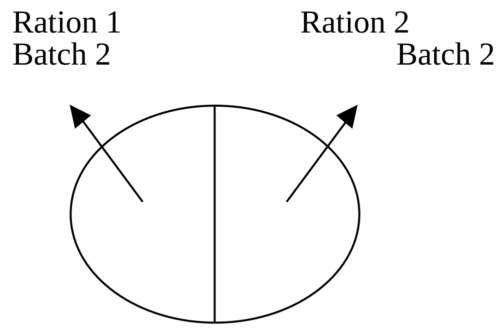
The branches used for this experiment should be cut where the diameter of the branch begins to exceed 10 mm (about the thickness of an ink pen). All the leaves from the thicker section of the branch should be striped from the branch and included with the harvested foliage. The mulberry foliage used in rations 1 and 2, should be cut and dried as soon as possible. If the foliage is left in piles for extended periods of time (3+ hours), especially in hot conditions, the foliage quality can be severely degraded. The foliage should be dried under shade, not exposed to intense sunlight, and drying must continue until the leaves and the branches are dry.

Responsibilities:

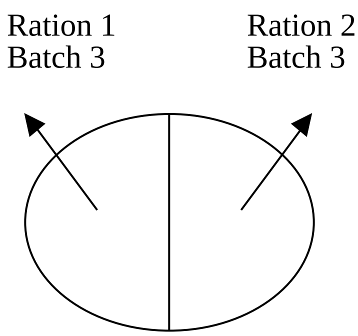
Replication of the prepared rations is necessary to compare forage quality among the different rations. Rations 1 and 2 will be replicated by preparing a minimum of four batches of each ration. Batches will be prepared by dividing each truckload of mulberry foliage between the two rations (see diagrams).



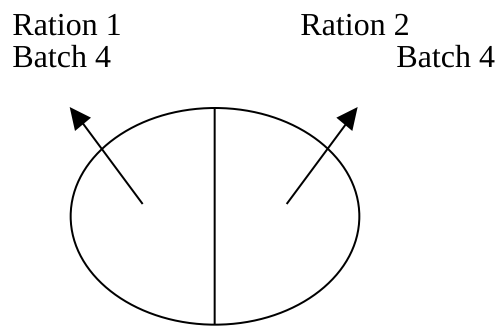
Truckload 1



Truckload 2



Truckload 3



Truckload 4

Each batch must be kept separate until the final sample is taken in January 2001.

Replication of foliage for Ration 3 (silage ration) may not be possible since all the foliage used must be processed immediately after cutting.

Forage Preparation Procedure

Ration 1: Once the leaves and branched are dry, the batches of dried mulberry branches must be stacked separately and stored until the feeding trial in January 2001. At the time of feeding, hay and barley will be added to the ration at the specified proportions.

Ration 2: Once the leaves and branches are dry, the batches of dried mulberry branches must be chopped in a mill to pass through a 5-6 mm screen. The batches of chopped foliage must then be stored in a receptacle to prevent losses from bugs, spoilage, and contamination. At the time of feeding, the chopped mulberry foliage will be mixed with the barley and chopped hay at the specified proportions.

Ration 3: Immediately after the mulberry branches are harvested, the entire branches with leaves attached must be ensiled together with freshly cut green grass. It is important that the mulberry foliage and grass are transported and processed immediately after cutting. If the silage ingredients dry to <70 % moisture, slow and undesirable fermentation can occur resulting in spoiled silage. The mulberry foliage and grass should be chopped together to ensure even mixing of both ingredients. Care must be taken to add the fresh grass and mulberry foliage into the chopper so that the proportions are consistently kept at 70:30 respectively. After chopping the grass and mulberry foliage together, the mix must then be well compacted into the silage trench. Compaction can be easily accomplished by driving a tractor over the mix many, many times. Good compaction of the forage mix is critical for proper fermentation and preservation; therefore an excessive amount of compaction is encouraged. Immediately after completing the compaction of the forage mix, the pile of silage must be covered with an airtight plastic cover to prevent the intrusion of oxygen into the forage. When the silage is fed to the sheep during the feeding trial, barley will be added to the mix at the specified proportions.

Responsibilities:

Coordinator	· Coordination of activities with the farmer and the scientist. · Arrange the purchase and delivery of the hay and barley.
M. Doran	· Leave money with coordinator for purchasing feeds, and paying the scientist and labor, and purchasing supplies. · Explain the details of the procedures to the coordinator and the scientist.
Scientist	· Oversee the processing and storage of the feeds. · Ensure that the storage area is clean and adequate for proper storage. · Ensure that the silage is properly compacted and covered.
Farmer	· Provide the area next to the pens for feed storage. · Provide the tractor and chopper to process and compact the silage. · Provide the forage chopper to process the foliage for ration 2.
Labor	· Clean the feed storage area. · Provide the labor necessary to process and store the feeds.

Sampling of Forages

Sampling procedure

All the forages must be sampled at several stages throughout the experiment. Special care must be taken so that representative samples are taken of the quantity of forage being sampled. To ensure a representative sample is taken, approximately 100-200 grams of dry material or 500-1000 grams of fresh material should be collected. Mulberry foliage samples should consist of entire branches. All samples are to be collected into labeled brown paper bags and oven dried at a temperature between 55 - 60º C for approximately 48 hours. After drying, the material should be ground to a 2-5 mm particle size to reduce the bulk of the sample and to homogenize the sample. Approximately 50 grams of the ground sample should be placed into labeled plastic Ziploc bags and sent to the University of California, Davis for fiber and protein analysis.

Sample periods

Ration 1: Mulberry foliage samples for ration 1 will be collected at the time of harvest, at the time the foliage is stored after drying, two weeks prior to the feeding trial in January 2001, and every 15 days during the feeding trial. Separate samples must be collected from each batch.

Ration 2: Mulberry foliage samples for ration 2 will be collected at the time of harvest, when the foliage is chopped and stored, two weeks prior to the feeding trial in January 2001, and every 15 days during the feeding trial. Separate samples must be collected from each batch.

Ration 3: Mulberry foliage samples for ration 3 will be collected at the time of harvest, immediately after the foliage is chopped and mixed with the grass, approximately 21 days after ensiling, two weeks prior to the feeding trial in January 2001, and every 15 days during the feeding trial

Hay and barley: The hay and barley supplies should be sampled at the time they are delivered to the experiment site, two weeks prior to the feeding trial in January 2001, and every 15 days during the feeding trial.

Samples that are not sent to the University of California, Davis by Morgan Doran must be sent by way of airmail.

Sample labels

The forage sample labels should appear as indicated in the following table. More or less labels may be necessary depending on the number of batches of each ration and the length of the feeding trial.

Ration 1 labels	**Ration 2 labels**	**Ration 3 labels**	**Hay & Barley labels**	**Feeding Trial labels**
Uzbek "date" Ration 1 batch 1 Harvest	Uzbek "date" Ration 2 batch 1 Harvest	Uzbek "date" Ration 3 Harvest	Uzbek "date" Hay Arrival	Uzbek "date" Ration 1 feed 15 day trial
Uzbek "date" Ration 1 batch 2 Harvest	Uzbek "date" Ration 2 batch 2 Harvest	Uzbek "date" Ration 3 Conserved	Uzbek "date" Hay Pre-feeding	Uzbek "date" Ration 1 feed 30 day trial
Uzbek "date" Ration 1 batch 3 Harvest	Uzbek "date" Ration 2 batch 3 Harvest	Uzbek "date" Ration 3 21 days Conserved	Uzbek "date" Barley Arrival	Uzbek "date" Ration 1 feed 45 day trial
Uzbek "date" Ration 1 batch 4 Harvest	Uzbek "date" Ration 2 batch 4 Harvest	Uzbek "date" Ration 3 Pre-feeding	Uzbek "date" Barley Pre-feeding	Uzbek "date" Ration 1 feed 60 day trial
Uzbek "date" Ration 1 batch 1 Conserved	Uzbek "date" Ration 2 batch 1 Conserved			Uzbek "date" Ration 1 feed 75 day trial
Uzbek "date" Ration 1 batch 2 Conserved	Uzbek "date" Ration 2 batch 2 Conserved		Uzbek "date" Hay 15 day trial	Uzbek "date" Ration 2 feed 15 day trial

Uzbek "date" Ration 1 batch 3 Conserved	Uzbek "date" Ration 2 batch 3 Conserved		Uzbek "date" Hay 30 day trial	Uzbek "date" Ration 2 feed 30 day trial
Uzbek "date" Ration 1 batch 4 Conserved	Uzbek "date" Ration 2 batch 4 Conserved		Uzbek "date" Hay 45 day trial	Uzbek "date" Ration 2 feed 45 day trial
Uzbek "date" Ration 1 batch 1 Pre-feeding	Uzbek "date" Ration 2 batch 1 Pre-feeding		Uzbek "date" Hay 60 day trial	Uzbek "date" Ration 2 feed 60 day trial
Uzbek "date" Ration 1 batch 2 Pre-feeding	Uzbek "date" Ration 2 batch 2 Pre-feeding		Uzbek "date" Hay 75 day trial	Uzbek "date" Ration 2 feed 75 day trial
Uzbek "date" Ration 1 batch 3 Pre-feeding	Uzbek "date" Ration 2 batch 3 Pre-feeding		Uzbek "date" Barley 15 day trial	Uzbek "date" Ration 3 feed 15 day trial
Uzbek "date" Ration 1 batch 4 Pre-feeding	Uzbek "date" Ration 2 batch 4 Pre-feeding		Uzbek "date" Barley 30 day trial	Uzbek "date" Ration 3 feed 30 day trial
			Uzbek "date" Barley 45 day trial	Uzbek "date" Ration 3 feed 45 day trial
			Uzbek "date" Barley 60 day trial	Uzbek "date" Ration 3 feed 60 day trial

Responsibilities:

Coordinator	· Provide the scientist with a drying oven and sample grinder. · Ensure that the forages are being sampled at the correct times. · Arrange the delivery the samples to UC Davis.
M. Doran	· Explain the sampling procedure to the scientist. · Collect the samples from the first harvest. This will be done with the scientist. · Provide the paper and plastic bags. · Provide the coordinator with copy of USDA permit.
Scientist	· Collect all subsequent samples. · Dry all the samples. · Grind all the samples. · Prepare all the samples for delivery.
UC Davis	· Send paper and plastic bags to Morgan. · Analyze the samples for fiber components and protein.

Animal Selection

A total of 36 rams born in the spring of 2000 will be used for the feeding trial. In August of 2000, forty rams will be selected and marked with ear tags. Of the forty selected rams, 36 will be chosen for the feeding trial in January. Selection will be random, but care will be taken to make groups balanced in terms of size and type of animal. For example, al groups should have about the same average body mass, shape, size and condition.

Responsibilities:

Coordinator	·	Communication with the farmer.
M. Doran	· ·	Selection of the rams. Provide ear tags.
Scientist	·	Selection of the rams.
Farmer	· · ·	Provide transport to the sheep herd. Locate the sheep in a corral. Ensure proper care of the rams until the feeding trial.
Labor	·	Assist with sheep handling.
UC Davis	·	Send ear tags to Morgan.

Feeding Trial Preparation

Facilities Preparation

The following tasks must be completed no later than January 15, 2001:

1. The area in and around the pens must be clean from all debris.
2. Sixteen pens will be used for the feeding trial. All pens must be of equal size.
3. All the pens must be carefully inspected and repaired, if necessary, to ensure that the animals cannot escape.
4. Water and feed buckets and/or troughs must be clean and ready to use.
5. Scales for weighing the animals and the forage must be in place and operational.
6. A forage chopper must be in place near the feeding area and operational.
7. A table should be in place near the pens for a working platform. Electricity will be available for the scale and for work when it is dark (probably most of the time during winter).

Responsibilities:

Coordinator	· ·	Communicate the schedule of activities to the farmer. Communicate with the scientist to ensure that the tasks are being completed.
M. Doran	· ·	Will arrive in Uzbekistan the third week of January. Provide scales for weighing the rams and the forage.
Scientist	· · · · ·	Ensure tasks are being completed. Coordinate the labor to complete tasks. Inspect the pens. Purchase any needed supplies. Work with the farmer to locate forage chopper near feeding area.
Farmer	· ·	Provide a forage chopper near the feeding area. Purchase materials needed to repair the pens.

Labor	·	Clean the pens and repair if necessary.
	·	Provide a forage chopper.
	·	Provide a table.

Sheep Preparation

The following tasks are to be completed by the date indicated:

1. The forty rams selected in August of 2000 must be brought to the experiment site no later than January 19, 2001.
2. By January 20, the 36 rams to be used in the feeding trial must be selected from the group of forty rams selected in August.
3. On January 20, each of the 36 selected rams will receive a dose of an antihelmentic for internal and external parasites, an antibiotic (oxytetracycaline) to eliminate any bacterial infections, and an injection of vitamins A, D, & E.
4. Beginning on January 21, the 36 rams will be fed a ration consisting of 85% grass hay and 15% barley. The rams will remain on this ration until the trial begins on February 1.
5. Data sheets must be prepared and ready to use by February 1.

Responsibilities:

Coordinator	·	Communicate the schedule of activities to the farmer.
M. Doran	·	Provide antihelmentic, antibiotic, and vitamins.
	·	Administer medications.
	·	Select final 36 rams.
	·	Prepare data sheets.
	·	Explain feeding trial procedures to scientist.
	·	Leave partial payment with the coordinator.
	·	Collect receipts for past expenditures.
Scientist	·	Work with farmer to transport rams to the experiment site.
	·	Administer medications.
	·	Select final 36 rams.
	·	Ensure that the rams are being fed the correct ration.
Farmer	·	Transport the rams to the experiment site on the specified date.
Labor	·	Assist in transporting the rams to the experiment site.
	·	Assist in the administration of medications.
	·	Assist in the care of the rams (feeding, water, cleaning pens).

Balancing Forage Rations

In the first week of January 2001, the final ration samples must be collected, dried, and immediately sent to the University of California, Davis. The samples should be sent Federal Express to ensure a rapid delivery. At UC Davis, the samples will be analyzed for fiber components and crude protein. The results of these analyses will be sent via e-mail to Morgan Doran, who will arrive in Central Asia during the second week of January. Based on the composition results, the rations for each group will be calculated to best meet the growth requirements for the rams.

Responsibilities:

Coordinator	·	Provide the scientist with a oven dryer and a sample grinder.
	·	Arrange the Federal Express delivery of the samples to UC Davis.

M. Doran	·	Formulate the rations.
	·	Communicate the rations to the scientist.
Scientist	·	Collect the forage samples.
	·	Dry the samples.
	·	Grind the samples.
	·	Prepare the samples for delivery.
UC Davis	·	Analyze the samples.
	·	Send analysis results to Morgan.

Feeding Trial

Assignment to Feeding Groups

The 36 rams will be divided into twelve groups of three rams by random assignment. Each group of three rams will then be assigned to a treatment, with each treatment consisting of three groups. Each group of three rams will then be randomly assigned a pen in the feeding barn. Each pen should have a sign posted indicating which treatment ration the pen is receiving and the ear tag numbers of each ram in the pen. This information should also be recorded on data sheets.

Responsibilities:

M. Doran	·	Assign sheep to treatments and pens.
Scientist	·	Make and post signs on pens.
	·	Explain procedures to the laborer(s).
	·	Move sheep into their respective pens.
Labor	·	Move sheep into their respective pens.

Feeding

The feeding of the rams must adhere to the following guidelines:

The feeding trial will begin on February 1, 2001.

1. During the feeding trial, each group of rams will receive the specified amount of feeds. Every time the groups are given their ration, the amount of feed should be weighed and the weight recorded on the data sheets.

2. If the rams are not consuming large quantities of their ration, the rations should be reduced to an adequate level.

3. If the rams are consuming all their rations, then the rations should be increased to a level at which they are leaving a small amount (about 10%).

4. Any changes to the quantity fed, must maintain the same proportion of ingredients in the specified rations.

5. Each pen of sheep must receive fresh water every day, even if the remaining water appears clean.

Responsibilities:

Coordinator	·	Communicate with the scientist to ensure that the activities are progressing well and according to the schedule.
M. Doran	·	Explain the feeding rations to the scientist.
	·	Provide sample bags.

Scientist	· · · · · ·	Explain the feeding procedures and rations to the laborer(s). Oversee the feeding of the sheep. Make adjustments to the rations when necessary. Record the amounts of each ingredient fed to each group. Ensure that the water is changed daily. Ensure that the pens are cleaned when necessary.
Labor	· · ·	Prepare feeding rations with assistance from the scientist. Change the water in each pen on a daily basis. Clean the pens when necessary.

Feed Refusals

Every pen must have a large plastic bag for feed refusal collections. Every day, before the rams are fed, the feed left in the trough should be collected into the large plastic bag. Any feces in the trough must be discarded. Each bag should be used for fifteen days. On same days that the feed and fecal samples are collected, the mass of feed in the bag will be determined and recorded, and a new bag must be used for the next fifteen days. Each bag will contain the feed refused from one pen for a fifteen-day period. At the end of the feeding trial, each bag should be separately ground to a 2-5 mm particle size. Approximately 100 grams of each ground sample should then be placed into a labeled plastic Ziploc bag and sent to the University of California, Davis for fiber and protein analyses.

Note: The feed refusals from the pens receiving ration 3 (silage ration) should be spread on some paper in an area protected from the weather to allow the feed to air dry before placing the feed in a the large plastic bag.

Sample labels

The feed refusal sample labels should appear as indicated in the following table.

Ration 1 feed refusals	Ration 2 feed refusals	Ration 3 feed refusals	Control group feed refusals
Ration 1 group 1 0-15 days Feed refusals	Ration 2 group 1 0-15 days Feed refusals	Ration 3 group 1 0-15 days Feed refusals	Control group 1 0-15 days Feed refusals
Ration 1 group 2 0-15 days Feed refusals	Ration 2 group 2 0-15 days Feed refusals	Ration 3 group 2 0-15 days Feed refusals	Control group 2 0-15 days Feed refusals
Ration 1 group 3 0-15 days Feed refusals	Ration 2 group 3 0-15 days Feed refusals	Ration 3 group 3 0-15 days Feed refusals	Control group 3 0-15 days Feed refusals
Ration 1 group 1 16-30 days Feed refusals	Ration 2 group 1 16-30 days Feed refusals	Ration 3 group 1 16-30 days Feed refusals	Control group 1 16-30 days Feed refusals
Ration 1 group 2 16-30 days Feed refusals	Ration 2 group 2 16-30 days Feed refusals	Ration 3 group 2 16-30 days Feed refusals	Control group 2 16-30 days Feed refusals
Ration 1 group 3 16-30 days Feed refusals	Ration 2 group 3 16-30 days Feed refusals	Ration 3 group 3 16-30 days Feed refusals	Control group 3 16-30 days Feed refusals
Ration 1 group 1 31-45 days Feed refusals	Ration 2 group 1 31-45 days Feed refusals	Ration 3 group 1 31-45 days Feed refusals	Control group 1 31-45 days Feed refusals

Ration 1 group 2 31-45 days Feed refusals	Ration 2 group 2 31-45 days Feed refusals	Ration 3 group 2 31-45 days Feed refusals	Control group 2 31-45 days Feed refusals
Ration 1 group 3 31-45 days Feed refusals	Ration 2 group 3 31-45 days Feed refusals	Ration 3 group 3 31-45 days Feed refusals	Control group 3 31-45 days Feed refusals
Ration 1 group 1 46-60 days Feed refusals	Ration 2 group 1 46-60 days Feed refusals	Ration 3 group 1 46-60 days Feed refusals	Control group 1 46-60 days Feed refusals
Ration 1 group 2 46-60 days Feed refusals	Ration 2 group 2 46-60 days Feed refusals	Ration 3 group 2 46-60 days Feed refusals	Control group 2 46-60 days Feed refusals
Ration 1 group 3 46-60 days Feed refusals	Ration 2 group 3 46-60 days Feed refusals	Ration 3 group 3 46-60 days Feed refusals	Control group 3 46-60 days Feed refusals
Ration 1 group 1 61-75 days Feed refusals	Ration 2 group 1 61-75 days Feed refusals	Ration 3 group 1 61-75 days Feed refusals	Control group 1 61-75 days Feed refusals
Ration 1 group 2 61-75 days Feed refusals	Ration 2 group 2 61-75 days Feed refusals	Ration 3 group 2 61-75 days Feed refusals	Control group 2 61-75 days Feed refusals
Ration 1 group 3 61-75 days Feed refusals	Ration 2 group 3 61-75 days Feed refusals	Ration 3 group 3 61-75 days Feed refusals	Control group 3 61-75 days Feed refusals

Responsibilities:

Coordinator	· ·	Provide the scientist with an oven dryer and a sample grinder. Arrange the Federal Express delivery of the samples to UC Davis.
M. Doran	· ·	Explain sampling procedure to the scientist. Provide sample bags and labels.
Scientist	· · · · ·	Collect feed refusals on a daily basis. Ensure that a new bag is used every 15 days. Dry the samples. Grind the samples. Prepare the samples for delivery.
Labor	·	Assist as instructed by the scientist.
UC Davis	·	Analyze the samples.

Sanitation

The pens must always be maintained in good condition without excessive moisture on the floor from urine and feces. Straw should not be used as bedding since the rams may eat the straw and disrupt the intake of their feed rations. If any of the rams become ill or

Responsibilities:

Scientist	·	Ensure that the pens are cleaned when necessary.
Labor	·	Clean the pens when necessary.

Fecal Samples

Fecal samples will be collected from each group of sheep every ten days of the feeding trial. Samples should be collected from fresh feces only and small samples should be collected from several different feces in each pen. Soon after collecting the fecal samples, they must be spread thinly and oven dried at a temperature between 55 - 60° C for approximately 48 hours. After drying, the samples should then be placed into labeled plastic Ziploc bags and sent to the University of California, Davis for fiber and protein analysis.

Sample labeling

The fecal sample labels should appear as indicated in the following table.

Ration 1 fecal samples	Ration 2 fecal samples	Ration 3 fecal samples	Control group fecal samples
Ration 1 group 1 15 day trial Feces	Ration 2 group 1 15 day trial Feces	Ration 3 group 1 15 day trial Feces	Control group 1 15 day trial Feces
Ration 1 group 2 15 day trial Feces	Ration 2 group 2 15 day trial Feces	Ration 3 group 2 15 day trial Feces	Control group 2 15 day trial Feces
Ration 1 group 3 15 day trial Feces	Ration 2 group 3 15 day trial Feces	Ration 3 group 3 15 day trial Feces	Control group 3 15 day trial Feces
Ration 1 group 1 30 day trial Feces	Ration 2 group 1 30 day trial Feces	Ration 3 group 1 30 day trial Feces	Control group 1 30 day trial Feces
Ration 1 group 2 30 day trial Feces	Ration 2 group 2 30 day trial Feces	Ration 3 group 2 30 day trial Feces	Control group 2 30 day trial Feces
Ration 1 group 3 30 day trial Feces	Ration 2 group 3 30 day trial Feces	Ration 3 group 3 30 day trial Feces	Control group 3 30 day trial Feces
Ration 1 group 1 45 day trial Feces	Ration 2 group 1 45 day trial Feces	Ration 3 group 1 45 day trial Feces	Control group 1 45 day trial Feces
Ration 1 group 2 45 day trial Feces	Ration 2 group 2 45 day trial Feces	Ration 3 group 2 45 day trial Feces	Control group 2 45 day trial Feces
Ration 1 group 3 45 day trial Feces	Ration 2 group 3 45 day trial Feces	Ration 3 group 3 45 day trial Feces	Control group 3 45 day trial Feces
Ration 1 group 1 60 day trial Feces	Ration 2 group 1 60 day trial Feces	Ration 3 group 1 60 day trial Feces	Control group 1 60 day trial Feces
Ration 1 group 2 60 day trial Feces	Ration 2 group 2 60 day trial Feces	Ration 3 group 2 60 day trial Feces	Control group 2 60 day trial Feces
Ration 1 group 3 60 day trial Feces	Ration 2 group 3 60 day trial Feces	Ration 3 group 3 60 day trial Feces	Control group 3 60 day trial Feces
Ration 1 group 1 75 day trial Feces	Ration 2 group 1 75 day trial Feces	Ration 3 group 1 75 day trial Feces	Control group 1 75 day trial Feces

Ration 1 group 2 75 day trial Feces	Ration 2 group 2 75 day trial Feces	Ration 3 group 2 75 day trial Feces	Control group 2 75 day trial Feces
Ration 1 group 3 75 day trial Feces	Ration 2 group 3 75 day trial Feces	Ration 3 group 3 75 day trial Feces	Control group 3 75 day trial Feces

Responsibilities:

Coordinator	· ·	Provide the scientist with an oven dryer. Arrange the Federal Express delivery of the samples to UC Davis.
M. Doran	· ·	Explain sampling procedure to the scientist. Provide latex gloves and sample bags.
Scientist	· · ·	Collect fecal samples. Dry fecal samples. Prepare samples for delivery.
UC Davis	·	Analyze fecal samples.

Measuring Animal Performance

Animal Weights

One component of animal performance that will be measured is the change in live body weight of the rams throughout the feeding trial. Each weight of each ram will be measured at the beginning of the trial, on February 1, and every 10 days during the feeding trial. The weights are to be recorded in a data book. Each ram will be weighed by a person who will hold the ram while standing on a human scale. The person's body weight will be subtracted from the total weight to determine the weight of the ram.

Responsibilities:

Coordinator	·	Ensure that the rams are being weighed at the specified times.
M. Doran	·	Provide scale.
Scientist	·	Weigh and record the weight of each ram.
Labor	·	Assist as instructed by the scientist.

Wool Growth and Quality

The other components used to measure animal performance are wool production and wool quality. At the completion of the feeding trial, a sample of wool from each ram will be collected and placed into a labeled plastic Ziploc bag. The wool samples must be sent to the University of California, Davis where they will be analyzed for fiber quality. After the experiment is finished and at the regular shearing time for the region, each ram will be shorn and the wool weighed. The wool weight for each ram must be recorded in the data book.

Responsibilities:

Coordinator	·	Arrange the Federal Express delivery of the samples to UC Davis.
M. Doran	· ·	Provide sample bags. Provide labels.
Scientist	· · · ·	Collect the wool samples. Prepare samples for delivery. Work with the farmer to arrange and coordinate the shearing of the rams. Weigh and record the weight of the wool for each ram.

Labor	·	Assist as instructed by the scientist.
UC Davis	·	Analyze the wool samples.

Nutritional characteristics of mulberry.

Objective

The overall objective is to evaluate the nutritional properties of mulberry foliage, *Morus alba*, for ruminant livestock.

Specific objectives

1. Determine the nutritional characteristics of *M. alba* as a supplement feed for sheep.
2. Estimate TDN, DE, ME, NE_m, and NE_g by measuring the digestibility of the NDF, ADF, EE, CP, lignin, and ash components of a 100 % mulberry foliage diet fed to sheep.
3. Measure the component values of NDF, ADF, EE, CP, amino acids, and minerals in mulberry leaves, and a mix of mulberry leaves and stems.
4. Determine protein degradability in the compartments of a ruminant digestive system by measuring ratio of a marker to nitrogen in the rumen and abomasum.
5. Determine the associative effects of supplementing oat hay with mulberry foliage.
6. Estimate TDN, DE, ME, NE_m, and NE_g by measuring the digestibility of the NDF, ADF, EE, and CP components of a 1:1 mix of oat hay and mulberry foliage fed to sheep.

Project design

In this trial, five treatment rations will be fed to wethers weighing approximately 50 kg. The feedstuffs and their proportions in the five rations are as follows:

Ration 1: 100 % oat hay

Ration 2: 1:1 combination of oat hay and mulberry foliage

Ration 3: 100 % mulberry foliage

Ration 4: 1:1 combination of oat hay and alfalfa

Ration 5: 100 % alfalfa

Each feedstuff will be chopped to pass through a 6 mm screen. Each ration will be pelleted if a Cr_2O_3 marker cannot be evenly distributed into the chopped feeds. In either the chopped or pelleted form, the Cr_2O_3 marker will be added at approximately a 0.4 % concentration. Alfalfa will be used as a reference feedstuff to which we can validate the digestibility of mulberry foliage. Each animal will be fed at approximately 1.2 x maintenance energy requirement as indicated below:

Maintenance ME/wether	450 kJ/kg BW $^{.75}$ * 1.2 * 50 kg $^{.75}$ = 10.15 MJ ME/day
100 % oat hay ration	1.92 Mcal ME/kg oat hay * 4.184 MJ/Mcal = 8.03 MJ/kg
	10.15 MJ/day / 8.03 MJ/kg oat hay = 1.3 kg oat hay/day
100 % mulberry ration	2.5 Mcal ME/kg foliage† * 4.184 MJ/Mcal = 10.46 MJ/kg
	10.15 MJ/day / 10.46 MJ/kg foliage = 0.97 kg foliage/day
100 % alfalfa ration	03 Mcal ME/kg alfalfa * 4.184 MJ/Mcal = 8.49 MJ/kg
	10.15 MJ/day / 8.49 MJ/kg alfalfa = 1.20 kg alfalfa/day
1:1 oat hay & mulberry	2.21 Mcal ME/kg† * 4.184 MJ/Mcal = 9.245 MJ/kg
	10.15 MJ/day / 9.245 MJ/kg = 1.10 kg /day
1:1 oat hay & alfalfa	1.97 Mcal ME/kg * 4.184 MJ/Mcal = 8.26 MJ/kg
	10.15 MJ/day / 8.26 MJ/kg = 1.23 kg /day

† The estimated ME for mulberry foliage is 2.50 Mcal/kg.

The total amount of each ration needed to complete the feeding trial is outlined below:

100 % oat hay	4 sheep	*	1.43 kg/day‡	*	14 days	=	80.1 kg	_ 100
100 % mulberry	4 sheep	*	1.10 kg/day‡	*	18 days	=	79.2 kg	_ 100
100 % alfalfa	4 sheep	*	1.32 kg/day‡	*	18 days	=	95.0 kg	_ 110
1:1 oat hay/ mulberry	4 sheep	*	1.21 kg/day‡	*	14 days	=	67.8 kg	_ 100
1:1 oat hay/alfalfa	4 sheep		1.35 kg/day‡	*	14 days		75.8 kg	_ 100

‡ Value represents 110 % of the estimated amount of feed required per day.

Twenty wethers will be randomly assigned to 20 different pens, and each ration will be randomly assigned to four pens producing four replicates per ration.

Adjustment Period

The adjustment period will consist of 7 days in which the wethers will be fed their specified ration twice per day, half in the morning and half in the evening.

Collection Period

Days 8-14 will be a collection period during which the feeding schedule will not change from the adjustment period. During the collection period, grab samples of feed and feces will be collected at the feeding times and once at mid-day. The fecal samples must be immediately dried in an oven at 60^{o} C for 48 hours.

Steady State Period

Immediately following the 7 day collection period, on day 15 the wethers from the 100 % mulberry and 100 % alfalfa treatments will continue being fed the same ration for 3 more days. During the 3 day feeding period, the wethers will continue on their same rations, but the amount will be equally divided over 12 feeding periods per day (every 2 hours). Grab samples of the feces will be collected several times per day to verify, *a posteriori*, that a steady state condition is attained. On the fourth day, each wether will be administered a lethal dose of anesthetic intended to stop all muscle contractions prior to death. The anesthetic will be administered to two wethers every two hours, one hour after the wethers are fed. Immediately after death, the wethers will be slaughtered and their entire gastro-intestinal tracts removed. The GI tract will be separated into the rumen, abomasum, small intestine, ceacum, colon, and rectum. The digesta contents from each compartment will be carefully and completely removed, weighed, subsampled, and stored separately for later analyses. The remaining carcass and offal will be sent to the rendering facilities.

Chemical Analyses

Collection period samples.

At the completion of the collection period the daily fecal samples for each wether will be pooled so that there are 20 total fecal samples (4 wethers * 5 rations). All the feed samples will be pooled into one sample. The feed and fecal samples will be analyzed for NDF, ADF, ADIN, EE, CP, and Cr_2O_3. Additionally, the feed sample will be analyzed for amino acids (type and quantity), lignin, ash, and minerals. Bomb calorimetry will be performed on the feed and fecal samples to directly determine digestible energy.

Steady state period samples.

The samples collected from the various GI compartments of the wethers will immediately be dried at 100^{o} C until completely dry. The dry samples will be weighed for total dry matter and then analyzed for NDF, ADF, total N, ammonia N, and CR_2O_3. Samples from the duodenum and/or abomasum will be analyzed for purines to determine the microbial mass in the samples. The microbial nitrogen content in these samples will then be subtracted from the total non-ammonia nitrogen content in order to determine the quantity of bypass protein.

Data Analyses

Collection period analyses

Energy

The TDN for each animal in each treatment will be calculated from the following formula (NRC 1996):

$$1 \text{ kg TDN} = 4.4 \text{ Mcal DE}$$

DE will determined as the difference in the energy released from bomb calorimetry of the feed (IE) and the feces (FE).

$$DE = IE - FE$$

Because the ratio of ME to DE is 0.8 (NRC 1996), the ME will be determined as follows:

$$ME = DE * 0.8$$

ME will then be converted to NE_m and NE_g (Mcal /kg DM) using the relationships reported by Garrett (1980)

$$NE_m = 1.37\ ME - 0.138\ ME^2 + 0.0105\ ME^3 - 1.12$$

$$NE_g = 1.42\ ME - 0.174\ ME^2 + 0.0122\ ME^3 - 1.65$$

Steady state period analyses

Passage

The outflow rates from the various compartments of the GI tract will be estimated according to the procedure described by Faichney (1975) in which

$$k = F/Q$$

where k is the fractional outflow rate (h^{-1}) from the compartment, F is the rate of marker administration (mg h^{-1}), and Q is the amount of marker in the compartment (mg). Q is determined from the equation

$$Q = C * A$$

where C is the concentration of the marker in the digesta (mg/g DM), and A is the amount of dry matter present in the compartment (g).

Bypass protein

The amount of CP that is undegraded intake protein (UIP) will be calculated as

$$\%\ UIP = \left(\frac{NAN_d - MN_d}{N_{feed}} \right) * 6.25$$

where NAN_d is the amount of non-ammonia nitrogen present in the digesta from the duodenum and the abomasum, MN is the amount of nitrogen contributed by microbes passed from the rumen, and N_{feed} is the amount of nitrogen in the feed.

The disappearance of nitrogen from the rumen will be estimated using nitrogen and Cr2O3 concentrations

$$\text{Rumen disappearance} = 1 - \frac{(Cr/N)_{diet}}{(Cr/N)_{chyme}}$$

where Cr and N are the concentrations of chromium and nitrogen in the diet and chyme respectively.

Appendix 3: Farmers Manual; Rangeland Condition in Kazakstan.

Report of Research and development of smallholder livestock production in Central Asia – Interim Report of activites in collaboration with ILRI.*

December 2000

Prepared by: Mary F. Carpenter and Emilio A. Laca

Goals

1. To determine the current pattern of rangeland condition as a function of the distance from villages and spatial pattern of use in order to provide detailed quantitative information upon which to base recommendations.
2. To produce a simple and brief forage management and animal feeding manual for smallholders of Kazakstan.

Range Assessment

Objective

· To determine the status of forage resources around villages for the purpose of recommending conservation measures. To determine the forage value of vegetation growing in abandoned croplands and seeded pasture as basis for land use recommendations in Northern Kazakstan.

Collaborators:

· UC Davis: E. Laca
· Institute of Feed and Pasture, Almaty: I. Alimaev
· Baraev Institute of Grain Farming, Shortandi: V. Yurchenko and K. Akshalov
· Kazak Sheep Breeding Institute: N. Malmakov

Accomplishments:

· Training of scientists in Kazakstan by E.A. Laca during which sampling methods were demonstrated and tested.
· Sampling sites were selected in the North and South. Transect sampling was completed in both regions for the growing season of 2000. Data are being analysed and soil samples are being prepared for transportation to analytical labs.

Next Steps:

· Data entry.
· Soil and forage analyses.
· Statistical analyses of results and preparation of report. Responsible parties: E.A.Laca, V. Yurchenko, I. Alimaev.

We expect to have completed a detailed report with the results and interpretation by June 2001.

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* The research reported here has been funded by the International Livestock Research Institute and the USAID Global Livestock CRSP.

Manual for Farmers

Objective

- To produce a simple and brief forage management and animal feeding manual for smallholders of Kazakstan.

Collaborators/Authors:

- UC Davis.
- Institute of Feed and Pasture, Almaty: I. Alimaev
- Sheep Breeding Institute of Kazakstan: N. Malmakov (Coordinator), K. Medeubekov, S. Aryngaziev (Department of goat selection and breeding), V. Terentiev (Laboratory of Wool Quality Analysis), K. Medeubekov (Kazak Center of Sheep Selection and Genetics)
- Institute of Botany and Phytoremediation: L. Dimeeva and L. Stokova
- The Agrarian University: A. Egeubaev
- Kazak Research Institute of Veterinary: U. Gorelov (Department of Small Ruminants diseases)
- Kazak Institute of Agricultural Economics: B. Ospanov

Accomplishments:

- Complete manual outline has been prepared (see attached).
- All authors have been contacted and contracts signed.
- Chapter drafts have been completed and are being translated.

Next Steps:

- Edit translated chapters, return to authors for corrections and obtain final drafts. This should be completed by June 2001.

Shepherd's Manual Outline.

1. Sheep selection and breeding. Prof. K.U. Medeubekov, Kazak Sheep Breeding Institute.

2. Sheep feeding. Prof. A.A. Egeubaev, Almaty State Agricultural University.

3. Wool and pelt production. Prof. V.V. Terentiev, Kazak Sheep Breeding Institute.

4. Sheep reproduction. Dr. N.I. Malmakov, Kazak Sheep Breeding Institute.

5. Heath Management of sheep. Dr. U.M. Gorelov, Kazak Research Veterinary Institute.

6. Forage Production. Dr. I.I. Alimaev, Kazak Research Institute of Fodder and Pastures.

7. Economics of sheep husbandry. B. Ospanov, Kazak Research Institute of Economics and Management in Agriculture.

8. Botany and management of rangelands. Dr. L.A. Dimeeva and Dr. L.L. Stogova, Kazak Research Institute of Botany. (translated draft available).

9. Goat husbandry. Dr. S. Aryngaziev, Kazak Sheep Breeding Institute.

Appendix 4: Farm monitoring by agricultural students of Kazakstan.

Goal and Objectives of the Research (from Work plans for GL-CRSP activities funded by ICARDA-IFAD grant)

The basic purpose of research is to involve agricultural science, Educational Institutions and farmers in revealing and handling livestock problems, and to develop collaboration between University of California - Davis and Kazakstan Agrarian Universities on preparing qualified experts for cattle-breeding sector. Major forces discouraging the development of rangeland-based livestock production will be revealed and the technologies on their elimination will be determined. The focus will be on the fieldwork and distribution of the results.

Several stock farms from different parts of Kazakstan will be selected for monitoring. It will be partial activity on item 3.2 of ICARDA workplans (ICARDA - International Center for Agrarian Research in Dry Areas), which is called "Involvement of Farmers and Scientists in Improving Livestock Production". This work can also help to accomplish the tasks on item 4.2 of ICARDA workplans, which is called " Effective Complex Use of Fodder Resources to Pass Through the Shortage of Fodder and to Prevent Further Soil Degradation ".

Main Objectives:

1. To establish linkage between producers, Agricultural Research Institutions and Educational Institutions of the region in order to develop the capacity that would be able to identify and resolve agricultural problems;
2. To enhance livestock production through revealing major constraints, and development and dissemination of methods and technologies to remove these constraining factors. The main concern here will be to assess genetically improved sheep developed under the University of Wisconsin-Madison project.
3. To improve productivity and sustainability of rangeland-based livestock production systems through revealing constraining factors, and development and application of proper management systems.

Student and Farm Selection.

Eight 3rd year students from Zoo-Engineering and Veterinary Faculty of the Kazakh State Agrarian University (KSAU) and two post-graduates from the Kazakh Research Sheep Breeding Institute (SBI) will be selected to conduct monitoring of sheep farms in September 2000. Each of them will work with the producers of 3 different categories from the same community:

1. Productive cooperative (or other group farm, such as Limited Liability Company -LLC,- etc.) with more than 1000 sheep;
2. Smallholding with more than 80-100 sheep;
3. 2-3 households having 10-20 sheep.

KSAU students and SBI graduates will monitor the farms monthly during 5-6 days (students from remote places will do it once in 1.5-2 months during 5-6 days) in 2000-2003. This monitoring will help to get a better understanding of basic production processes such as: lambing, shearing, sowing, washing, harvesting, mating, forage storing, marketing of the produce, etc. Each student should have a formal letter from the University explaining the goal of the research to be submitted as needed. Each student (graduate) will get $800/year as travel expenses. This work will be the basis for their diplomas and candidate thesis. Those students and graduates who prepare the best papers and enclose informative reports and analysis on the research done will be awarded small grants to write their diplomas or candidate thesis.

Workplan on Sheep Farm Monitoring

Visit Akim (Deputy Akim) of the Settlement (once a year).

To document the settlement history, figures on the community population, names and number of organizations providing people with jobs (e.g. cooperative, school, hospital, mill, sausage factory, etc.); figures on livestock and poultry population (for the top of 1990, 1995, 2000); the names and number of the legalized agri cooperatives, farms, and data on their activities (farming or cattle raising, number of farm members, total land area, livestock number, availability of stock barns and equipment). Together with Akim to select objects (cooperative, farm or 2-3 households) for monitoring among those who are positive to such cooperation. So as the map of the community or of the former state farm is available, to make its copy and to mark water wells and winter places (sheepyards) there (the map in necessary to study the utilization of agricultural lands: arable lands, rangelands and water wells).

Cooperative Monitoring

Meet the Chairman and Chief Specialists of the Cooperative and to get the following information:

- History of the farm (state or collective farm): farm typology, livestock number, quantity of production, number of workers in different years; names and working periods of the farm Ex-Directors, the name of the Director who made the farm profitable and type of business that made the farm successful. To think if this approach can be applied today.

- Table 1 is a draft questionnaire for cooperative monitoring. Data should be collected once a year. The questionnaire reflects the results of the cooperative activities for one year. For example, in 2000 the cooperative sold... tons of wool for... tenge, spent ... tons of fuel for... tenge, etc. One should focus on costs and benefits (balance).

Data for Table 2 should be collected once a month. It gives the picture of cooperative activity for a short period (month). One should again pay attention to costs and benefits. Table 2 should include current prices for key agri products, such as: meat, milk, wool, pelts, live animals, fuel, in Almaty, in the monitored village and in the nearest district or regional center.

With the permission of the Cooperative Director to select one flock of ewes to be monitored on their productivity for 3 years. Weight and body condition score of ewes will be determined four times a year: mating season (October), middle of pregnancy (January), lambing (April), and during lactation period of summer grazing (July). 100 ewes will be selected randomly and weighed. Their fatness will be determined on the methodology of Russel et al.(1969) (Russel A.J.F., Doney J.M. and Gunn R.G. Subjective assessment of body fat in live sheep. Journal of Agricultural Science, Cambridge, 1969, 72:451-454) (see Attachment 1).

Table 1. Draft questionnaire on cooperative (farm) monitoring with more than 1000 sheep.

Name of the farm:

Director's name:

1. Village:
2. District:
3. Region:
4. Number of employees, inc. administration
5. Total land area (th. ha.):

Inc.: arable lands
irrigated lands
non irrigated lands
rangelands
kitchen gardens
other lands

6. Agricultural equipment:

cars
trucks
tractors
combines

7. Livestock number:

cattle
horses
camels
sheep
goats
poultry
others

8. Facilities:

cowsheds
stables
sheep barns
others

9. Sales:

_) Crop products: wheat grain
barley grain
vegetables (fruit)
hay
others

_) Animal products: milk
meat
stud animals
live animals (exc. stud ones)

wool
pelts
others

10. Costs: taxes
salaries
fuel
purchase of new equipment (stud animals,
seeds for planting, etc.)
purchase of spare parts, etc.
other costs

Table 2. Sample questionnaire for collecting monthly data on cooperative activities.

1. Total livestock number, th.:
   inc.: ewes
   rams
   ewe lambs
   ram lambs
2. Performance of the monitored sheep:
   _) General data: breed (s)
   sheep number (if the flock is mixed, to document number of sheep of each sexual and age group)
   rangeland location and name (data of moving from one rangeland to the other), in winter – data on dietary pattern (e.g.: grazing + 1 kg of hay or 0.3 kg of barley).
   average live weight, kg (_ + m) (4 times a year: lambing, weaning, mating and middle of pregnancy)
   fatness, mark (M + m) (4 times a year: lambing, weaning, mating and middle of pregnancy)

   b) Lambing: dates of the beginning and the end of the period
   number of lambed sheep
   number of aborted sheep
   number of non pregnant sheep
   number of the lambs born,
   inc. dead-born
   c) Weaning: date
   number of lambs weaned
   average live weight of ram lambs, kg (_+m)
   average live weight of ewe lambs, kg (_+ m)

3. Marketing of agri produce (to focus on: to whom and how the products are sold, i.e. to middlemen or there are some contracts on produce supply, e.g. with the milk plant , for cash or on barter, etc.):

_) Crops: wheat grain
barley grain
vegetables (fruit)
hay
others

_) Animal products: milk
meat
stud animals
live animals (exc. stud ones)
wool
pelts
others

4. Costs: taxes
salaries
fuel
purchase of new equipment (stud animals, seeds for planting, etc.)
purchase of spare parts, etc.
other costs

Monitoring of the private flock.

Together with community Akym (Deputy Akym) to select a private flock with at least 80-100 sheep. It may be a flock grazed in the village or in the area of 5-10 km from the village.

Table 3. Draft questionnaire for individual flock monitoring

1. Name of the flock owner

2. Breed(s)

3. Total sheep number:
inc.: ewes
rams
ewe lambs
ram lambs

4. Performance of the monitored sheep:

_) rangeland location and name (data of moving from one rangeland to the other), in winter –dietary pattern (e.g.: grazing + 1 kg of hay or 0.3 kg of barley).

average live weight, kg (_ + m) (4 times a year: lambing, weaning, mating and middle of pregnancy). If the flock contains 80-100 sheep then all sheep are weighed, if more – only 100 sheep.

fatness, mark (M + m) (4 times a year: lambing, weaning, mating and middle of pregnancy)

b) Lambing: dates of the beginning and the end of the period
number of lambed sheep
number of aborted sheep
number of non pregnant sheep
number of the lambs born,
inc. dead-born

c) Weaning: date
number of lambs weaned
average live weight of ram lambs, kg (_+m)
average live weight of ewe lambs, kg (_+ m)

3. Income: a) Salaries of the working family members

b) Marketing of agri products (to focus on: to whom and how the products are sold, i.e. to middlemen or there are some contracts on produce supply, e.g. with the milk plant , for cash or on barter. To learn if animals or animal products are taken to the nearest city markets or they are sold to middlemen).

Livestock products: milk
meat
live animals
wool
pelts
others

4. Costs: taxes and utilities
salaries to workers (if there are any)
fuel
veterinary treatment (purchase of medicine, payment for washing, etc.)
purchase of new animals, spare parts, etc.
purchase of forage (hay, concentrates)
foodstuffs
clothes
other costs

Monitoring of the flocks of 2-3 community members having 10-20 sheep.

To select 2-3 community members for monitoring (together with Akim or his Deputy). Questionnaire is very much the same as for private flock monitoring (Table 3) with some additional information on family members:

- Number of family members (who currently live in this community and in this house); which of them are working and where;
- Number of animals (cows, horses, camels, sheep, goats, pigs, poultry. Sheep are most important. Other animals can help to understand current situation.).
- To place particular emphasis to monitoring of receipts and costs. To be diplomatic while doing this.

Table 4. Household monitoring (to be filled in for each separate family member)

1. Name of the flock owner

2. Sheep breed(s)

3. Total sheep number:
   inc.: ewes
   rams
   ewe lambs
   ram lambs

4. Performance of the monitored sheep:

a) rangeland location and name (dates on moving from one rangeland to the other), in winter – feeding diet (e.g.: grazing + 1 kg of hay or 0.3 kg of barley grain).

average live weight, kg (_ + m) (4 times a year: lambing, weaning, mating and middle of pregnancy). If the flock contains 80-100 sheep then all sheep are weighed, if more – only 100 sheep.

fatness, mark (M + m) (4 times a year: lambing, weaning, mating and in the middle of pregnancy)

b) Lambing: dates of the beginning and the end of the period
number of lambed sheep
number of aborted sheep
number of non pregnant sheep
number of the lambs born,
inc. dead-born

c) Weaning: date
number of lambs weaned
average live weight of ram lambs, kg (_+m)
average live weight of ewe lambs, kg (_+ m)

3. Income: _) Salaries of the working family members
b) Receipts from the marketing of animal products

milk
meat
live animals
wool
pelts
others

4. Costs: taxes and utilities
salaries to herders
fuel
veterinary treatment (purchase of medicine, payment for washing, etc.)
purchase of forage (hay, concentrates)
foodstuffs
clothes
other costs