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SR-CRSP

Annual

Report

1996

SMALL RUMINANT COLLABORATIVE RESEARCH SUPPORT PROGRAM

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Board for International Food and Agricultural Development and Economic Cooperation (BIFADEC)
Joint Committee on Research and Development (JCORD)

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Indonesia -- Agency for International Research and Development (AARD)
Kenya -- Kenya Agricultural Research Institute (KARI)



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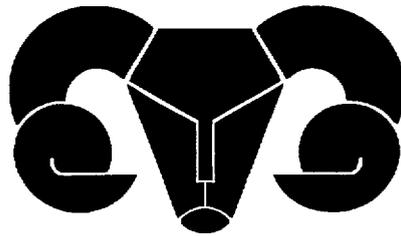
SMALL RUMINANT CRSP ANNUAL REPORT 1996

EDITED AND DESIGNED BY SUSAN L. JOHNSON
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COVER PHOTO : BRANCH MANAGER FOR COMMERCIAL BANK OF ETHIOPIA SPEAKS TO THE GUMI GAYU ASSEMBLY OF 3,000 PASTORAL BORANA LEADERS IN SOUTHERN ETHIOPIA. HE IS EXPLAINING PROCEDURES FOR BANKING AS A MEANS TO STORE WEALTH IN ADDITION TO CATTLE. THE GUMI GAYU MEETING HAS BEEN HELD ONCE EVERY 8 YEARS SINCE THE 1600S. A BORAN TRANSLATOR (STANDING NEXT TO THE BRANCH MANAGER) IS TRANSLATING HIS REMARKS TO THE CROWD. PHOTO COURTESY OF LAYNE COPPOCK.

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TABLE OF CONTENTS



| | |
|-----------------------|-----------|
| FOREWORD | 1 - XV |
| PROJECTS IN KENYA | 1 - 59 |
| PROJECTS IN INDONESIA | 63 - 94 |
| SMALL GRANTS PROGRAM | 97 - 142 |
| WORKSHOPS | 145 - 206 |
| PROJECT EXPENDITURES | 209 - 215 |
| GLOSSARY | 217 - 222 |

PREFACE

Each year, the Small Ruminant Collaborative Research Support Program (SR-CRSP) publishes an annual report in compliance with grant requirements. This annual report covers research performed during the calendar year, January 1, 1996 through December 31, 1996. The principal investigators for each project submit reports on research conducted with SR-CRSP funding. Each report is the expression of the principal investigator with grammatical and format editing by the Management Entity. All individual reports give the name, address, telephone, fax number and email address of the principal investigator for that project. Inquiries are welcome.

This year's annual report also includes a section on research conducted under the Small Grants Program and summaries of major workshops held in 1996. The workshop in Indonesia concludes a successful program in the country and a summation of the research and experiences of the scientists. The workshops in East Africa, Central Asia and Latin America were the first step in a new direction for the Small Ruminant/Livestock CRSP and a process that emphasizes bottom-up, customer input, team building and planning.

I would like to take this opportunity to express my gratitude and acknowledge the support of Janette Reyes, Alie Guico, Araceli Cortez, Tara Foster and Katherine Lui. This past year we have relied very heavily on the hardwork and dedication of our student assistants. Each has contributed in their own way to the production of this publication and this year's accomplishments.

Susan L. Johnson
Annual Report Coordinator

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FOREWORD

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INTRODUCTION

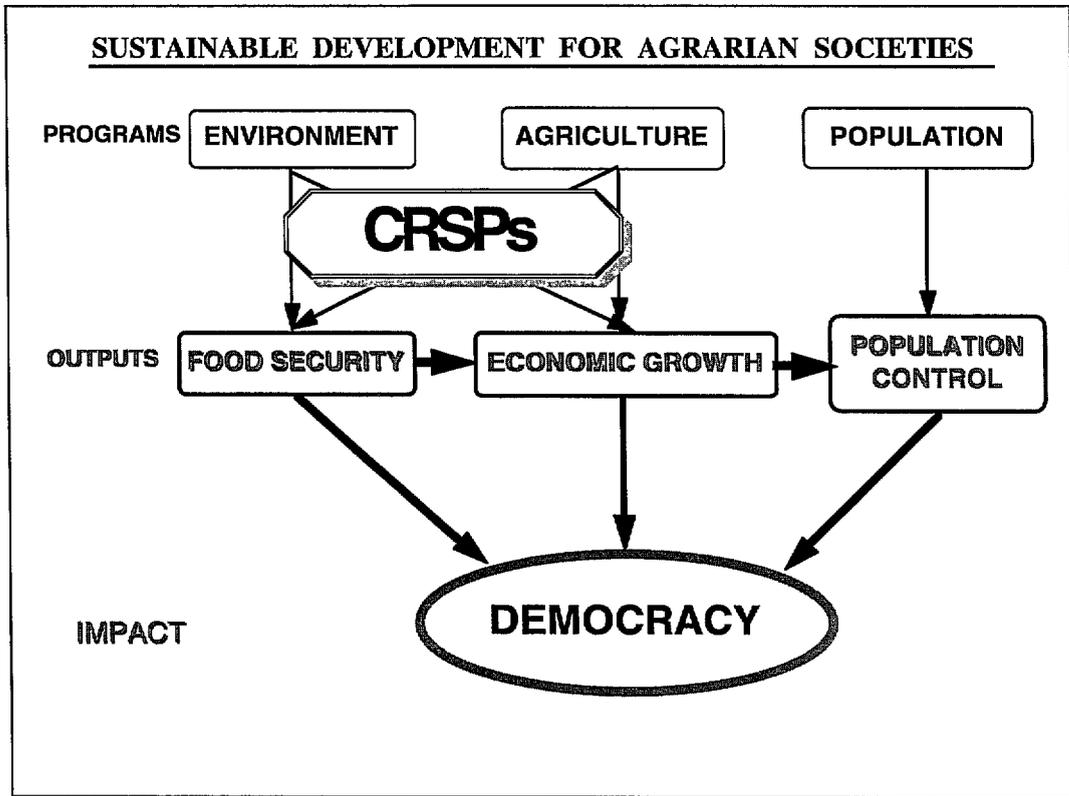
This year has been one of change. In 1995 Dr. John Lewis, the Director of the Office of Agriculture and Food Security at USAID, asked the SR-CRSP to reengineer our programs and its structure to respond to USAID's new vision. We initiated the process at Winrock in May of 1995. We convened some of the best people in the field of livestock development from US Universities, the CG system, NARS and the private sector to develop a plan for the renewal of the SR-CRSP. At that meeting we decided to take some new directions and those new directions required a broader focus on more than just small ruminants, hence the SR-CRSP will become the Global Livestock CRSP in 1998.

The reengineering proceeded at a rapid pace through the year, involving Advisory Panel meetings to set broad agendas and approve process, three regional workshops that set regional priorities, a call for Assessment Team (AT) proposals, the selection of ten ATs and one continuing team, an AT workshop at University of California, Davis and the initiation of AT field work. The details of the process I describe below, but the impact is that our CRSP

is now active in Central Asia, East Africa and Latin American with sixteen US universities, six foreign universities, ten foreign research institutes, five IARCs, five NGOs, two NARS, six private sector companies, three other CRSPs and the USDA. We are taking on livestock to address economic growth, impact on the environment and the role of animal products in the development of children.

With growing concern about the environment and population, the importance of agriculture to the developing countries increases. This view is reflected in Figure 1. The assumption of this conceptual model is that for democracy to develop and be maintained, three elements must be in place. First, economic growth must provide the majority of people with the aspiration of reward for work and the security that the future is worth the work. Second, the environment and agriculture must be productive and sustainable to insure that food is available and nutritious enough for children to develop into productive adults. Third, when economic growth and food security are in place, people reduce their reproductive rates and do so faster when population control mechanisms are

Figure 1:



available to them. Economic growth, food security and reduced population growth combine to form a context for democracy.

The Collaborative Research Support Programs (CRSP) are strategically focused to address the issues of economic growth, food security and environment. The central role of agriculture in food production, the economic growth of most developing countries and the impact of production practices on the environment, place the CRSPs in a key position to have a major development impact. With a shrinking USAID portfolio in agriculture in the 1990s, the CRSPs have become a major component of the Agency's activity in agricultural research in developing countries and the major linkage between USAID and the US Land Grant University System. However, they now

operate on budgets that in real terms are 40% of their original allocation 10 years ago.

TITLE XII

The CRSPs were created under the International Development and Food Assistance Act of 1975. The intent of the act was to use the resources in the US Land Grant University system to improve the US Government's efforts to bring food security to the developing countries of the world. The US Land Grant system has a proven capability to transfer the benefits of basic science to application and in doing so has been a major reason for the remarkable capabilities of US agriculture. The US Land Grant system has great scientific depth and diversity. For example, there are more soil scientists at UC Davis than in the entire CG system. The US Land Grants are deep in disciplinary expertise

that not only spans the traditional agricultural sciences but also includes the social sciences, the environmental sciences, ecology, demography and human health and nutrition.

The other intent of the legislation was to have a domestic impact. By engaging US Universities in the Title XII Act the federal government was influencing the focus of university activities. The Act built an international capability that developed connections to train and focus US scientists in international issues, open new markets overseas, provide genetic material and new more global scientific insights. In a more diffuse but equally important way, the program would help develop countries that would share a common ideal of free markets, democracies, and global responsibilities. These shared values would reduce the requirements for US foreign interventions and allow all to reap the benefits of a safer global society.

GENERIC STRUCTURE AND ORGANIZATION OF THE CRSP

Advantages to the CRSP model

The CRSPs have developed two images in their 19 years of existence. The first, perhaps the more wide spread image, is that of entitlement programs. The development community, familiar with the politics that have supported the CRSPs sees them as an instrument of

Congress that binds the Agency to US Land Grant Universities. This view is partially correct in fact but not in spirit. There is indeed a benefit to US Universities from this linkage but hardly without some logic about either the magnitude of the problem being addressed and the capability of the institutions enlisted. Much of what is done by the government has political roots, be it in environment, population or agriculture. In the truest sense, politics

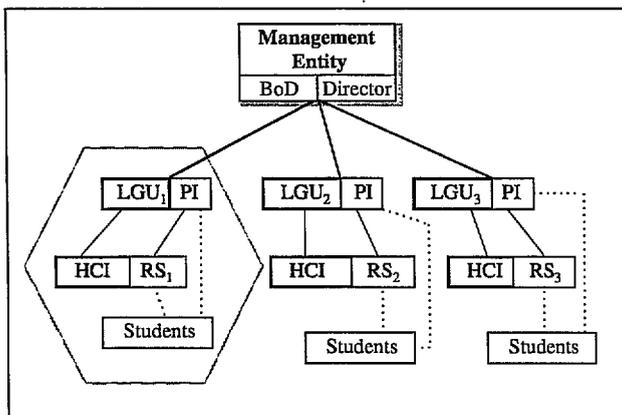
Title XII: Famine Prevention and Freedom from Hunger

"...in order to prevent famine and establish freedom from hunger the U.S. should strengthen the capacities of U.S. land grant...universities to improve their participation in the U.S. government's international efforts to apply more effective agricultural sciences to the goal of increasing world food production and...support the application of science to solving food and nutritional problems of developing countries."

should reflect the collective will of the people expressed through the legislative process. That said, programs also need mechanisms for change and renewal.

The second image is less well known and appreciated. This image is the one of a creative set of time tested structures that have evolved among the CRSPs to optimize the collaborative process between universities and NARs. This research/development model (Fig. 2) links US universities through Principal Investigators (PIs), NARs and their resident scientists (RSs). The programs have research problems as their focus and traditional activities of development such as training, institution building, and technology development all flow naturally from the research theme.

Figure 2:



personal, fostering close relationships between US scientists and host countries that persist and enhance the careers of both parties; and responsive, making connections between the varied research requirements for development, host country scientists and appropriate disciplinary scientists in US universities.

The CRSP model is cost effective. Because of the PI/RS linkage there is little need to base expatriates overseas. The cost to maintain expatriates and their families is a major expense in overseas development programs. The CRSP legislation also incorporates a requirement for the US Universities to match 25% of the USAID contribution to the grant. Furthermore, all the CRSPs have been very successful in attracting additional funds from host countries and other funding agencies. On average the CRSPs have added \$.74 for each dollar contributed by USAID and the SR-CRSP has led all other CRSPs by more than matching USAID's contribution over the life of the CRSP. This level of outside matching contribution is unprecedented in USAID programs.

As mentioned above, the developing countries have access to the world's most powerful agricultural research institutions through the CRSPs. The quality and extent of this contact is dependent on the quantity of funding available and the effectiveness of the development mechanisms that make the connections. The CRSP mechanism is flexible, allowing constant adaptation of missions and objectives to changing research and development needs;

The CRSP model has an innovative training role. First, it has internationalized US Land Grant institutions by providing overseas research opportunities for US students. In a culture as powerful and pervasive as America's, it is easy to spend one's entire scientific life within its boundaries and have a complete and fulfilling career. If we are to be active in global problems,

In real dollars the SR-CRSP operating budget is 25% of what it was 10 years ago.

solutions and markets we must have scientific participation overseas. CRSPs use what might be termed a "Peace Corps" model. US students establish a research project in the host country in the context of the program's research agenda. They must function within the country in the same way host country scientists operate. In the process they learn to conduct research in an international setting, respond to cross cultural differences and solve problems of both science and society simultaneously. In the end they are scientists ready to conduct research in

other cultures, inclined to have an international perspective as teachers and educators and usually remain active collaborators on the international scene.

Second, the CRSP is a very effective training mechanism for foreign students. Most foreign students in other programs received their graduate training wholly in the US. The contacts that a graduate student makes during their graduate student tenure are some of the most important in their careers. They establish scientific networks with other researchers in their field that serve to enhance the quality of their science. Then, upon completion they are required to return to their home countries where they have few if any professional contacts. This situation places them in a major disadvantage in their community of scientists. The CRSP model allows a certain amount of course training to occur in the US, but, because the program has a research project in the host country, the students spend most of their graduate education completing their degree research in their own country. They develop and maintain the contacts with their compatriots and this network is an attractive and supportive framework to which they return at the end of their training. For this reason, CRSP programs have very high rates of return of foreign students.

The long-term nature of the CRSP programs has built strong bridges between the cooperating institutions and their scientists. Within this culture, students and young scientists benefit from the trust that has built up over time and this atmosphere allows US scientists to continue to assist and support young

host country scientists as they advance through the early years of their careers.

CURRENT ENVIRONMENT

The current development environment is characterized by shrinking funding, and shifting focus and influence from the sustainable agriculture movement. The last 10 years have seen the agricultural research budget of the agency decline from about \$225M in 1985 to about \$50M presently. The funding for CRSPs have remained at about \$15-17M but the number of CRSPs has increased. In real dollars the SR-CRSP operating budget is 25% of what it was 10 years ago. While these numbers are bleak and reflect a major programmatic shift to de-emphasize agriculture within the Agency, the Administrator has made recent statements that this trend will be reversed. The reconstitution of BIFAD, with its advisory role, has assisted greatly as a voice for agriculture at USAID. I see considerable other activity in Washington to increase funding for international agriculture and a greater understanding of the importance of this sector to our own national interests.

The Clinton administration's vision for a development agenda included a strong emphasis on population control and environment. These areas have received increased funding in USAID in the last four years. Unfortunately, while conceptually linked to agriculture, they are administratively separated. This separation means that some of the most important topics in environmental sciences and agriculture, which lie at the intersection of these fields, have institutional barriers that prevent creative approaches.

The maturing issues of sustainable agriculture have had a major impact on the field of international development. The sustainable agriculture movement has a strong base in grass roots farmer organization and, as such, has

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championed the view that the end customer should have a major role in setting agendas. This concept is fundamental to USAID reengineering.

Two issues were the central themes of the sustainable agriculture movement: long-term performance of systems and environmental impact. The word sustainability indicates a concern with time. Clearly one of the most important issues in agriculture is the long-term performance of agricultural systems, how we measure it and predict it. The importance of this topic for development is the introduction of the long-term concept of performance into the development context. The other issue is the elevation of the importance of environmental impact. Many of the impacts are slow, almost unnoticed, degradation in the environment that have insidious consequences for the food production system and the natural resource base. Because many of these processes occur slowly and are chronic, the joining of environmental issues and a long-term timeframe is a critical conceptual link for international

agricultural development and the environmental sciences.

By raising these topics, sustainable agriculture has had other impacts on our field. The problems of environment, agricultural systems and long-term performance are all aggregated problems. They are large in time and space and therefore require interdisciplinary teams with the capacity to integrate lower level process to understand system function. Interestingly, the CRSPs have used this model for close to 20 years.

CHARACTERISTICS OF THE NEW CRSP

A series of meetings and discussions, initiated at Winrock International in May 1995, produced an agenda of change for the SR-CRSP. The new characteristics were developed in response to identified weaknesses in the present CRSP program, to new visions for the operations of federal programs (Vice President Al Gore's National Performance Review), and to the reengineering effort at USAID. A number of issues were raised in this discussion and they were distilled into the following major characteristics:

Reduce Transaction Costs. The amount of reporting and governing bureaucracy in the CRSP were viewed by most researchers and administrators as excessive to the point where the very best scientists were not interested in participating. The mandate was to streamline operations.

Diversify Granting Mechanisms. The SR-CRSP, partly because of the nature

of the program's research agenda, has used about all of its funds in major grants to lead universities. These grants and the governing structure were important in maintaining continuity but were not as responsive or open as necessary to meet new needs and recruit new scientists. Because of the nature of the CRSP research, which has involved long-term breeding projects, the grant renewal process (every five years) has not been an opportunity for major changes in direction. Now that the agenda has changed, the Winrock meeting produced a consensus that new mechanisms should be incorporated that would allow more open access to CRSP funds, provide the ability to respond rapidly to changing development issues and expand opportunities to attract young faculty into the international arena.

Effective Assessment and Problem Resolution. The reengineering approach places considerable emphasis on team building and results orientation. The initial results of the Agency's experience in reengineering is that, although planning and team building require considerable time and resources, the outcome is quite positive. The CRSP planning process was designed to devote considerably more effort to the assessment and team building stages. Moreover, a problem/results orientation was developed from the onset.

Diversify Partnerships. The clear lesson, learned from a survey of past collaborations across all CRSPs, is that collaborations that succeed are those where the partners participate in the early stages of the collaborative process. The assessment process provides an excellent

entry point for the collaboration, as well as an efficient mechanism by which partners in collaboration are identified based on the problem instead of the collaboration defining the problem. The assessment phase allows sufficient time for partnerships to be developed in the region with IARCs, NARs, NGOs and farmer organizations.

Regionalization. With the number of countries having USAID missions declining, USAID has taken a regional approach to development. Regionalization is an effective tactic as countries open markets and borders, develop regional associations in research, trade and politics, and have similar problems of environment, pastoral people, animal disease, human nutrition and policy. The regional approach was adopted also to encourage broad views of research application, a

...collaborations that succeed are those where the partners participate in the early stages of the collaborative process.

diversity of institutional contacts and a compatible match with USAID organization structure in the field.

Customer Oriented. A major emphasis of the reengineering effort has been to provide more grass roots input into the identification of research/development problems. In our planning process we attempted to have input at all levels, but gave considerable resources to middle level and grass roots. By combining regional conferences and a considerable

assessment phase, input into the problems models, team formation and implementation of the project has been achieved.

THE MAJOR RESEARCH AREAS

The meeting at Winrock and the Advisory Panel Meeting in Washington DC in October 1995 provided the input into the choice of research issues. The issues identified were economic growth, environmental impact and human nutrition. An overriding theme of inquiry, in addition to those of biology and social sciences, was to be a policy focus.

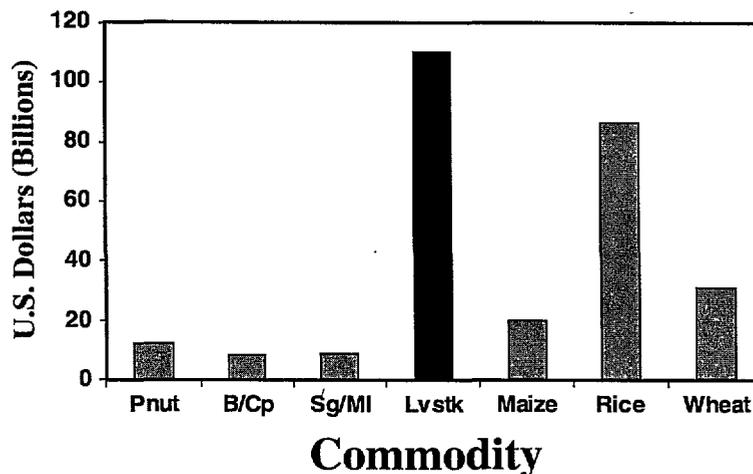
In terms of economic growth, livestock is the single largest component of agricultural GDP (Fig. 3). In most of the developing countries, agriculture is the largest single sector of the economy, usually accounting for 30-70% of all revenues. Of that, livestock represents from 30-50% of agricultural GDP. Clearly if economic growth is to proceed

in these agrarian based economies, even if they are to become more industrial based, agriculture must be more productive and profitable. The impact of improved economic growth from the agricultural sector has benefits beyond just profits. The security of that growth and the increases in human nutrition affect the ability of these societies to develop human capital.

Livestock is the single greatest anthropogenic use of the land (Fig. 4). While there is considerable debate about the positive and negative impacts of grazing animals, there is no question that they change the landscape and in doing so are major factors in the functioning of many of the ecosystems of the world. In Africa, for example, the competition between land for grazing and food production, on the one hand, and conservation of biodiversity and the economic importance of tourism, on the other, sit in juxtaposition in many countries. This complex relationship requires approaches that cross the

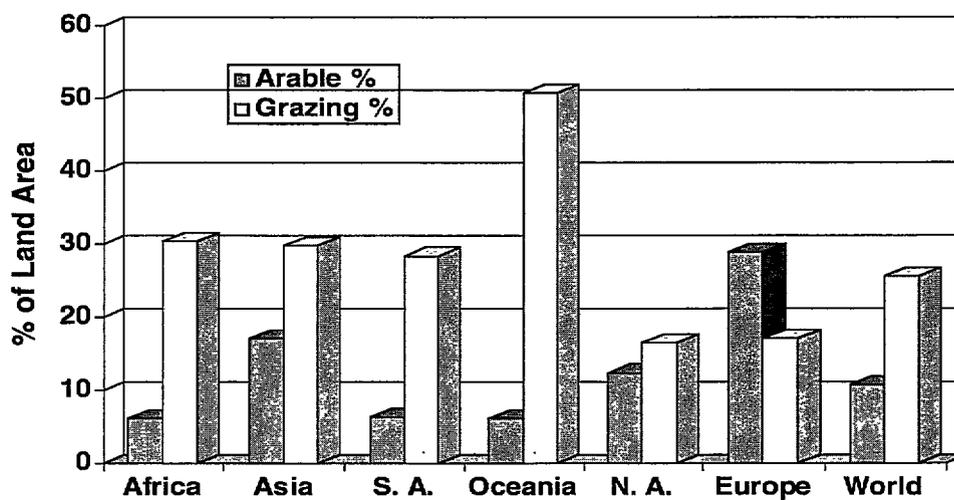
Figure 3: Source, CGIAR 1992

Global Production Values of Major Commodities in LDC's



Comparison of land use -1992

Figure 4: Source, *FAO Production Yearbook, Vol. 47*



traditionally strong boundaries that separate livestock and wildlife administrative and research entities.

Perhaps one of the most important and positive issues in the livestock research and development agenda is the role of animal products in child development. Animal products have a critical role to play in providing the micronutrients required by children for normal cognitive and physical development (the key points in this argument are summarized in Fig. 5). The critical point is that as many as 50% of the children in sub-Saharan Africa may suffer from these deficiencies and this malnutrition has an insidious impact because it lowers the overall creative capacity of the population to develop, compete and live normal

lives. In essence it takes away their ability to develop themselves. Animal products appear to be a very effective mechanism to introduce critical micronutrients into the diet, and do it in a sustainable and profitable way.

In the past, livestock development research, while not ignoring policy, strongly emphasized the biological and physical environment. Several authors, including Dr. Kevin Cleaver of the World Bank, have argued that the policy environment is at least as important, if

Livestock, Nutrients & Child Development

- ◆ Shortages in calories and protein are not as serious a problem as has been assumed.
- ◆ Shortage of suite of micro-nutrients implicated in growth stunting and irreversible problems in cognition, behavioral and physical development.
- ◆ Animal products in diet are only dietary variable that predicted child development.
- ◆ Cereal diets are associated with micro-nutrient deficiencies, especially Fe.
- ◆ Children 6 - 24 months cannot meet nutritional requirements for normal development without supplementation or fortification when animal products are not in diet (WHO).

Figure 5: Source, *Nutrition CRSP*

not more, than the others because the implementation and adoption of technological knowledge requires an enabling policy/economic environment. For this reason, where appropriate for the problem chosen, policy study will be a component of the research agenda.

SHIFTING THE FOCUS TO LIVESTOCK

Why shift the focus from small ruminants to livestock? The broad topics chosen by the Advisory Panel represent a subtle, but important response to the changing development agenda of the Agency. The Administrators emphasis on economic growth, environment and human populations and their health is strongly reflected in the Advisory Panels selection of topics for the CRSP. The characteristics of these topics are that they are broad, taking in large scales of time and space, and highly aggregated, combining many lower level processes and disciplines. Because of these characteristics, the problems can not be considered solely from the study of small ruminants. Issues of environment, human nutrition, economic growth and policy cut across species making the appropriate research focus animal agriculture.

The CRSP, like many programs and agendas, within USAID is conducted at the will of the Congress. Support, direction and funding flow from Congress dependent on the perceived value of the program. Recently Congress has shifted from supporting programs for purely humanitarian reasons to those where foreign assistance has an important domestic impact. Because small ruminants are relatively unimportant in our national economy

relative to other species of livestock, the CRSP is placed at a major disadvantage in this regard if it is to be judged on its domestic impact. Clearly related to this issue is the fact that the SR-CRSP was developed in the late 1970s when cattle research was strongly supported by donors. The design of the SR-CRSP was a clear attempt to differentiate the program and address other needs outside cattle research. During the 1980s cattle research support declined precipitously (and with it research activity) but is presently on the rebound, presenting an opportunity to expand into areas presently not addressed in this major livestock species.

Perhaps there is no more compelling a reason for the more general portfolio than the link between animal products and human nutrition. In development circles the emphasis of research and intervention has been through supplemental pills or plant breeding for enhanced nutrient composition. Animal products are likely to provide a very effective, efficient and sustainable way to supply some of the most important and limiting micronutrients. Yet, which animals and which products, in which situations (economically feasible, environmental producable, socially acceptable) is a research question. Small ruminants will likely supply part, but not all, of the answer.

DESIGN OF THE GLOBAL LIVESTOCK CRSP

Customer Orientation

The first step in involving the customer is to identify the customers. In the CRSP we have three sets of customers:

programmatic level customers, the first is the Agency itself, Congress and the domestic livestock industry; the next level are the national research institutes in the developing countries, the NARs, governmental agencies, and national universities; third are the users of the research products in the field, the farmers, households, and consumers. We planned the modification of the CRSP to have input at all three levels.

First, the Winrock and the Advisory Panel Meetings provided a forum for level one input. In this forum wide ranging discussions occurred and consensus was reached on the broad agenda that would satisfy interests of USAID, Congress, and the domestic private sector, and the University research community. This top down approach represents a planning exercise common to many CRSPs.

Second, the level one agenda served to direct the three workshops that were held in regions (Figure 6) identified as critical for CRSP participation and to allow level two participation. These workshops held in early 1996 were conducted with a

regional organization as a cosponsor and regional representatives of the countries to provide a prioritized list of problems for the CRSP to address. The four day meetings developed problem models, which were analogous in form to a research model, providing a working hypothesis, a conceptual model of the processes influencing the problem, a set of activities that would be engaged in to solve the problem and a list of the institutions and individuals active in this problem in the region. In general, ten or so of these problem models were developed and they formed the basis for RFAs for Assessment Teams.

The third level of input is being addressed through the assessment process. Once the assessment teams were chosen (ten new plus one from continuing activity), they received a budget and about nine months to work closely with their regional partners to redefine the problem model, identify new team members and provide mechanisms for grass root input. This process allows considerable activity in the region to fully explore possible linkages and garner a diversity of inputs

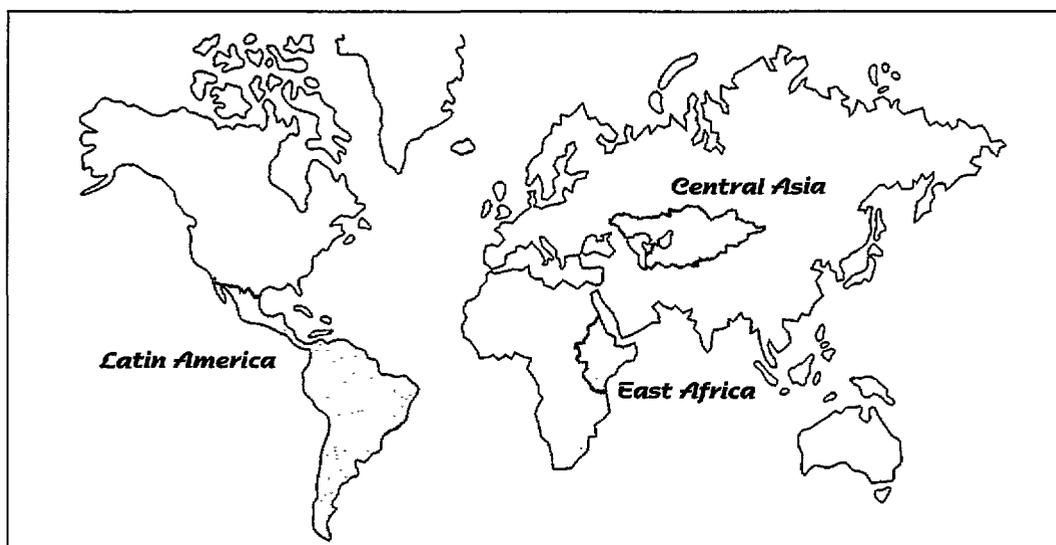


Figure 6: In 1996, the SR-CRSP sponsored workshops in Central Asia, East Africa and Latin America.

from which to design the project before submission for the final competition in 1997.

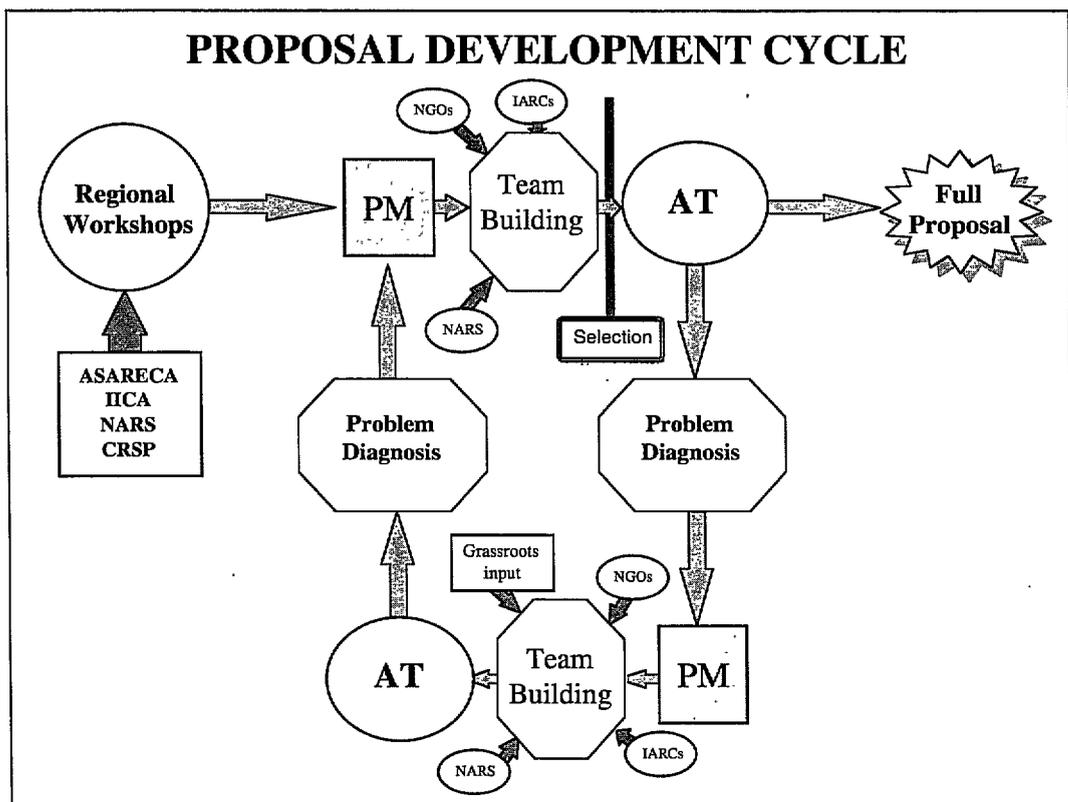
Reduce Transaction Costs

The Management Entity (ME) is working closely with administrators at USAID to reduce the reporting load on the project scientists. The present reporting requirements for USAID are far greater than for other federal funding agencies, such as NSF (National Science Foundation) or USDA (US Department of Agriculture). Since we compete for many of the same scientists it is critical that Agency funding not be disadvantaged. Furthermore, the recent unpredictability of funding, above and beyond the macro-funding problems, have given USAID, in general, and the CRSP programs, in particular, a image

of a risky place to invest scientific capital.

In an attempt to reduce management costs and remove conflicts of interest, the functions of the Board of Directors and the Technical Advisory Committee have been amalgamated in the responsibilities of the Advisory Panel. This panel draws from all sectors of the development community (World Bank, IARCs, US Universities, NGOs, Private Sector, USAID) and provides a broad perspective about the development field while removing the inherent conflicting interests of the member institutions. The Panel will provide technical advice, as well as an organizational structure of the PIs and Resident Scientists that will be formed when the composition of the CRSP members is determined in the final proposal selection.

Figure 7



Diversify Granting Mechanisms

In the past, the SR-CRSP has been characterized by relatively stable research components that have been funded for long periods. This stability has been a very valuable characteristic for the small ruminant research that required considerable time for completion such as the breeding programs in Kenya and Indonesia. However with a refocusing of the program to topics with shorter time horizons, the CRSP needs to develop mechanisms that provide both continuity for long-term research and also the opportunity for attracting new participants. To achieve this goal, sub-contracts will be restructured to make the relationship between the ME and US Land Grant Institution dependent on the participation of the original PI. Grants will run for 3 years and be renewed in an open competition.

A small grants program will be instituted that will be used to respond to new issues that develop within the framework of the grant that requires scientists of new expertise and focus. These grants would also be used to attract young scientists into international work and allow the CRSP to identify capable faculty that show an aptitude for international science.

Effective Assessment and Problem Identification

The commitment of resources and time in the problem identification and assessment process is unprecedented in the CRSP. From the Advisory Panel to the regional workshops to the assessment team regional conferences, there is a

demonstrated attempt to have quality input from all our customers. The problem models are the central component of the process. With research areas broadly defined by the Advisory Panel, the problem models were developed by the regional workshop participants and then modified and refined in the assessment phase (Fig. 7). The problem model development was designed to be an iterative process with team building. The initial model served as the basis for the RFAs to which potential US Universities responded. The leadership role for the universities was to develop an AT that fit the problem model and present a plan for assessment to the CRSP in competition with other ATs. The ATs then had selected the resources to begin an in-depth analysis of the model and the regional situation. As they conducted this analysis with particular emphasis on regional grass roots input (usually through a series of regional workshops and meetings) they would likely modify the model. With changes in the model, additions and subtractions to the AT would occur and these new points of view would require adjustments to the model. Because the iterative process was initiated by identifying the problem, projects would develop that likely have a problem oriented focus.

Diversify Partnerships

The assessment process and the regional workshops were specifically designed to allow collaborators to be identified early in the planing process to achieve real and effective collaborations. The regional workshops were a first step since they were a means of informing the regional players of the CRSP's program. The

assessment phase served to further diversify collaborations with the involvement of more institutions than ever before. However the goal is not diversity for diversity's sake. The problem model and team building principles encourage the formation of meaningful collaborations. Every attempt will be made to identify and reward those ATs that successfully achieve that goal.

Regionalization

The workshops accomplished several goals related to regionalization. First, they demonstrated that the CRSP was and would be actively involved in the region. Given the recent funding history, it was important for the CRSP to be seen as an active player and a program with a viable future. Second, in Central Asia the workshop educated the participants about the CRSP and strengthened their contact with the US. Third, the workshops provided a strong message that the CRSP program would involve regional and grass roots participants. In both East Africa and Latin American where the CRSP has been active in a single country over a long period, the workshops signified the change to a regional program with projects that would be active in several countries. Workshop participants also recognized that the regional approach would be a flexible and dynamic one that would allow country focus to change as necessary with the maturity of the individual projects.

The assessment process also was a catalyst for regionalization. It provided the time required to make multiple alliances with institutions and

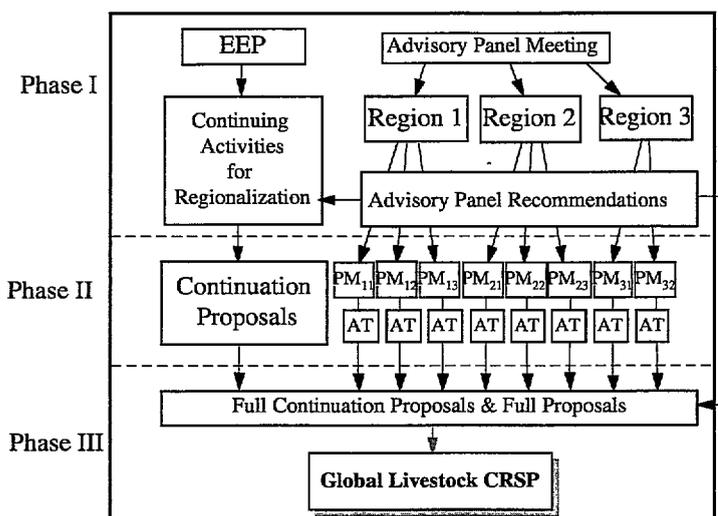
researchers within the region. The regionalization model is conceptually simple but operationally complex. Time is a critical resource to develop each linkage and ensure that all collaborations fit with the problem model. The benefits are that ATs have a greater pool of institutions from which to choose and therefore a greater ability to select those with the greatest comparative advantage. For the region this approach has the obvious benefit of making linkages between regional centers of excellence, allowing regional connections to drive a strategy for effective institution building and strengthen the newly formed regional organizational endeavors.

GRANT RENEWAL PROCESS

The SR-CRSP will be applying to USAID for a renewal of the overall grant for the CRSP to occur in 1998. The proposal that will be submitted will represent the culmination of the assessment process, selection of full proposals and the writing of a new proposal to USAID based on the full proposals selected. The process is presented in Figure 8. There are two mechanisms by which projects can be funded in the renewal. The first is the assessment process, described above, that has gone through the priority setting at the regional workshops, selection of assessment teams and selection of the full proposal. The second is the continuation of ongoing work, redesigned to fit the criteria of the Global Livestock CRSP.

The first process has been described in detail above. The second avenue to funding was initiated with the report of

Figure 8: Grant Renewal Process



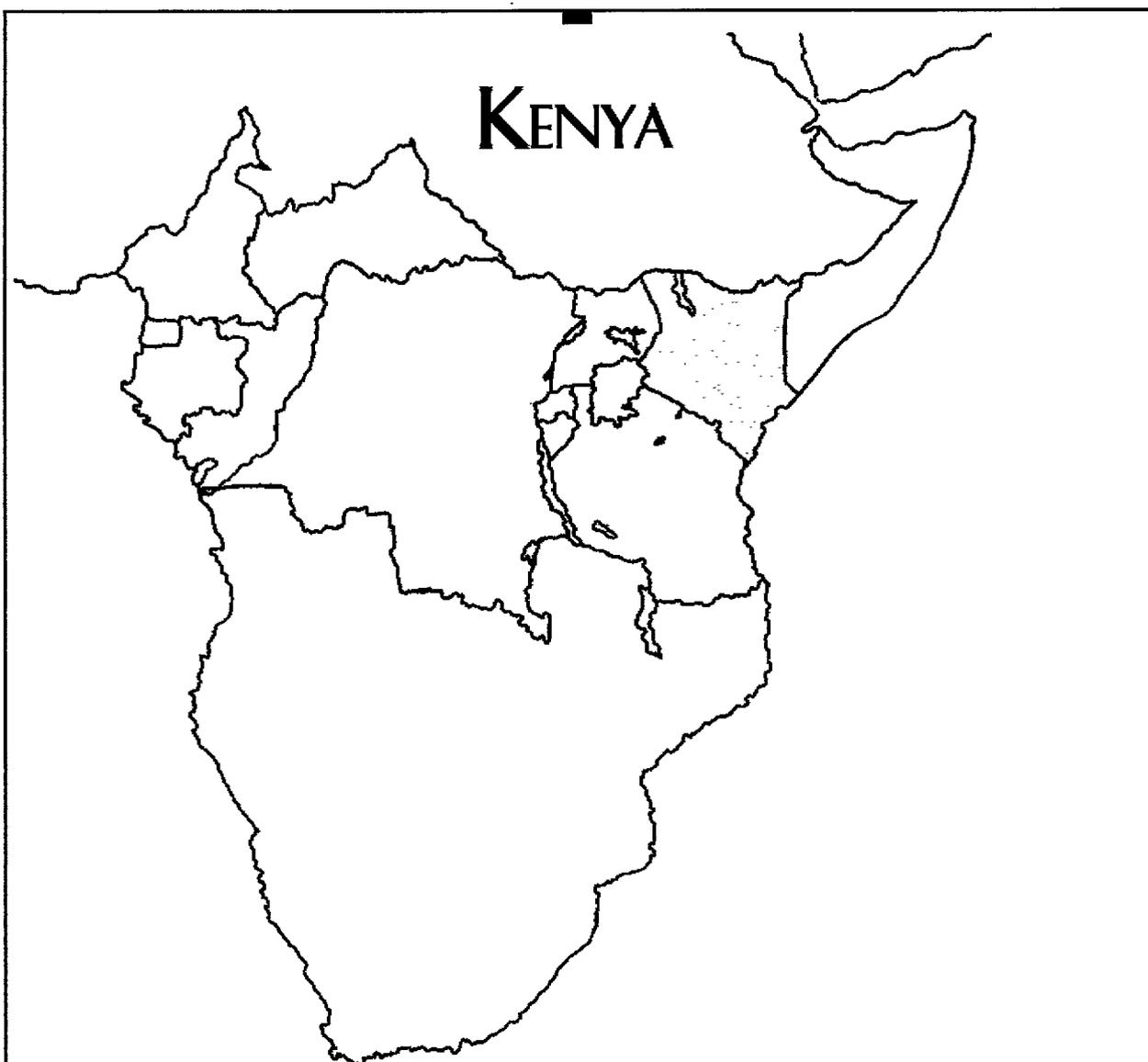
the External Evaluation Panel on continuing activities. The Kenya project was recommended for consideration. The project, focused around the CRSP/KARI breed of goat (Kenya Dual Purpose Goat), has formed an AT and received funding for those activities. They will be submitting a full proposal for the regionalization of their activities, previously focused in Kenya, and in line with the criteria for full proposals. The continuation proposal and the other AT proposals will form the pool from which the projects for the renewed CRSP will be formed.

CONCLUSIONS

This year's reengineering efforts have been a stimulating and demanding experience for the CRSP team, but an essential one if the intent of Title XII is to be translated into action in the next century. We must recognize that the spirit of the Title XII legislation was a noble one; to use our best resources in agriculture to help those less fortunate in the world. Lofty goals and aspirations are often easy targets in a modern world of downsizing, "enlightened self-

interest" and "trade not aid". What really gives value to what we do in the world of international development is a process that makes all people healthier, more creative, more productive and more self sufficient. Agriculture, as the food it produces and the land it uses, is the foundation of this process.

The reengineering of our CRSP has responded to a wide range of suggestions to make our work more effective and efficient; to make our impact greater and in the end address the fundamental problems of development. We hear recognition of the key problems of development residing in the root causes of chronic poverty, strife and famine but unfortunately often the lack of political will and leadership to attack those issues requiring long-term attention. One of Title XII's great contributions has been its commitment to fund programs that attack these long-term problems. It is unfortunate in the extreme that this congressional wisdom is often viewed as political pork barrel when in fact it remains one of USAID's most effective and cost efficient programs.



| | |
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| BREEDING A GENETICALLY IMPROVED DUAL PURPOSE GOAT ADAPTED FOR PRODUCTION IN KENYA | 1 |
| DUAL PURPOSE GOAT PRODUCTION SYSTEMS FOR SMALLHOLDER AGRICULTURISTS IN KENYA | 14 |
| KENYA DUAL PURPOSE GOAT: SOCIOLOGICAL ANALYSIS OF SMALL RUMINANT PRODUCTION SYSTEMS | 20 |
| MULTI-VALENT VIRUS-VECTORED VACCINE FOR GOATS AND SHEEP | 39 |
| SOCIOLOGICAL ANALYSIS OF SMALL RUMINANT PRODUCTION SYSTEMS: KENYA MULTIVALENT VACCINE | 50 |

BREEDING A GENETICALLY IMPROVED DUAL PURPOSE GOAT ADAPTED FOR PRODUCTION IN KENYA

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NARRATIVE SUMMARY

In the phase-out period of the Kenya Dual Purpose Goat (KDPG) Breeding project in Kenya, work at Ol'Magogo focused on the production of advanced generations of KDPG with selection for growth, milk production and resistance to *Haemonchus contortus*. The flock is downsizing through the culling of F₁ animals and the distribution of KDPGs to collaborating multipliers. The flock at Ol'Magogo will provide an elite nucleus flock for the provision of elite bucks to the registered sector. Flock development has also focused on the development of feed resources with the objective of achieving economic self-sufficiency.

The multiplication and distribution phase of the KDPG project is underway with the cooperation of NGOs and private breeders. The KDPG is registered as a breed and our philosophy is that NGOs and private breeders will possess a vested interest in the multiplication of the KDPG. The SR-CRSP, KARI and MALDM are providing technical backstopping to the management of programs at each collaborating site to ensure that animal losses are minimized and that critical data are collected to allow the evaluation of impact and adaptation of the breed. Twenty-five

does and three bucks were distributed to Kirathe Limited, a livestock oriented operation located at Rongai, Nakuru district in the Great Rift Valley. A total of 40 does and 17 bucks were transferred to Kilifi Plantations Limited located in Kilifi District. The plantation has about 500 goats, 2,500 head of cattle, a modern milk processing plant and has been a source of breeding stock for the whole of the Coast Province. The 17 KDPG bucks purchased by Kilifi Plantations are intended for an upgrading program. The on-farm impact assessment research concentrated on monitoring the adaptability of the breed under various environment conditions, e.g., dryland vs. coastal humid as compared to Ol'Magogo. Although initial problems were experienced with high mortality rates, the survivability of the KDPG progeny is now at an acceptable level. A total of 111 KDPG goats now exist with farmers at Katumani and the coast sites.

One hundred and forty weaner KDPG were selected after screening for endoparasites and each was infected artificially with 10,000 *Haemonchus contortus* larvae. Routine sampling during both the prepatent postpatent periods of infection was undertaken and

infection was terminated after six weeks using Ivermectin. Thirty-five weaners were subsequently challenged after maintaining a EPG of below 1,000 and a PCV of at least 20%. Only six of these kids maintained an EPG of less than 1,000 and were classified as resistant. Twenty animals at Ol'Magogo are resistant to internal worms. Four bucks from this group are being used for breeding resistance into the KDPG. The anthelmintic efficacy of benzimidazoles (BZs), levamisole (LEV), rafoxanide (RAF) and Ivermectin (IVM) was evaluated at Ol'Magogo using the fecal egg count reduction test, larval cultures and a controlled slaughter trial. Results indicated simultaneous resistance of *Haemonchus contortus* against BZs, LEV and RAF and *Trichostrongylus columbriformis* and *Oesophagostomum* sp. against LEV. Injectable and orally administered Ivermectin was effective against the BZ and LEV resistant *H. contortus*.

RESEARCH

Activity: *Multiplication and stabilization of the KDPG nucleus flock at Ol'Magogo.*

Problem Statement and Approach: In the phase-out period of the KDPG Breeding project in Kenya, work at the Ol'Magogo estate has focused on the production of advanced generations of KDPG with selection for growth, milk

Table 1:
Distribution of
genotypes at
Ol'Magogo.

| | November 1996 | | |
|-------|---------------|-----|------|
| | EA/Galla | F1 | KDPG |
| Does | 0 | 140 | 465 |
| Bucks | 0 | 7 | 345 |
| Total | 0 | 147 | 810 |

production and resistance to the gastrointestinal tract parasite *Haemonchus contortus*. The flock is downsizing through the culling of F1 animals and the distribution of KDPGs to collaborating multipliers. The flock at Ol'Magogo will ultimately provide an elite nucleus flock for the provision of elite bucks to the registered sector. Flock development has also focused on the development of feed resources at Ol'Magogo with the objective of achieving economic self-sufficiency.

Progress: Table 1 gives the current inventory of the animals at Ol'Magogo. The table reflects the culling of purebred and F1 animals, and of the 957 animals approximately 85% are now four-way composites and their progeny.

The composition of the flock is evolving towards an elite nucleus flock which will serve to provide elite breeding stock to satellite multipliers. This is being accomplished by initially culling, by age, the F1 generation. The Catholic Diocese of Nakuru, Heifer Project International (HPI) and the Mirembe Self-Help Program in Uganda are the beneficiaries of this culling. The culling will facilitate KDPG management and is compatible with facilities and resources at Ol'Magogo.

During the year, the availability of pastures and browse for goats at Ol'Magogo estate depended on rainfall. Pastures were abundant during the rainy season and supplementary feeding (mainly alfalfa) was used to meet the animal's nutrient requirements particularly the indoor reared animals such as the kids. Most of the supplements are now grown on the farm.

A forage plot with sweet potato vines was established during the year and three kid crops have been fed and weaned on the vines. An alfalfa plot (currently yielding approximately 30 bales per cutting) was established and has been in use together with the vines for the maintenance of indoor kept animals — especially kids before weaning. The plot is being expanded to provide a target yield of 150 bales per cutting. The establishment of a forage plot for seasonal feed supplementation is crucial to the maintenance of the elite herd at Ol'Magogo. During the year, the existing plot resulted in a substantial reduction in the cost of flock maintenance.

Activity: *Multiplication, privatization, technology transfer, and impact assessment of the KDPG distributed to smallholder farmers at the coastal and Katumani sites. Identification of collaborating farmers and distribution of KDPG to initiate the privatization of the KDPG multiplication process.*

Problem Statement and Approach: The multiplication and distribution phase of the KDPG project is currently underway with the cooperation of NGOs and private breeders. The KDPG is registered as a breed and the philosophy of our approach is that NGOs and private breeders will possess a vested interest in the multiplication of the KDPG. The SR-CRSP, KARI and MALDM are providing technical backstopping to the management of programs at each collaborating site to ensure that animal losses are minimized and that a minimum amount of critical data are collected to allow the evaluation of impact and adaptation of the breed at each site.

Progress: Table 2 shows the number of KDPG transferred from Ol'Magogo to the two farmers participating in the privatized multiplication program.

KARI has formally agreed to the KDPG multiplication program. The primary objective of the program is to establish

| | <i>Kilifi Plantations</i> | <i>Kirathe Farms Ltd.</i> |
|--------------|-------------------------------|-------------------------------|
| <i>Does</i> | 40 | 25 |
| <i>Bucks</i> | 17 | 3 |
| <i>Kids</i> | 20 | 15 |
| <i>Total</i> | 87 | 43 |

Table 2:
Distribution of KDPG to privatized multipliers.

a KDPG stud breeding program with the aim of enhancing the production of quality goats to ensure that the country and farmers, in particular, continue to benefit from the program. The program aims at expanding the source of quality, pedigree breeding goats by expanding the genetic pool of the KDPG and extending its availability to farmers. The program intends to encourage more farmers to accept and participate in the production of a quality breed of goats and hence to accelerate agricultural growth; initiate support and service a KDPG breeding infrastructure; and use the information supplied by the stud breeder for the purpose of providing training, monitoring, and technical backstopping.

A memorandum of understanding between KARI and the selected Multiplier was drafted and finalized between KARI and the private breeders interested in undertaking stud breeding of the Kenya Dual Purpose Goat. The memorandum defined the role of KARI/SR-CRSP in the provision of the

breeding stock and for monitoring, and the responsibilities of the breeder in ensuring sustained breeding of the goat and close cooperation with the elite herd at Ol'Magogo. The contract agreement was dispatched to the initial private farms of Kilifi Plantations, Meruai Farm and Kirathe Limited for their perusal and comments. Kilifi Plantations Limited signed the contract without alteration. Meruai Farm had reservations on the terms and were replaced by Kirathe Limited. The signed contracts were then presented to the Director of KARI for his signature authorizing the subsequent transfer of goats to the stud breeders. The finalized plans for the transfer of goats to Kilifi Plantations Limited and Kirathe Limited included the procurement of veterinary movement permits and 25 does and 3 bucks were distributed to Kirathe Limited. Kirathe Limited is a mainly livestock oriented operation located at Rongai, Nakuru district along the Great Rift Valley. Climatically, it is

Table 3: KDPG involved in Impact Assessment.

| | <i>Katumani</i> | <i>Kwale</i> | <i>Kilifi</i> |
|--------------|-----------------|--------------|---------------|
| <i>Does</i> | 19 | 29 | 13 |
| <i>Bucks</i> | 15 | 18 | 17 |
| <i>Total</i> | 34 | 47 | 30 |

a high rainfall area. The farm has 200 crossbred goats and 300 head of cattle. A total of 40 does and 17 bucks were transferred to Kilifi Plantations Limited which is located in Kilifi District. The plantation has about 500 goats and 2,500 head of cattle. It has a modern milk processing plant and has been a source of breeding stock (both cattle and goats) for the whole of the Coast Province. The main cash crop grown on the plantation

is sisal. The 17 KDPG bucks purchased by Kilifi Plantations are intended for an upgrading program. Each multiplication unit utilizes a primary buck for breeding and two bucks for clean-up.

The data to be collected at each multiplication site will depend primarily on the records the farmer is currently keeping. During the transfer, the need to maintain pedigree identification records for registration purposes was emphasized. A follow-up visit was made to both collaborators to assess the performance of the animals since placement. On both farms there were minimal problems with adjustment to the sites. Both farms were willing to replace their existing goat population with the KDPG. Twenty does transferred to Kilifi Plantations have kidded on-farm. Fifteen does transferred to Kirathe Farm have kidded on-farm. A commercial unit has been developed at Kilifi Plantations Limited to cater for KDPG production. The enterprise is known as Kasingamongo Goat Production Service. This is a crucial development in multiplication and commercialization of goat production in the country.

Table 3 shows the number of KDPG currently located at the three sites at which the Impact Assessment study is underway.

The on-farm research concentrated on monitoring the adaptability of the breed under various environment conditions, e.g., dryland vs. coastal humid as compared to Ol'Magogo. Although initial problems were experienced with high mortality rates, the survivability of the KDPG progeny is now at an acceptable level. A total of 111 KDPG

goats now exist with farmers at Katumani and the coast sites.

At Kwale, six kiddings were recorded and the average milk production was 1-2 kg of milk per goat per day. One-half kilogram of goat milk currently sells for KShs 20. A KDPG breeding buck now sells for KShs 3000.00 (60 USD). The group participated at the Coast Provincial Show winning best goat trophies. One doe was transferred to Kwale to replace a doe which was recommended for disposal by slaughter. At Kilifi, one breeding buck was transferred to Kilifi to replace a stolen buck. Eight does kidded, one doe aborted and a breeding buck fetches about KShs 3500.00 (70 USD). Four does and one buck were transferred to Mtwapa Regional Research Station for the establishment of a livestock management demonstration centre. This is important to the sustainability of on-farm research in KARI. At Katumani, two bucks were transferred to Katumani for breeding. A breeding KDPG buck fetches up to KShs 4000.00 (80 USD).

Activity: Selection for optimum milk and meat production and resistance/resilience to *Haemonchus contortus*. Development of segregating families for *Haemonchus* resistance.

Problem Statement and Approach: A major production constraint of cattle, sheep and goats in tropical and subtropical areas is the detrimental effect of the stomach worm *Haemonchus contortus*. These effects include reduced productivity, cost of continuous treatment and dangers to smallholders handling the anthelmintics. Through

field testing, this project has established that there is wide ranging variability for resistance/resilience to *Haemonchus contortus* in the genetically segregating KDPG population and that various measures of the phenotype of resistance (EPG and PCV) have a genetic basis. Since drugs have been only marginally effective for control in LDCs and there is evidence that parasites may develop resistance to these drugs, development of genetically mediated resistance or resilience in small ruminants has been recommended. If strains of resistant/resilient goats could be identified and selected, a major constraint to production and food chain contamination could be alleviated. Further, these animals would be of considerable economic benefit to the host country as the export demand for live animals, semen and embryos would likely be great.

| | <i>KDPG</i> | <i>E₁</i> |
|--------------|-------------|----------------------|
| <i>Does</i> | 9 | 7 |
| <i>Bucks</i> | 4 | 0 |
| <i>Total</i> | 13 | 7 |

Table 4: Goats resistant to *Haemonchus contortus*.

Progress: Table 4 shows the number of goats determined to be resistant to infection by *Haemonchus contortus* through sequential artificial challenge. A major small ruminant production problem in Kenya is the detrimental effects of internal parasites. Evaluation of helminthiasis resistance in the goat flock at Ol'Magogo has been an on-going research activity. One hundred and forty weaner KDPG were selected after screening for endoparasites and were confined in a clean, elevated and slatted floor pen and each was infected artificially with 10,000 *Haemonchus*

contortus larvae. Routine sampling during both the prepatent postpatent periods of infection was undertaken throughout the period of November 1995 to July 1996. Infection was terminated after six weeks using Ivermectin. Eggs per gram of feces and packed cell volume were monitored. Thirty-five weaners were challenged for a second time after maintaining an EPG of below 1,000 and a PCV of at least 20%. Only six kids subsequently maintained an EPG of less than 1,000 and were characterized as being resistant. A total of twenty animals on the farm are resistant to internal worms. Four bucks from this group are being used for breeding resistance into the KDPG flock.

Blood samples were collected from progeny of resistant bucks and the current resistant animals for genetic studies into the inheritance of resistance to stomach worms.

Also related to helminthiasis control, a study was initiated to investigate Albendazole resistance at Ol'Magogo. Twenty-five weaner kids were used for this experiment using four commonly employed deworming agents. The anthelmintic efficacy of benzimidazoles (BZs), levamisole (LEV), rafoxanide (RAF) and ivermectin (IVM) was evaluated at Ol'Magogo using the fecal egg count reduction test, larval cultures and a controlled slaughter trial. The results of this study indicated simultaneous resistance of *Haemonchus contortus* against BZs, LEV and RAF and *Trichostrongylus columbriformis* and *Oesophagostomum* sp. against LEV on the farm. Injectable and orally administered Ivermectin was effective

against the BZ and LEV resistant *H. contortus*.

Activity: *Regionalization of the Kenya Dual Purpose Goat.*

Problem Statement and Approach: The transition of the SR-CRSP to a Global Livestock CRSP offers the opportunity to regionalize the impacts of the KDPG Component within East Africa and to position the current component for the development of a competitive proposal for the CRSP renewal.

Progress: Request for goats have been received from neighboring countries including Uganda and Tanzania. Several farmers have expressed their willingness to multiply goats and to purchase breeding bucks for the genetic improvement of their local flocks. The project sold four KDPG bucks to the Multisectoral Rural Development Project (MRDP), Busoga Diocese, Uganda. The Mirembe Self-Help Project in Uganda has also expressed an interest in the KDPG. Preliminary efforts were made towards this goal by discussing the progress of the KDPG bucks purchased by the MRDP with the financiers, Mr. and Mrs. Anthony Holmes. A subsequent meeting indicated an interest in purchasing additional bucks for the rural farmers in Uganda. Evaluation of the first year's performance results will be performed before additional goats are transferred to Uganda.

PARTICIPATION IN THE DEVELOPMENT OF A REGIONAL PROPOSAL

Potential sites: The target areas are characterized as being 'areas in transition.' Areas in this category in East Africa are classified as being semi-arid (marginal). They define almost two-thirds of the total land mass and possess over 80% of the region's livestock — especially unimproved small ruminants. They are also characterized by a high population pressure as a result of opportunist migration into these areas from higher potential regions where the population densities are very high. This increased human activity is leading to a fragmentation of the land holding and an intensification of land use. The livestock carrying capacity is easily exceeded resulting in an inability to support families. Further, the ecosystems are very delicate and the soils and vegetation are easily degraded as a result of the increased human activity. The increase in population is not matched to the available resources and residents and immigrant settlers both attempt to grow crops and maintain livestock as an insurance against crop failure. These target areas offer an opportunity for an improvement in the integration of crop and livestock production to enhance livestock productivity. Since these areas have historically not been heavily populated, the general infrastructure is poorly developed. For example, there are no developed markets, graded roads, electricity, telephones, shopping centers, banks or industries. The challenge for the GL-CRSP will be to introduce existing, tested technologies into these areas to

improve the household and community incomes which will contribute to improved standards of living.

Human nutritional stress: The semi-arid areas are further characterized by drought and famine which are caused by both environmental hazards and human factors and which lead to hunger through food insecurity. Farmers in these areas are resource-poor and practice subsistence farming. As a consequence, human nutritional stress is prevalent and results in malnutrition, especially when there is a severe deficiency in micronutrients which adversely affects growing children. The proposed GL-CRSP project will endeavor to introduce interventions to improve the general environment and living standards. Our efforts will focus on influencing the households and communities in the target areas to accept interventions, or packaged technologies, which will enhance productivity and genetically improve their small ruminants to improve the health of the community. The increased productivity, household and community incomes and improved living standards will likely lead to the development of appropriate infrastructures, access to health, education and housing which will lead to stable communities in the marginal areas throughout East Africa.

The KDPG in capital formation: For a large number of households in these areas in transition, goats are a major source of food and income. The traditional goat production systems rely on indigenous breeds whose overall productivity is generally low and whose disposal to market is frequently determined by immediate monetary

needs rather than biological criteria. Given the increase in population in these areas, the demand for food of animal origin and an increased household income is concomitantly increasing the need for appropriate and widely applicable technologies such as the KDPG which can increase livestock productivity in these areas. Viable KDPG interventions for marginal areas include introductions in small-scale purebreeding schemes or upgrading schemes using KDPG bucks to genetically improve the productivity of the local breeds. Although the markets are not well developed in these areas, the KDPG has a high potential for growth (about 75 g/day preweaning) and milk production (peak yield 4 kg/d and an average yield of 2.0 kg/d). Therefore an increase in animal productivity in developing markets will not only raise incomes and nutrient intake per household, but will also stimulate community development and ensure the sustainability of the introduced technologies. The potential for socioeconomic impact with the KDPG at the household and community levels (such as women's self-help groups, schools and rural training centers) is high compared to the high potential and periurban areas, where there are a multitude of alternative sources of household and community income.

Disease constraints: Animal disease is one of the major constraints to small ruminant production encountered in the marginal areas and requires the urgent delivery of health interventions. Tick-borne diseases and other sporadic diseases caused by mycoplasmas and viruses are prevalent in the region. These diseases have hampered the exploitation

of the full production potential in terms of meat, milk, hair and skins of small ruminants. The most important tick-borne diseases include anaplasmosis and heartwater, while contagious caprine pleuropneumonia (CCPP) caused by a mycoplasma is also prevalent. Viral diseases such as bluetongue, Rift Valley Fever and sheep and goat pox occur sporadically. Anaplasmosis is a chronic wasting disease which occasionally causes mortality when animals are stressed by poor nutrition. The disease causes economic losses since infected animals have delayed maturity, reproduce poorly and milk production is hampered. Heartwater and CCPP cause a mortality of about 80% in susceptible small ruminants. The viral diseases occasionally cause morbidity and mortality.

Potential for regional impact: Since marginal areas form the bulk of the physical geography of East Africa, interventions to improve small ruminants (50 million) and alleviate poverty in these areas has a high chance of making a regional impact. The large number and the widespread distribution of small ruminants compared to large ruminants and other livestock demonstrates that people in these marginal areas have a strong interest in small ruminant husbandry because of their inherent ability to adapt to severe climatic changes and their flexibility in terms of feeding habits. Small ruminants reproduce quickly, have greater survival rates in harsh environments, are easily converted into cash compared to cattle and therefore they are highly appropriate for restocking vast stretches of marginal lands after severe droughts or political upheaval. The inception of land

settlement programs in the post-independence era and the dramatic population increase have led to rapid population increases in these marginal areas.

Priority area for national and local governments: Several programs in the region with a special emphasis on the marginal areas are supported by the government and other non-governmental organizations (NGOs). In Kenya, the SR-CRSP/KARI has been collaborating with some of these government and NGO small ruminant programs, including the Small Ruminant Improvement Project in Laikipia District whose objective is to increase the sheep and goat productivity of small scale farmers settled on formerly livestock ranches.

SHORT-TERM TRAINING

Three hundred and fifty DNA samples were collected from goat families segregating for the horned and polled phenotypes traits in the Ol'Magogo KDPG herd. DNA extraction was undertaken at the Kabete Biotechnology laboratory by **Mr. Rick Brenneman** (a U.S. graduate student at Texas A&M University under the supervision of the PI) and Dr. Joseph Kogi. The DNAs were transported by Mr. Brenneman to our laboratory at Texas A&M University where final DNA purification was accomplished, the DNAs were aliquotted to 96 well microtiter plates and microsatellite genotypes were scored. These data are now ready for analysis to localize this locus in the goat. The objective of the work was essentially twofold. First, it was geared towards

POTENTIAL COLLABORATORS

Kenya:

Kenya Agricultural Research Institute
Heifer Project International
Laikipia Research Project
Aramat-KARI Project (Narok)
Farm Africa
Oxfam
Ilkerin Integrated Project (Narok)
Elangata Wuas Project (Kajiado)

Uganda:

National Agricultural Research Organization
Makerere University

Tanzania:

Sokoine University
Ministry of Research and Training

research into the chromosomal localization of the horn locus in goats, and second, additional DNA samples were harvested from families of sires indicating resistance to *Haemonchus contortus*.

ENVIRONMENTAL IMPACT AND RELEVANCE

Small ruminants, and goats in particular, have unjustifiably been criticized for contributing to the degradation of much of the world's agricultural lands. Often, such degradation is due to non-sustainable human agricultural practices, such as slash and burn cropping, but when overgrazing is a contributing factor, the fault is again due to non-

sustainable human management practices. Even where overgrazing is a contributing factor to degradation, critics of small ruminants must not overlook the fact that goats are usually the only livestock species that can utilize these marginal lands to convert browse to human food protein. The SR-CRSP Dual Purpose Goat component has addressed these issues in the design of the program which focuses on the integration of small ruminant and crop production in the smallholder context. The central theme of the component has been the production of a Techpac, published in English and Kiswahili, designed to present an integrated production technology to producers that will ensure that small ruminant production will enhance soil conservation and fertility rather than contribute to its degradation. The Techpac is undergoing testing in the smallholder context utilizing the KDPG on-farm in the semi-arid Katumani and the tropical Kilifi and Kwale coastal regions.

AGRICULTURAL SUSTAINABILITY

The Breeding Project has targeted the development of a dual-purpose goat designed to meet milk and meat components of human protein consumption within the context of a sustainable farming-systems model. This model integrates crop and restricted-grazing animal production using by-product feeding and low-tillage agriculture that incorporates animal manure as fertilizer. The Techpac is designed to ensure that the small ruminant component contributes to soil conservation and fertility rather than allowing degradation due to human

allowance of overgrazing. Research into *Haemonchus* resistance has a major objective of reducing producer dependency on chemicals for parasite control.

CONTRIBUTIONS TO U.S. AGRICULTURE

The genetic studies on *Haemonchus contortus* are of importance to the U.S. due to the cost of production losses and due to the increasing importance of parasite resistance to chemotherapy. Resistant bucks have now been extensively used in the breeding herd at Ol'Magogo and this resource herd provides a useful resource for future research.

The Breeding project has now developed 27 polymorphic caprine microsatellite markers which are published, or are in the process of being published, and available to other U.S. researchers. We have obtained DNAs for the international sheep reference families from Dr. Noelle Cockett at Utah State University and will complete the genotyping of our markers to the international sheep genetic map in January 1997.

CONTRIBUTIONS TO HOST COUNTRY

Linkage and Networking: An Impact Assessment project involving Heifer Project International, KARI, MALDM and all of the Kenya projects continues to evaluate the potential of the KDPG to benefit smallholder farmers.

The PIs, Resident Scientists and representatives of KARI and MALDM have commenced the privatization of the multiplication of the KDPG.

Collaboration with IARCS and other CRSPs: The PI is developing a collaboration with Dr. Leyden Baker and Dr. Alan Teale of ILRI to obtain access to the ILRI laboratories and these scientists for graduate student co-supervision within the GL-CRSP proposal.

SUPPORT FOR FREE MARKETS AND BROAD BASED ECONOMIC GROWTH

The project continues to collaborate with HPI in the implementation of the KDPG impact assessment study. This study follows a model of privatization and decentralization for the multiplication and distribution of the KDPG.

CONTRIBUTIONS TO AND COMPLIANCE WITH MISSION OBJECTIVES

Consultations with the USAID/K Mission ensure that the design and implementation of the multiplication and distribution phase of the KDPG Breeding project is in accordance with Mission objectives.

CONCERN FOR INDIVIDUALS

The major contribution of the Breeding project indicative of a concern for individuals is the commitment of the project to training to provide a mechanism for life-long advancement. The Breeding project and the ME provided resources to support a U.S.

graduate student, Mr. Rick Brenneman, to conduct collaborative research in Kenya. The project also continues to support the research of Dr. R.M. Waruiru, a faculty member at the University of Nairobi, through collaborative research regarding the genetics of *Haemonchus* resistance.

SUPPORT FOR DEMOCRACY

The model selected for the multiplication of the KDPG is to utilize private breeders as the primary source of supply of the KDPG to smallholders. This model supports the concept of privatization and free trade inherent to the democratic principle.

HUMANITARIAN ASSISTANCE

In collaboration with HPI, 51 smallholder families continue to benefit from receiving KDPG does and technical training through the distribution of KDPGs in the Impact Assessment study.

Two private Kenya farms have now received the KDPG to facilitate the privatization of the KDPG multiplication program. These farms will provide KDPGs to the Kenya private sector.

COLLABORATING INSTITUTIONS

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Texas Agricultural
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Kenya:

Joseph Kogi
Resident Scientist, KARI
R.M. Waruiru
Lecturer, University of Nairobi

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DUAL PURPOSE GOAT PRODUCTION SYSTEMS FOR SMALLHOLDER AGRICULTURISTS IN KENYA

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NARRATIVE SUMMARY

Since 1980, the Production Systems Project (PSP) has endeavored to provide on-farm client-oriented research on developing, evaluating, and promoting dual-purpose goat production systems based on low-cost and low-risk technology packages, with the objective of enhancing dietary and financial well-being of farm families. Towards these goals PSP adopted a farming systems research approach resulting in positive research impact. In western Kenya, where PSP started its research, farmers are now fully aware of the Kenya Dual Purpose Goat (KDPG) and its potential. Some have put into practice technologies developed and the process of farmer-to-farmer extension is in motion.

To show that the KDPG is not only adaptable to the western Kenya environment of high humidity and rainfall, the SR-CRSP Kenya Programme Advisory Committee felt there was a need to test the dual-purpose goat elsewhere. In late 1993 a KDPG Impact Study was initiated in semi-arid (Machakos) and coastal humid (Kwale and Kilifi) districts. At the same time,

there were recommendations to field test the efficacy of the CCPP vaccine (developed by SR-CRSP Kenya) and to continue with our regionalization activities in southern Tanzania.

On-farm monitoring research was conducted throughout the year to provide insights on preferred forage species, dry matter intake, frequency of watering, management strategies, tethering pattern and the general outlook of the KDPG as perceived by smallholders. Information gathered helped to develop model farms in each village. In the course of new fodder species introduction, *Panicum maximum* and *Clitoria spp.* were identified as suitable indigenous fodder species for further research. They are excellent alternatives to napier grass and exotic clovers, respectively.

While the Animal Health Project (AHP) tested the thermal stable vaccine in different production systems, the PSP monitored system changes and potential management alternatives. Participatory rural appraisals (PRAs) were conducted to supplement monitoring research in

describing production systems and identifying constraints interventions and opportunities.

During the year, the PSP continued to be involved in regional activities in southern Tanzania; Newala goats are being characterized and synthesis of a dual-purpose goat and technology are in progress.

RESEARCH

Activity: On-farm monitoring research of Kenya Dual Purpose Goats.

Management and grazing studies aimed at on-farm monitoring research of KDPGs have been conducted to coincide with peaks of wet and dry seasons. Studies have provided insights on preferred forage species, dry matter

intake, digestibilities, frequency of watering, management strategies, tethering pattern and general outlook of the KDPGs as perceived by smallholders. Data for this study has been collected and is currently being analyzed. Some of the forage species unknown to us have been sent to the National Herbarium for identification. Table 1 is a summary of some of the preliminary results.

Activity: Adaptation and development of sustainable technologies for the KDPG.

To meet this objective, fodder species that were previously introduced in western Kenya were introduced in the new sites. They included *Pennisetum purpureum*, *Leucaena leucocephala*, *Gliricidia spp.*, and *Ipomoea batatas*. Planting materials

| Event | Vuga | | Kitanga | | Kimutwa | |
|--------------------------------------|---|---------|--|---------|---|---------|
| | Dry (2) | Wet (2) | Dry (2) | Wet (2) | Dry (2) | Wet (2) |
| Grazing | 49±19 | 78±17 | 66±13 | 68±4 | 71±14 | 62±7 |
| Resting standing | 10±4 | 8±6 | 9±3 | 22±7 | 17±4 | 18±5 |
| Resting lying | 3±0 | 8±9 | 3±4 | 6±1 | 25±13 | 28±10 |
| Ruminating standing | 14±1 | 5±3 | 14±10 | 14±8 | 4±1 | 16±2 |
| Ruminating lying | 18±1 | 10±6 | 20±7 | 24±4 | 11±6 | 11±4 |
| Walking | 12±4 | 6±2 | 16±5 | 10±3 | 9±4 | 6±1 |
| Drinking | 1±0 | 2±1 | 2±1 | 1±0 | 2±0 | 1±0 |
| Selected forage species | 11 | 41 | 24 | 40 | 26 | 35 |
| Duration out (hrs) | 8.9 | 9.8 | 10.8 | 12.0 | 11.6 | 11.8 |
| Three major forage species out of 51 | <i>P. trichocladum</i> <i>P. purpureum</i> <i>D. milanjiana</i> | | <i>T. triandra</i> <i>Andropogon spp.</i> <i>L. ukambensis</i> | | <i>C. ciliaris</i> <i>P. mezianum</i> <i>A. tortilis (pods)</i> | |

Table 1: Observed activities of KDPGs on-farm every five minutes

() Represents number of KDPG observed per season
± Standard Deviation

Table 2: On-farm production of feed resources

| Village | <i>Leucaena leucocephala</i> (Seedlings) | Napier grass (Cuttings/Splits) | <i>Gliricidia spp.</i> (Seedlings) | <i>Ipomoea batatas</i> (Cuttings) |
|------------|--|--------------------------------|------------------------------------|-----------------------------------|
| Kimutwa | 1000 | 1200 | - | 3000 |
| Kitanga | 1000 | 1100 | - | - |
| Vuga | 1200 | 1200 | 350 | - |
| Matuga HPI | 1000 | 1000 | 350 | - |
| Kakanjuni | 200 | 1200 | - | - |

have been distributed as shown in Table 2. Unfortunately, germination of the fodder has been poor due to moisture stress resulting from erratic and insufficient rainfall in Years 17 and 18. Survivors of the droughts will be used in coming years. In the course of the study, *Panicum maximum* and *Clitoria spp.* were identified as suitable fodder crops for further research. Both are indigenous and have good yields of palatable fodder. They are good alternatives for napier grass and exotic clovers. Further work on these species is planned, such as propagation methods, seed production and utilization.

Activity: *Model farms.*

Six model farms have been established based on strategies of a highly successful model farm in Maseno. They have served as case studies and vehicles for farmer to farmer extension. The model farms have incorporated many technologies generated by SR-CRSP and KARI scientists from research findings at Maseno, Katumani and Mtwapa and all inputs and outputs into the farms are

accurately measured to ascertain production potential. It is hoped that on full analysis of the data, results will provide invaluable information on the maximum potential of typical subsistence farms.

Activity: *Monitoring research on resources management in areas where the efficacy of CCPV vaccine is being tested.*

The Animal Health Project (AHP) is conducting extensive field trials of CCPV vaccine efficacy. At the trial sites where different production systems are conducted, PSP has conducted Participatory Rural Appraisals (PRA) to supplement monitoring research in description of the systems, identification of constraints, interventions and opportunities. Preliminary results of flock structures, liveweights and PRAs are presented in Tables 3, 4, 5 and 6.

| Area | Age in Years | | | | | | | | | | | | | | | | | | Total |
|------------------------|--------------|----|---|-----|----|---|-----|---|---|-----|----|---|----|---|----|----|-----|-----|-------|
| | ≤1 | | | 1≤2 | | | 2≤3 | | | 3≤4 | | | ≥4 | | | ≥8 | | | |
| | F | M | C | F | M | C | F | M | C | F | M | C | F | M | C | F | M | C | |
| Kajiado | 20 | 34 | - | 14 | 8 | 3 | 8 | 1 | 4 | 17 | 3 | 2 | 43 | 3 | 8 | 16 | 1 | - | 185 |
| Koibatek | 19 | 20 | - | 15 | 16 | 1 | 17 | 6 | 2 | 32 | 7 | 4 | 51 | 5 | 4 | 10 | 1 | 1 | 211 |
| Overall ⁽¹⁾ | 39 | 54 | - | 29 | 24 | 4 | 25 | 7 | 6 | 49 | 10 | 6 | 94 | 8 | 12 | 26 | 2 | 1 | 396 |
| % ⁽²⁾ | 10 | 14 | - | 7 | 6 | 1 | 6 | 2 | 2 | 12 | 3 | 2 | 24 | 2 | 3 | 6 | 0.5 | .25 | 100% |

(1) Number of goats

(2) Percentage of the total flock

F = female, M = male, C = castrate

Table 3: Flock structure of East African goats in Koibatek and Kajiado districts

| Age in Years | Sex | | |
|--------------|-------------------|-------------------|-------------------|
| | Female | Male | Castrate |
| <1 | 19.0 SD 3.64 (39) | 21.4 SD 3.39 (54) | - |
| 1<2 | 23.5 SD 3.41 (29) | 25.8 SD 4.59 (24) | 27.4 SD 3.09 (4) |
| 2<3 | 25.0 SD 3.10 (25) | 32.4 SD 5.30 (7) | 32.9 SD 3.56 (6) |
| 3<4 | 28.2 SD 3.28 (49) | 36.7 SD 6.29 (10) | 37.7 SD 3.77 (6) |
| >4 | 30.5 SD 3.97 (94) | 37.1 SD 6.48 (8) | 47.3 SD 5.45 (12) |
| >8 | 28.8 SD 3.62 (26) | 38.5 SD 10.6 (2) | 41.0 SD (1) |

Table 4: Average liveweights of East African goats in Koibatek and Kajiado districts

| Problem | Kapyemit | Suswa | Lodariak |
|---------------------|----------|-------|----------|
| Feed shortage | 4 | 2 | 4 |
| Water shortage | 1 | 1 | 2 |
| Drought | 2 | - | 1 |
| Food shortage human | 3 | - | - |
| Predation | - | 5 | 3 |
| Limited land | 5 | 3 | - |
| Low prices on offer | - | 4 | 5 |

Table 5: Ranking of Small Ruminants Production Constraints in Kapyemit, Suswa and Lodariak

Table 6: Some problems, causes, producers' current coping strategies and possible opportunities for small ruminants in Kapyemit, Koibatek district

| PROBLEM | CAUSES | COPING STRATEGIES | OPPORTUNITIES |
|-------------------|--|---|---|
| 1. WATER SHORTAGE | 1. Low rainfall 2. Lack of dams 3. Lack of springs | 1. Excavation 2. Migration 3. Reduction of watering frequency 4. Bring in water for kids/lambs | 1. Dam construction & water pens 2. Bore holes 3. Piped water 4. Roof catchment 5. Reforestation |
| 2. DROUGHT | 1. Lack of rainfall | 1. Migration 2. Cutting tree branches | 1. Plant drought tolerant grasses 2. Conservation |
| 3. FOOD SHORTAGE | 1. Low rainfall 2. Pest damage 3. Baboons 4. Inappropriate varieties | 1. Buy 2. Guarding (even at night) 3. Seek compensation from KWS | 1. Introduce appropriate varieties 2. Crop extension 3. Fertilizer |
| 4. FEED SHORTAGE | 1. Low rainfall 2. Stony terrain | 1. Shifting 2. Supplementation through lopping/pods 3. Conservation standing hay 4. Forced culling | 1. Reseeding 2. Conservation 3. Purchase 4. Assessment of stocking rates versus animal and land productivity |
| 5. CCPP | 1. Wind dispersal 2. Introduced 3. Not all farmers treat/vaccinate 4. Expensive drugs 5. Ignorance | 1. Drugs - broad spectrum antibodies 2. Isolation 3. Vaccination 4. Transfer to other areas | 1. Vaccination 2. Treatment |

Activity: Newala Goat Project in Southern Tanzania.

At the invitation of the Tanzania research establishment, PSP took the opportunity to regionalize SR-CRSP in southern Tanzania, utilizing technologies developed in western

Table 7: Goat Flock at Mnima Ranch (Newala Goat Project)

| Age | <4 months | 4-18 months | >18 months | Total |
|-------------------|-----------|-------------|------------|-------|
| Newala Male | 11 | 6 | 17 | 34 |
| Newala Female | 12 | 5 | 76 | 93 |
| Crosses Male | 15 | 3 | - | 18 |
| Crosses Female | 15 | 1 | 7 | 23 |
| Ang.Nubian Male | - | - | 2 | 2 |
| Ang.Nubian Female | - | 7 | - | 7 |
| Toggenburg Male | - | - | 3 | 3 |
| Toggenburg Female | - | - | - | - |
| Total | 53 | 22 | 105 | 180 |

Kenya and currently under development at the Coast. PSP has been established in southern Tanzania since 1993. Despite financial shortfalls, the project continued throughout the year to characterize Newala goats and to follow a breeding plan towards the synthesis of a dual-purpose goat. Research was also conducted on the utilization of cassava peels. Flock inventory is presented in Table 7.

SHORT-TERM TRAINING

Short one-day courses for farmers were conducted at Kimutwa, Kitanga, Vuga and Kakanjuni. Courses discussed KDPG management and nutrition. One hundred and fifty farmers attended the courses.

Three one-day PRAs were conducted in Kapyemit, Suswa and Loodariak with a total attendance of one hundred and thirty-four pastoralists.

Our KDPG farmers exhibited their goats with good results at Machakos and Mombasa agricultural shows.

ENVIRONMENT

- Encouraged use of KDPG manure rather than inorganic fertilizers.
- Introduced leguminous shrubs that are efficient nitrogen fixators for feeding livestock.
- Promoted growing of appropriate grasses to hold terrace benches installed for soil conservation.

AGRICULTURAL SUSTAINABILITY

Our research has focused on integration of animal and crop agriculture: utilization of crop residues, manure, dual-purpose crops and multi-purpose trees.

CONTRIBUTIONS TO U.S. AGRICULTURE

Technology of sweet potato vines and leaves as a milk replacer has been exported to the US.

CONTRIBUTIONS TO HOST COUNTRY

Awareness of small ruminants as important contributors to the economy and household food security. Established annual SR-CRSP workshops.

COLLABORATION WITH IARCS

Good collaboration with ILRI continues. Patterson Semenye is a committee member of ILRI's African Small Ruminant Research Network (SRNET).

COLLABORATING PERSONNEL

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KENYA DUAL PURPOSE GOAT: SOCIOLOGICAL ANALYSIS OF SMALL RUMINANT PRODUCTION SYSTEMS

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NARRATIVE SUMMARY

Three general activities were the focus of research by KARI and University of Missouri researchers in sociology and economics with this year of funding. The first area, the impact assessment of the Kenyan Dual Purpose Goat (KDPG) at the household level focused on the economic performance of the KDPG enterprise, its role in household income, gender domains of the technology, and flexibility of the KDPG to adapt to different agroecologies, production systems and ethnic groups. Climatic conditions are not considered good for the years in which the KDPG has been introduced, and the technology appears to be performing. Research findings on performance during 1995 are encouraging, in that the enterprise shows positive returns in all clusters at the Coast (3 clusters) and Machakos (2 clusters). The relative importance in household agricultural income varies according to the production system and level of household wealth. At the cluster level analysis we find that the Coast clusters are relatively poorer than the Machakos clusters, therefore the relative importance of the KDPG is higher for the former. We also find at the Coast that the clusters had higher rates of pass on, and better relative performance. This

is the case for both Kilifi and Vuga when compared to Kitanga and Kimutwa in Machakos. Matuga is the only Coast cluster that did not perform well. The multiplication of the KDPG, a second research activity this year, focused on analysis of the smallholder multiplication system. Upgrading practices were observed as introduced by smallholder producers owning KDPGs. The third activity focused on community and social networks developed by each cluster: Vuga and Matuga in Kwale, Kilifi at the Coast, and Kitanga and Kimutwa in Machakos. Community organization, social networks, and social capital were studied combining PRAs and actor oriented research to understand the positive externalities created by the pass on of the KDPG, and the conditions that make possible this type of multiplication. All cluster members were interviewed and a study completed. This is the basis for further research on the role of social capital, community organization, and nongovernmental organizations in the success of development projects. A Resource Management Gender and Labor questionnaire was developed to study gender income and labor domains at the household level, credit and income

transfer mechanisms available to each cluster, as well as the presence of credit systems and other networks in the area. This was applied to all clusters and is currently being analyzed. During year 18 (1997), we will concentrate on further analysis of the data at both the household and community levels. This has been the first year of full and stable funding for the impact assessment and it has raised interesting questions that will be pursued in 1997. Further information on this project can be found at the MU Social Science web site. Reports and publications from this component are also available. The URL is: <http://www.ssu.missouri.edu/ssu/srersp>.

RESEARCH

Activity: *Impact Assessment of the KDPG at the Household.*

Problem Statement and Approach: The impact on the welfare of households, the result of the introduction of the KDPG as an economic enterprise, and the importance of asset building in smoothing income shocks are central research questions of the social sciences project. The effects of the KDPG on farm can be measured through: 1) the output generated, 2) changes in the intrahousehold allocation of resources, and income related to the KDPG that may change the bargaining position of members of the household, and 3) building of assets that contributes to economic security, especially food security. Expenditure patterns of men and women have been shown in several studies to differ, especially in Kenya. If KDPGs become the income domain of female heads of household the

probabilities of milk and cash from this activity being spent in consumption items for the family will increase. Gender along with wealth and ethnicity must be considered in the analysis. In western Kenya, Chaiken and Conelly found that income and poverty had stronger effects than gender in deriving benefits from the KDPG. In her analysis of the changing roles of women with development, Boserup states that male migration, in colonial times, resulted in women's greater control of production activities in rural areas, especially food production.

The assessment of the impact of the KDPG focuses on economic viability of the KDPG, measuring income generation, cash and in-kind, of the KDPG enterprise, and the diversity of economic activities carried out by the household producers on and off the farm; gender analysis through intrahousehold allocation of resources focusing on labor and income, to determine domains of the economic enterprises; and the flexibility of this technological package as it integrates to the household economy.

Progress:

1. Economic viability of the KDPG.

The Kenya Dual Purpose Goat (KDPG) and the accompanying management package were introduced into a number of smallholdings in the semi-arid midlands and in the humid Coastal lowlands of Kenya during the short rains season of 1993. These innovations were intended to help improve the welfare of smallholder households through increased income (cash and in-kind) and

nutrition. Introduction of livestock based innovations usually has significant impacts elsewhere in the farming systems.

A baseline survey of the main characteristics of the study sites was undertaken in 1993, preceding placement of the KDPG innovation. A monitoring survey designed to assess the extent of impacts was carried out in the five clusters between 1994 and 1996. Highlights of on-going research are presented in this report.

A combination of case-studies and questionnaires on all farmers was adopted for this study. Four instruments to capture farm and household information were designed, pretested and applied. The timing and frequency at which these instruments were applied were matched to the production and household activity calendars in the two sites. To keep track of the production, consumption and sales of livestock and products as the KDPG integrates into the farming systems, monthly farm visits were conducted.

Rapid Rural Appraisals (RRAs), one in each of the five clusters during the short rains season of 1993, preceded placement of the KDPGs. Base-line information about the small holdings in the regions was used as a benchmark for impact assessment. Each of the two clusters in the Machakos site (Kitanga and Kimutwa) and the two in the Coast site (Kilifi, Vuga) had 20 smallholder households that had been randomly selected from the farming community. The Heifer Project International (HPI) cluster had been formed previously with the purpose of promoting the keeping of

dairy cows by members. Each cluster was allocated ten does and two bucks, five farmers received two does each. Each recipient was required to be a member of the group, to practice acceptable management, to facilitate data collection, and to pass on the first two doelings to members on the waiting list. Individual groups were also required to regulate themselves. Kitanga, Kimutwa, Vuga and HPI clusters received their KDPGs during the short rains season of 1993, and the Kilifi cluster during early 1994.

Following the placement of the KDPGs on the farms, the Impact Assessment study was planned and implemented. Prior to this implementation, research themes were identified and the required data sets itemized. Finally, data capture instruments were drawn up and pre-tested.

The four instruments used to capture farm and household data were:

I. Form M was designed to be administered monthly. Items of data recorded on this are: 1) Family labor availability (through changes in the family structure); 2) Family labor use: main occupations; 3) Household non-agricultural labor supply; 4) Wage rates; 5) Milk consumption/sales; and 6) Animal sales.

II. Agricultural form to be applied 6 times a year, in April, July, October, November, February and March. Land use and cropping activities, access to credit, and remittances from friends and relatives were recorded. Information about production, sales and consumption of permanent crops and fodder was

recorded. Difficulties in data collection stages did not allow full year coverage (e.g., monthly and agricultural). Fortunately, few data items were found to be too sensitive to the frequency at which data were collected.

III. Captured on Form I were agricultural inputs (costs, source and use), mainly seeds, fertilizers and chemicals. The enumerator had ample opportunity to record pertinent observation. This instrument was designed to be administered at the beginning of each season.

IV. Form O was designed to record the production of seasonal crops.

In both the Machakos and the Coast sites, data collection started during the short rains season of 1994/1995. In the ninth month of data collection at the Katumani site, 37 out of 40 farms (92.5%) had been interviewed concerning input questionnaires and 33 out of the same 40 farms (82.5%) had been interviewed using output questionnaires. Similarly, during the same period, 154 out of the 180 farms (85.6%) had been interviewed with respect to the bi-monthly questionnaire on agricultural operations. This was quite a successful operation. However, the more regular monthly interviews were not equally successful. Indeed, of the 360 interviews to be carried out during the same period, only 148 (41%) were completed. This was the year in which SR-CRSP funding was not available for the project.

In the Coast sites interviews started in August 1994, however, serious disruptions were experienced throughout. Whereas 61.4% of the

interviews were carried out in August, only 35% of them were successfully carried out in September 1994. The following month interviews picked up to 96.5% but dropped to 52.6% in November. In December, no interviews were done. In January 1995, modest activity resumed (35.1% of the interviews). The following three months (February, March and April) no interviews were done. In May about a third of the interviews were carried out (36.8%).

Over all, the Katumani site did relatively better than the Mtwapa site in data collection. Considering that both sites were receiving their financial support from the same source, it is evident that institutional constraints were greater in Mtwapa than in Katumani. Following consultations with the center management in Mtwapa, arrangements were made to ensure more regular data collection in the future. It was decided that two field assistants be recruited for the highlands (Kitanga), lowlands (Kimutwa) in Machakos and one field assistant for the Kilifi cluster. The field assistant who was already in place at the Coast would concentrate on the HPI and Vuga clusters in Kwale district. Due to delays in identifying a second field assistant for the Machakos site, it was decided that the one field assistant already in place would cover the two clusters. By January 1995, these measures had already been effected. However, the necessity to follow institutional regulations in channeling resources to the field assistants created some delays. The effects of institute wide shortages of personnel in the socio-economics field were also felt through the inability of collaborating scientists

to allocate more time to the supervision of field work and data management.

Nevertheless, the 1995-1996 data represents a significant improvement over the previous year. There are fewer missing observations. In terms of consistency, missing observations, recording errors, etc., the performance of the Machakos field assistant appears reasonable. The Kilifi field assistant also performed satisfactorily, as did the Kwale field assistant, despite delays in dealing with logistical problems the latter was facing.

Estimation of the Impact of the KDPG on Farm Income.

The KDPG, introduced to existing farming systems during the short rains season of 1993, were expected to generate in-kind or cash income through the production of milk, bucklings, and possibly manure and skins. Products were multiplied by their respective cash values in Kenya Shillings to calculate

total income. Enterprise specific (variable) costs were assessed by estimating the value of inputs which were basically, housing, drugs and treatment, and in some cases water and supplementary feeding. The cost of labor was assumed to be constant and was not priced.

Seasonal conditions and performance of the farm enterprise.

This section is intended to provide a description of the seasonal conditions within which production took place. This has a direct bearing upon the interpretation of production data that is presented in the following sections. Table 1.1 shows rainfall data for the short and long rains from 1985-1996 for National Dryland Farming Research Center (NDFRC) Katumani. There was almost total crop failure during the long rains 1994 season, as in the preceding two seasons. This contributed to the difficulties in interviews because of the unavailability of responsible persons

Table 1.1: Climatic Conditions

| Year | Seasonal rainfall (m) | | for 1985-96, NDFRC | |
|------|-----------------------|----------|--------------------|----------|
| | Long rains season | | Short rains season | |
| 1985 | | | 311.2 | Average |
| 1986 | 327.2 | Average | 342.3 | Average |
| 1987 | 181.3 | Fail | 281.0 | Marginal |
| 1988 | 362.4 | Good | 455.8 | Average |
| 1989 | 263.4 | Marginal | 344.8 | Average |
| 1990 | 565.0 | Good | 395.8 | Good |
| 1991 | 197.4 | Fail | 342.5 | Average |
| 1992 | 240.9 | Marginal | 618.6 | Good |
| 1993 | 186.6 | Fail | 244.7 | Marginal |
| 1994 | 296.4 | Marginal | 589.4 | Good |
| 1995 | 316.7 | Average | 259.5 | Marginal |
| 1996 | 272.4 | Marginal | | |
| Mean | 291.8 | | 380.5 | |

present on the farms during our visits (most would be away seeking means of sustenance).

To date we are searching for comparable data for the Coast. Interviews with farmers are yielding the following perception regarding climate and cropping seasons: the short rains 1994 were "poor"; the long rains of 1995 were "fair to good"; the short rains of 1995 were "poor"; and the long rains of 1996 were "poor to fair".

Performance of the farm enterprise.

To assess impact on farm-household income, cash and in-kind income from other enterprises were measured. Four general classes of activity have been identified. These were: seasonal (mainly food) crops; perennial crops; other livestock; and a variety of non-farm enterprises.

These assessments are summarized as follows:

$$Y = \sum_{j=1} (p_j y_j - p_j x_j) \quad j=1,2,\dots,n$$

Where Y is non-KDPG income, p_j represents the factor x and product y prices in the j th enterprise. For expository convenience, these enterprises are grouped as follows:

- i) Seasonal (mainly subsistence) crops
- ii) Perennial and high value horticultural crops (mainly for cash)
- iii) Productive animals other than the KDPGs (cattle, sheep and goats)

- iv) Draft and pack animals (mainly oxen and donkeys)
- v) Non-farm enterprises (wage/salaried employment, petty trading and crafting)
- vi) Borrowing and lending

To the extent that borrowing does, in many instances, allow smallholder households access to scarce capital resources which could supplement what can be generated on the farm, it was also considered as an inflow into the farm and credit repayments as outflows.

Among the commonly used farm inputs are x_i seeds, fertilizers, and crop pest and disease control chemicals. The number of miscellaneous inputs such as gunny bags can be very large, depending upon the crop enterprise in question.

$$K = \sum_{j=1} (p_j k_j - p_j x_j) \quad j=1,2,\dots,m$$

Where K is 'net' income generated through operation of the KDPG enterprise and p_i represents factor x and product k prices.

$$I_t = \frac{K_t}{(Y_t + K_t)} \times 100 \quad t=1,2,\dots,s$$

I_t represents impact of the KDPG in the t th site, cluster, or farm household, as the case may be.

Although cash remittances and credit were regarded as inflows and gifts and loan repayments were considered to be outflows, these did not directly enter into the calculations of net income from farm operations.

Table 1.2:
Contribution of the
KDPG enterprise to
the farm-household
(cash and in-kind)
income expressed in
Kenya Shillings.

| | Kitanga | Kimutwa | Kilifi | Vuga | HPI |
|---|-----------------|-----------------|-----------------|-----------------|-----------------|
| KDPG | | | | | |
| Weight gains (value in KShs) | 1191.00 | 1258.67 | 1748.58 | 1202.48 | 867.00 |
| KDPG milk (value in KShs) | 446.40 | 235.20 | 1166.80 | 364.80 | 375.60 |
| Sub-total (KDPG) | 1637.40 | 1493.87 | 2915.01 | 1567.28 | 1242.60 |
| Less variable costs | -107.00 | -169.00 | -308.28 | -207.5 | -240.00 |
| KDPG (net contribution) | 1530.40 | 1324.87 | 2606.73 | 1359.78 | 1002.60 |
| Crops | | | | | |
| Seasonal crops | 19717.00 | 30829.00 | 2789.00 | 2737.00 | 2960.00 |
| Add tree crops | 139.96 | 130.30 | 6019.00 | 7629.00 | 4886.00 |
| Sub-total crops | 19857.00 | 30959.30 | 8808.00 | 10366.00 | 7846.00 |
| Less variable costs (KShs) | -3887.00 | -3754.00 | -171.00 | -608.00 | -492.00 |
| Net contribution (Crops) | 15970.00 | 27205.30 | 8637.00 | 9758.00 | 7354.00 |
| Livestock | | | | | |
| Cattle | 13018.80 | 20000.00 | 0.00 | 0.00 | 10000.00 |
| Goats | 1950.00 | 2811.11 | 1662.50 | 1866.60 | 2558.00 |
| Sheep | 875.00 | 800.00 | 0.00 | 0.00 | 0.00 |
| Sub-total livestock sales | 15843.80 | 23611.10 | 1662.50 | 1866.60 | 12558.00 |
| Add cattle milk | 837.96 | 352.80 | 652.40 | 828.00 | 1149.60 |
| Subtotal | 16681.70 | 23963.90 | 2314.90 | 2694.60 | 13707.60 |
| Less variable costs | -1266.70 | -1083.30 | -800.00 | -336.00 | -433.00 |
| Net contribution (livestock) | 15415.00 | 22880.60 | 1514.90 | 2358.60 | 13274.60 |
| Contribution by farm enterprises | | | | | |
| Crops | 15969.96 | 27205.30 | 8637.00 | 9758.00 | 7354.00 |
| Livestock (other than KDPG) | 15415.01 | 22880.58 | 1514.90 | 2358.60 | 13274.60 |
| KDPG | 1530.40 | 1324.87 | 2606.73 | 1359.78 | 1002.60 |
| Total value of farm production | 32915.37 | 51410.75 | 12758.63 | 13476.38 | 21631.20 |
| Crops % | 48.52 | 52.92 | 67.69 | 72.41 | 33.99 |
| Livestock other than KDPG % | 46.83 | 44.51 | 11.87 | 17.50 | 61.37 |
| KDPG % | 4.65 | 2.58 | 20.43 | 10.09 | 4.63 |

Source: Data base monitoring 1995.

Main findings

The impact assessment study was designed to estimate likely impacts of the KDPG technology on household income, division of labor by gender and age groups within the smallholder families, crops and livestock interactions, and potential flexibility of the package.

We summarize the main findings relating to the contribution of the KDPG to income and nutrition in Table 1.2. In addition to these contributions, there were other benefits associated with the KDPG enterprise. These were direct consumption of the KDPG meat and production of manure which must have gone into improving the cropping system.

In the Machakos cluster, seasonal crops contributed well over half of the household income. Other important sources were livestock sales as well as remittances from those working off-farm. Perennial crops and credit seem to have contributed little. The KDPG enterprise contributed 2.58% to farm income in the lowlands (Kimutwa) and 4.65% in the highlands (Kitanga) cluster. This stands in sharp contrast with the situation at the Coast. The Kilifi cluster income generated from the KDPG represents 20% of the income, 10% in the case of Vuga and 4.6% in the case of the HPI/Matuga cluster. These percentages are sensitive to the size of the income, as can be seen in Table 1.2, the net value contribution (in Kenya

| Cattle/Goat milk | Cluster | | | | | Total |
|------------------|------------|------------|------------|------------|------------|---------|
| | Kitanga | Kimutwa | Kilifi | Vuga | HPI | |
| Milk | Value KShs | KShs |
| Cattle | 837.96 | 352.80 | 652.40 | 828.00 | 1149.60 | 3820.76 |
| No. of obs. | 8 | 8 | 5 | 2 | 4 | 27 |
| Cattle % | 65 | 58 | 80 | 69 | 75 | |
| Goat | 446.4 | 235.2 | 1166.8 | 364.80 | 375.60 | 1606.80 |
| No. of obs. | 2 | 4 | 3 | 8 | 4 | 21 |
| Goat % | 35 | 42 | 20 | 39 | 25 | |
| Total | 1284.36 | 606.00 | 819.20 | 1192.80 | 1525.20 | 5427.56 |

Table 1.3: The value of milk production in the five clusters

Source: Monitoring Data Base Socioeconomics.

Shillings) does not exhibit those differences. Net contributions are higher in the case of the Kilifi cluster and this is relative to milking information. Remittances were 5% of total farm value produced in 1995 by the Kitanga cluster, 4% for the Kimutwa cluster, 11% in the Kilifi cluster, and 12% for the Vuga cluster. Absolute value of the remittances did not vary as much as the relative importance resulting from the greater differences in total value of production. Perennial crops clearly have a major role in their smallholder economy of the Coast. The contribution of the KDPG in the Vuga cluster is between two and five times that of the Machakos clusters.

The KDPG was intended to enable smallholders for whom dairy cows were out of reach to have access to milk. Milk

production was therefore an important aspect of the KDPG impact assessment. This assessment involved the estimation of the numbers of farmers who milked the KDPGs, the amount of milk produced, the amount sold, if any, and the prices obtained. The main findings are presented in Table 1.3. No less than 21 farm families, two in Kitanga, four in Kimutwa, three in Kilifi, eight in Vuga, and four in the HPI clusters had some goat milk during 1995. KDPG milk accounted for 20-42% of milk produced.

Table 1.4 highlights farmers characteristics, regarding land use, remittances and credit. Farmers at the Coast have less land in average. This, combined with the fact that Kilifi and Vuga reported no access to credit in 1995, highlights the importance of the added KDPG enterprise, in generating

| Cluster | Land Use (acres) | Remittances K.Shs. | Credit K.Shs. |
|---------|---------------------|-----------------------|------------------|
| Kitanga | 27.8 (33) | 1520 (1322) | 80 (177) |
| Kimutwa | 17(16) | 1982 (2752) | 228 (539) |
| Kilifi | 15 (6) | 1466 (929) | - |
| Vuga | 9 (5) | 1692 (2025) | - |
| HPI | 8 (6) | 800 (578) | 850 (1344) |

Table 1.4: Land Use Credit and Remittances by Cluster at the Coast and Machakos during 1995.

Source: Land size Baseline 1993, Other Data base Monitoring, 1995.
Standard Deviations in Parenthesis

additional sources of income that may be consumed or invested in other activities.

Impact on the crop livestock interactions.

Crops and livestock interactions in smallholder farming often involve the feeding of crop residues to livestock; use of organic fertilizer to raise yields through improved plant nutrition, and in the case of oxen, supply of draft for timely field operations. Although the number of goats was small, these interactions were observed in all five clusters. In the three clusters at the Coast, all farmers reported that they used maize bran to feed the KDPGs, while in the Machakos clusters, various types of crop residue were used as supplementary feed for the goats. Goats produced manure which farmers claimed was richer than that from local goats. Average production of KDPG manure was 81 and 67 kg per goat in the Kimutwa and Kitanga clusters respectively. At least seven households had some KDPG meat: three in Kilifi, one in Kitanga, one in Vuga and one in the HPI clusters.

2. Gender Analysis.

Field research on three specific activities of the household impact assessment workplan were targeted from June through August. A combination of open ended interviews and a questionnaire, were completed. Qualitative and quantitative analyses was conducted. The questionnaire included three areas:

- a. Gender Analysis: Gender domains with the introduction of the KDPG to understand technology domains to

assist with diffusion and extension. This focused on labor and income to determine the domains of the economic activities related to the KDPG to understand the new household dynamics introduced by the new activity;

- b. Adoption of technological practices to determine if there are differences in adoption of elements of the technological package, and to analyze the correlation between gender, income, ethnicity and religion, distance to markets, availability of inputs, and/or agroecological conditions; and
- c. Credit sources available to farmers by gender. Data for the Machakos cluster has been entered and cleaned. Questionnaires for the Coast are currently being entered. This will be analyzed in the first quarter of 1997. Some frequencies from this survey have been completed and incorporated into the "Of Goats Groups and Gender" report.

The qualitative research took place from June through August. Results are presented in the technical report TR-MU-1 "Of Goats Groups and Gender". It was clear in all clusters that women were the primary caretakers of the goats. In the open-ended questions, the farmers were asked to explain what happened to a goat throughout the day. In most cases, it became clear that women were responsible for daily care of the goats and for their general management. Yet there were differences between the two regions which may be directly related to access of information. In Machakos, the women attend meetings, are often

members of other groups, and have time to interact and exchange information. At the Coast, men are seen as better caretakers because they appear to be more knowledgeable of the management system. Men usually attend the meetings, while women have little time to access information on the care of the animals, because they are more likely to be working at home.

3. Flexibility of the KDPG Technological Package.

The tradition of livestock is very important in the adoption of the KDPG (Table 1.5). Farmers in Kwale knew the most about the various technologies that accompanied the KDPG. In contrast, the farmers of the Machakos district were less able to enumerate the various technologies, and were also less likely to use them, with the exception of the sheds. However, the farmers in Machakos were more likely to use technologies learned for other purposes, for instance, nappier grass.

Farmers at the Coast have not been pastoralists; therefore, they are more likely to adopt 'the whole package'. On the other hand farmers in Machakos have a tradition of raising goats, and thus are more relaxed, adopting elements that interest them.

| Technology | Machakos | The Coast |
|----------------------|------------------|----------------------------------|
| Milking | 8 | 7 |
| Fetching Water | 8 | 21 |
| Cut and carry | 11 | 10 |
| Herding | 8 | 19 |
| Tethering | 8 | 19 |
| Kidding | 10 | 21 |
| Planting Fodder | 11 | 13 |
| Record Keeping | 7 | 11 |
| Spraying and Dipping | 12 | 20 |
| | N=12 (with KDPG) | N=23 (with KDPG and Crossbreeds) |

Source: Resource Management Labor and Gender Questionnaire, 1996, and "Of Goats Groups and Gender".

Table 1.5:
Adoption of
KDPG
Technological
Elements at the
Coast and
Machakos, 1996
(number of
farmers)

Activity: Markets -- Multiplication and Privatization.

Problem Statement and Approach: At the market level an analysis of sustained models for the multiplication of the Kenya Dual Purpose Goat Multiplication Program will be documented. Two distinct models will be analyzed: privatized multiplication flocks of elite KDPG (moderate/commercial and small scale/micro-enterprise), and the upgrading model (at the small scale).

Case studies will be developed documenting the small scale multiplication schemes at the Coast and Machakos. Both the pure breed pass-on scheme and the up-grading schemes will be analyzed. Prices of KDPG bucks will be recorded, as well as the rules set by each cluster to ensure both the pass-on mechanisms and the rotation of bucks. Capital accumulation at the household and community levels generated by the sale of bucks for upgrading will be recorded. Interviews will also be conducted with Non-Governmental Organizations (NGOs) interested in facilitating credit for micro-enterprise development.

A study of privatized multiplication flocks of elite KDPG with moderate scale commercial producers will be undertaken as part of the component's effort to sustain multiplication of this breed. Socio-economics tasks are:

1. Market analysis of current pure breeds in Kenya to look at price formation in order to set a price for the registered KDPG; and
2. Development of instruments for the economic evaluation of this multiplication strategy.

Progress: Commercial multiplication was initiated with an analysis of the potential multipliers and selection of two breeders. A profile of the Kenya breed market was developed and reported in last year's annual report. The study served as a base to set the prices for sale to commercial multipliers. At the end of July 1996, KDPG seed stock was sold for this purpose to these selected commercial farmers.

Two commercial multipliers signed agreements with KARI (see breeding annual report). An instrument for data collection of the commercial multiplication process was developed with the other projects. Evaluation of the multipliers will take place in 1997.

The upgrading multiplication process

will be formulated for the full proposal for regionalization of the KDPG. Here we report basically on the process of multiplication through the pass-on. Details on community organization related to the pass-on are described in the next section, "Community: Social Networks."

The initial clusters had 20 members each. By 1996, each cluster had 17 active original members. Four of the clusters started at the end of 1993; Kilifi started in March of 1994 with does that were not pregnant, which has affected the multiplication process delaying it roughly from ten to twelve months. Therefore, numbers on growth are not comparable between Kilifi and the other four clusters.

Activities in 1995-1996 have focused on the small scale/micro-enterprise multiplication model. Assessment of the rate of pass-on and identifying constraints are activities under the economic assessment of the KDPG on-farm. Crosses of native does with KDPG bucks are being documented to provide information for the development of a model of multiplication through upgrading.

At the small scale level the pass-on rate shows that the Vuga cluster has almost completed almost the process to all the original members in waiting, 82%

Table 2.1:
Households Owning KDPGs and Upgrades, and growth of flocks.

| | Kimutwa | Kitanga | Vuga | HPI | Kilifi | Total |
|-------------------------|---------|---------|------|-----|--------|-------|
| Farmer # with KDPG | 9 | 8 | 14 | 4 | 7 | 42 |
| KDPG # | 19 | 22 | 49 | 11 | 20 | 131 |
| Farmer # with up-grades | 1 | 0 | 9 | - | 2 | 12 |
| Up-grade # | 4 | 0 | 35 | - | 3 | 42 |
| % Pass-On | 52.9 | 47 | 82 | 29 | 41 | 49 |

Source: Resource Management Labor and Gender Questionnaire and Monitoring Data Base.

(Table 2.1). The other clusters have had more difficulties in the process. The Kilifi cluster had a delay of almost a year because the does were placed on-farm almost five months late and were not in kid at the time. The pass-on rate is close to that experienced in Machakos. The Matuga (HPI) cluster has not performed well. Analysis of the development of pass-on institutions is further developed in the next section.

In terms of the growth of KDPG numbers, this has increased by 262% from the original base flock of 50 placed on small scale farms. Mortality rates were high in the first year affecting the rate at which the flock grew. A progress report of the animal health project (1996) indicates that the mortality rates during this year have dropped dramatically, which will contribute further to the multiplication and the pass-on of the KDPG.

Activity: Community: Social networks.

Problem Statement and Approach: This activity focused on the impact of the KDPG at the community level, both at the Coast and Machakos, in terms of the development of social networks and positive externalities. Successful economic development is currently being correlated to the strengths that communities may have. Social networks facilitate access to resources in situations where markets do not function efficiently. The introduction of the KDPG in Kwale, Kilifi and Machakos is based on a community effort.

Social capital may be defined as the diversity of social networks that a

person, family, household, or community belongs to, allowing access to resources, information or assistance (e.g. insurance in case of income shocks). The networks may serve different purposes. Structural adjustment programs in some developing countries motivated the formation of networks so that families could deal with the problem of hunger. People's kitchens became popular in poor urban areas. In Andean societies, rural communities that have strong traditions and governing rules access their "social network" to use and exchange resources and services. A strong social network allows households to access resources under market failure conditions. SR-CRSP in a Bolivian peasant community showed that the presence of networks allowed families with different levels of wealth access to similar amounts of land. Existence of a strong social network also resulted in the construction of facilities and irrigation systems for tap water in the community, thereby reducing risk and improving the quality of life. Access to information was also instrumental in seeking funding for development projects for this rural community.

To approach these issues, the development of case studies documenting past community efforts, and the requirements introduced by small scale multiplication efforts that did not previously exist were utilized. Some have been more successful than others in promoting cooperative actions. This will be analyzed further, taking into account their history, social relations, economic base and demographic characteristics. Information is currently being collected on non-market mechanisms to access resources. Pass-

on of the KDPGs, funding mechanisms for various related activities, and degree of participation will be documented.

Criteria for evaluation was the development of case studies based on the five clusters to characterize the positive externalities of the pass-on, and the importance of networks and social capital in the success of the multiplication efforts.

Progress: Impact of the KDPG at the community level in terms of the development of social networks and positive externalities: PRAs and Actor Oriented Research. It is important to note that this research captures the perceptions of the farmers.

Participatory Rural Appraisals.

A series of participatory rural appraisals (PRAs) for the purpose of improving current understanding of the social and economic mechanisms which might propel smallholder adoption decisions pertaining to KDPG technologies were implemented. In response to concerns expressed about the poor performance of the KDPG technology on the farms in the Machakos site, two PRAs were implemented at the site during the third week of December 1995. The purpose was to facilitate a common understanding among farmers, KARI/SR-CRSP researchers, and extensionists about the causes of poor performance. Standard PRA procedures were used with minor adaptations. PRAs were also conducted at the Coast, and at the Kilifi cluster particularly. During the second week of July 1996, KARI/SR-CRSP researchers and members of the local extension service conducted a PRA

among farmers within the Kilifi cluster, at different levels of the organization.

Social Networks and Community Perceptions.

Field work conducted during June, July, and August at all clusters, with an actor oriented approach, has been completed (see technical report TR-MU-1 "Of Goats Groups and Gender"). Main findings on the pass on and community networks are the following:

Social networks are an integral part of the KDPG. In the case studies it became very clear that each group interpreted the purpose of the group and its goals differently. Vuga is closest to the initial objective for creating the groups, and has the past experience of members belonging to HPI. Kitanga has been the most creative with the group, using it as a means for uniting members for other projects as well as creating an ethic that secures a goat for each member by the end of the project. Kilifi and Kimutwa are still trying to find a position for the group in their communities.

Each group seems to require a certain impetus to ensure its survival. However, too much intervention is also not good, as is seen in Kilifi, to the degree at which some members did not believe the goats really belonged to the group. It is interesting and important to note that each group has fostered new networks in their communities. It is crucial for any new research to be able to gauge exactly how important the existing networks are for future pass-on systems. Further research will be carried out in 1996-1997, along with the information gathered from the resource management

labor and gender questionnaire which captured information on networks. The groups have provided some members with an opportunity to learn about goats and how to organize themselves.

Cohesion is important and it is something all the groups lack. There was very little to no collective history in the groups. Most of the information that members provided on the functioning of the groups was sparse. Both cohesion and social networks require some time. All the clusters are very young in this sense, and have not established themselves to cultivate networks that may assist with the pass-on system. The PRAs described above were in this sense very important. Although they were meant to get information from the farmers, they also served as a venue for them to meet. In other words, time and opportunities for interaction are important elements in making the pass-on system a success.

Active participation and contact with leaders, may this be through extension or from within the group, may have a positive effect, as experienced by the Vuga cluster. On the other hand, in the Kilifi cluster the same active participation resulted in a sense of the goats not belonging to the farmers. The contact that brought with it information about the goats and the groups was a positive effect on the Vuga cluster.

The case studies show that each group has a distinct dynamic. The biggest difference seems to be the level of interaction group members have with each other. The group that has performed better in terms of pass-on is also the one with most contact among members. An

objective of the pass-on set up by the project was to use the group as a means of social control to ensure care of the goats. Though the concept is good, groups of limited contact could not build social networks to enforce this form of control. The groups were much too young, and although the farmers are in the same area and know each other, more opportunities are required to build social networks. These are very important in a system like the pass-on, but little attention has been given so far to mechanisms for building them.

It is clear that the direct interaction between the farmers in the group and the people from the project is very important. The group with the most face to face contact with the project has the highest pass-on rates (Vuga). The groups with little interaction have lower rates of success (Kitanga and Kimutwa). In the Kilifi cluster, too much intervention has created a sense of not belonging and ambivalent results.

Delay in passing-on does is one of the major constraints identified by some clusters. This may be attributed to lack of social control; little pressure exists to avoid goat deaths. It may also be attributed to high mortality in previous years, as well as higher male kidding rates and abortions.

Two general questions drive this research activity that we will continue to pursue in 1997:

- a. How does the KDPG pass-on contribute to the development of social capital?
- b. How does the existence of social capital (presence of networks, other

group organizations, active leaders in the community) contribute to the success of the KDPG multiplication effort through the pass-on system?

Our hypothesis is that differences in existence, and strength of social networks and leadership in the community will be correlated to the level of success of the clusters; the higher the social capital the more successful the cluster will be in the pass-on and seeking assistance when problems arise. Extended families, ethnic groups, and the presence of community organizations to improve infrastructure are forces that can contribute to social capital formation. It is also important to discern if the success of the pass on is related to the added or continuous presence of extension and research personnel in the household, training opportunities, education levels, or other income generating opportunities. Therefore, non-governmental organizations' work with livestock, especially small ruminants and pass-on systems, will be studied further.

TRAINING

United States:

The SR-CRSP project is not currently funding training of graduate students through this program. There are two graduate research assistants involved in activities related to the SR-CRSP, one from Rural Sociology, *Nicoline de Haan*, and one from Agricultural Economics, *Dekha Sheikh*. A Kenyan undergraduate is involved in the resource management and labor activities related to the KDPG and is completing an internship with us. *Ms. Grace Njeru* was

field assistant for the impact assessment in Machakos before coming to Missouri to complete her undergraduate degree. She is writing a literature review on gender research and is working on the development of a data set from the Resource Management Labor and Gender questionnaire in Machakos and the Coast.

Short term in Kenya:

Elizabeth Wekesa and *Lutta Muhammad* were involved in the planning and execution of several PRAs in the Coast area and Machakos to bring together the members of the pass-on clusters.

ENVIRONMENTAL IMPACT AND RELAVANCE

Introduction of livestock is carried out with a supporting package to avoid the negative effects encountered in some areas as a result of overgrazing. Manure

COLLABORATING INSTITUTIONS

Kenya Agricultural
Research Institute (KARI)
P.O. Box 57811
Phone: 254-2-583304
Fax: 254-2-583344
E-mail: karinet@arcc.or.ke

United States:

Texas A&M University
Washington State University
Winrock International

from the goats is used to enhance soil productivity by the farmers participating in the impact assessment.

AGRICULTURAL SUSTAINABILITY

The KDPG is being assessed in two different agroecological environments to test the flexibility and adaptability of the technological innovations.

CONTRIBUTIONS TO U.S. AGRICULTURE

Research experience in interdisciplinary research and micro-enterprise development are crucial to sustainable production systems design in Africa and in the new agricultural policy setting of the U.S.

CONCERN FOR INDIVIDUALS

The focus is on peasant household families, and the purpose is to find ways to increase their welfare through technology and policy. Measuring the impact of the KDPG may be performed from the perspective of how this effort/event in their village contributes to the development of networks that create other positive externalities. For example, Kilifi farmers visited in August of 1995 mentioned that members were contributing funds to the group and there were discussions of investing in other enterprises, and that if the KDPG had not come they would not have met as they were now doing. (Another, perhaps positive externality brought on by the fact that the research project is working with extension, is that farmers are establishing links and obtaining information from the government extension services officers). Positive

impacts of the KDPG may be catalyzing the construction of networks outside the extended family setting, building social capital. These groups are an asset when there is interest in accessing group lending institutions.

CONTRIBUTIONS TO HOST COUNTRY

Development of interdisciplinary on-farm methodologies for biological and social science research at NARS. Introduction of livestock enterprises increase economic security and induce investments facilitating transition to market economies. Facilitating the commercial multiplication of the breed, the KDPG, contributes to the sustainability of the technology in the long run. Collaborative research with KARI scientists strengthens both U.S. and Kenyan research institutions, and provides opportunities for exchange that last many years.

LINKAGES

This is being developed with NGOs such as Heifer Project International, to assist in the on-farm multiplication and diffusion of the KDPG. This year, Farm Africa and other institutions have been visited to establish linkages for the regionalization of the KDPG.

GENDER ANALYSIS

Our household level analysis includes intrahousehold allocation of resources and income domains, as well as decision making. Since a form of impact is on nutrition, and studies show that women

outspend men 1 to 30 on food purchases for the children, we have to consider who manages the outputs generated by the KDPG and look for mechanisms to facilitate the flow if it does not exist.

COLLABORATION

The Sociology project bases its research on collaboration between Kenyan and U.S. scientists, and among all disciplines participating in the component. Research is also based upon collaboration with the private sector (commercial multipliers) and NGOs.

SUPPORT FOR FREE MARKETS AND BROAD BASED ECONOMIC GROWTH

Growth of in-kind and cash incomes contribute to family welfare, enabling accumulation and diversification to other economic activities and facilitating the development of demand which is crucial in economic development.

CONTRIBUTION AND COMPLIANCE WITH MISSION OBJECTIVES

Commercialization and micro-enterprise linkages of rural-urban flows is being emphasized by the USAID Kenya Mission. Our research is looking into privatization and community organizations, as well as safety-net mechanisms that will contribute producers participation in the markets.

SUPPORT FOR DEMOCRACY

Improving the economic and nutritional well-being of families through the KDPG increases their ability to participate in the economy. The KDPG

has also increased the ability of farmers to organize and seek other projects, helping to build social capital.

COMMENTS

This was a very active year. We had a resident scientist conducting research at Machakos and coordinating data collection and processing for the Coast and Machakos. At first, responsibility for the Coast was placed on the Collaborating Scientists, but a readjustment took place, in coordination with them, because data collection was still a problem at this site, even when research funds were available. The resident scientist had responsibility for KDPG research activities and coordinated with Willie Njoroge, who conducted an evaluation of breed markets for the impact assessment, and later concentrated on animal health research. The resident scientist was assigned to the site for a month to solve problems of lack of data for some farmers. We also had the opportunity of sending a doctoral candidate, rural sociologist Nicoline de Haan to conduct field research at both sites and coordinate the field testing and application of the resource management and labor questionnaire. Finally we were able to obtain internship funds for Grace Njeru to review the literature on gender and livestock for developing countries and work on the development and processing of the data from the resource management questionnaire. The Machakos data has been entered. The Coast questionnaires were recently completed and sent to Missouri for processing and analysis. Transportation problems delayed access to the field but these problems were eventually solved.

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MULTIVALENT VIRUS-VECTORED VACCINE FOR GOATS AND SHEEP

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NARRATIVE SUMMARY

The problem being addressed by this component is that infectious diseases including internal and external parasites continue to constrain efficient sheep and goat raising and to limit the introduction of improved breeds. Infectious diseases can be controlled by vaccines and univalent vaccines derived from attenuated or inactivated organisms are available for some diseases of sheep and goats. These univalent vaccines are used where production and distribution constraints can be overcome. However their use is very limited in most countries where sheep and goats are important sources of meat and milk. To make vaccines that control important diseases more readily available and economical to distribute and use, we are developing multivalent virus-vectored vaccines which could induce protection against several infectious diseases. These vaccines have several advantages over univalent vaccines, including economy of production and distribution, as well as not requiring expensive refrigeration lacking in many countries. It should be noted that the same virus vector could be used for sheep and goat vaccines and that some vaccine genes could be the same for diseases occurring in both goats and sheep.

To develop virus-vectored vaccines, a virus vector is needed and we chose to evaluate attenuated capripoxvirus (CPV) as a vector to deliver the foreign genes. Use of capripoxvirus meets many of the safety requirements because it is already being used as a univalent vaccine for goat and sheep pox. A capripoxvirus vector could be used to deliver a multivalent vaccine in the host country (Kenya), the rest of Africa, all of Asia, and possibly several other areas of the world. The addition of appropriate foreign genes from other organisms to the attenuated vaccine strain of capripoxvirus results in a recombinant capripoxvirus that is multivalent. That is, it should induce a protective immune response against capripoxvirus and to the disease from which the foreign gene was derived. A major activity of SR-CRSP funding is to evaluate a recombinant capripoxvirus expressing Rift Valley fever virus glycoprotein genes. Since vaccine genes from organisms causing other diseases are needed to increase the valence of the vaccine, research was done during previous grant periods on haemonchosis and Nairobi sheep disease. *Haemonchosis* is a parasitic disease of small ruminants that occurs in most countries of the world, including

the United States. Nairobi sheep disease virus infection of sheep and goats occurs throughout East Africa and may occur in many other African countries. Infection of flocks causes heavy losses due to acute gastroenteritis and abortion. There has been considerable progress on identifying the appropriate genes from *Haemonchus contortus* and from Nairobi sheep disease virus which should help bring these research areas to significant measurable endpoints. The component has also participated in the assessment of the health management of the Kenya Dual Purpose Goat (KDPG) in various sites in Kenya and in the preliminary field evaluation of the CCPV vaccine. Strategies were evaluated to control diseases in the KDPG study sites that are effective, but affordable by the farmers

RESEARCH

Activity: *Evaluate protective immunity induced by a new recombinant CPV expressing Rift valley fever virus glycoprotein genes (rCPV-RVFFV).*

Problem statement and approach: The problem continues to be the development of a vector that is safe and that will also express foreign genes in such a way to induce protective immune responses to the proteins encoded by the foreign genes. CPV, the cause of goat and sheep pox, was selected because these are important diseases in countries throughout Africa and Asia and because CPV is attenuated and is already being used as a vaccine in sheep and goats. In addition, some gene insertion sites and insertion plasmids have been described which work with CPV.

Progress: We now have the appropriate permission and new vector to complete this experiment. Obtaining both the permission and making the new vector have been extremely difficult. Research completed this year was focused on improving the insertion plasmid used to make recombinant capripoxviruses. Thymidine kinase, the gene fragment used for homologous recombination by p1114 was switched from a fragment derived from vaccinia virus to one which is very homologous to capripoxvirus. Using this recombination plasmid, a recombinant capripoxvirus that expresses the Rift Valley fever virus glycoproteins was isolated. The foreign genes were inserted in the capripoxvirus thymidine kinase gene and are functioning as predicted. Now with both permission and a constructed vector, the vector has been tested for its ability to induce an immune response in mice which was preliminary to its use in sheep. The mice experiments completed thus far indicate that the vector is working and will induce a neutralizing antibody response in mice to Rift Valley fever virus. However the titers have been low. Current experiments are trying to improve on the mouse response by changing dose and route. Nevertheless, recombinant capripoxvirus is being expanded and purified for the sheep experiment. As soon as the virus stock is sufficient, sheep will be immunized as proposed. The vaccinated animals will be given a booster inoculation one month later and then evaluated for antibodies to capripoxvirus and to Rift Valley fever virus using ELISA and virus neutralization tests. Implementation of a second booster inoculation will depend on the amount of antibody present to the two viruses. When a suitable antibody titer is obtained, both immunized sheep

and control sheep will be challenged with live viruses to determine the level of protective immunity induced by vaccination. Virus challenges will be done sequentially in both immunized and control animals first by using a capripoxvirus challenge and evaluation, followed by a Rift Valley fever virus challenge. We have tried to construct a prototype virus-vectored vaccine to induce protective immunity and to give positive results. However, induction of complete protective immunity may require optimization of the dosage of vaccine and route of administration. In summary, we anticipate that the necessary experiments can now be completed.

Activity: Evaluate protective immunity in goats induced by a new recombinant vaccinia virus expressing the *Haemonchus contortus* gut microvillar surface proteins designated GA1.

Problem statement and approach: Haemonchosis affects most goats and sheep in the world. In tropical and subtropical countries, it causes severe disease requiring expensive and regular drug treatment. A vaccine for haemonchosis would be of significant benefit to small ruminant owners, a benefit that would be enhanced by its inclusion in a multivalent vaccine. Our immunization trials using parasite gut homogenate to immunize young goats resulted in a significant protective immune response against *H. contortus* larvae challenge. A likely explanation for these results is that the parasite ingests antibody and immune cells as it feeds on blood and that these immune components kill or injure the worm. We described immunization with isolated

gut proteins in a previous report and the protection obtained was considered to be moderate, although very significant since the results identified specific gut surface antigens that induced protection against a blood-sucking nematode parasite. These proteins included 46, 52, and 100 kDa proteins that were designated GA1. The gene encoding these proteins was isolated and sequenced. The gene sequence included an open reading frame that encoded the 100 kDa protein that contained the sequence for the 46 and 52 kDa proteins. It should be noted that identification of this gene for testing does not guarantee that it will induce the protective immune response against *H. contortus* that we are seeking. It does mean that we can engineer the gene into a recombinant poxvirus using techniques that were successful with the Rift Valley fever virus glycoprotein gene.

Progress: A recombinant vaccinia virus was identified which contained the gene encoding GA1 except for a small portion of the 5' end of the gene which may encode a leader sequence. This recombinant virus did not express GA1 when evaluated by western blotting using a polyclonal antibody to GA1. The strategy was changed to use plasmid DNA vectors which would express the GA1 gene which injected intramuscularly. In addition, the complete GA1 sequence was used to construct the vector and it contains both leader and anchor sequences. This vector was used in immunizations experiments similar to those proposed for the recombinant vaccinia virus since it was anticipated that the information using this DNA vector would be similar to what would have been obtained with

the recombinant vaccinia vector. Goats were injected with plasmid DNA and boosted in the same way one month later. After the second injection, the DNA injected goats and control goats were challenged with *H. contortus* larvae. The two groups were evaluated by determining fecal egg counts between 20 and 35 days after challenge and by counting worms in the abomasum on day 36. There was no significant protection against challenge in the DNA immunized group. Since the isolated native GA1 protein causes significant protection against challenge, the results with DNA immunization indicate that we still have not found a practical way to make the GA1 protein for immunization.

Activity: Evaluate effective strategies for control of goat diseases in the coastal region of Kenya and other places selected for impact assessment of the Kenya Dual Purpose Goat (KDPG).

Problem statement and approach: Diseases including parasitic diseases (internal and external) form one of the main constraints to efficient goat production in many parts of Kenya. The nature and frequency of these problems may vary from one agro-ecological region to another and interventions should be designed to meet the needs of each area. In the impact assessment study, the approach to alleviation of animal health constraints was designed to allow maximum involvement of the animal owner in order to ensure sustainable health interventions during multiplication of the KDPG. Successful farmer's groups were formed and ways of raising money to purchase routine animal health inputs, such as acaricides and anthelmintics, were identified. A proportion of money raised

from sale of young bucks was set aside for animal health management. Through Participatory Rapid Appraisals, various animal health problems and constraints including trypanosomiasis, enterotoxemia, mastitis, coccidiosis, abortion and stillbirths, pneumonia, tick-infestation, and heartwater; lack of acaricide sprays; and high cost of drugs and anthelmintics were identified. To enhance farmers knowledge on animal health, a short course was organized. The farmers were taught methods of identifying sick animals, efficient application of acaricides and anthelmintics, administration of colostrum to goat kids soon after birth, and record keeping on animal health input data. Using this community participation approach in collaboration with the veterinary extension and KARI regional research centers, several strategies towards sustainable animal health were established and their effectiveness monitored. To minimize the initial high morbidity and mortality encountered when goats were moved to the coast region, the KDPG four-way crosses are now vaccinated against brucellosis, enterotoxemia and contagious caprine pleuropneumonia at least three weeks before movement from Ol' Magogo to a new site. At the farm level, the farmers have been encouraged to use effective acaricides to control tick infestation and tick-borne diseases and effective anthelmintics for control of gastrointestinal nematodes. To enhance tick control, the project provided a hand spray pump and some acaricides to the Vuga group. The acaricides were applied at weekly intervals. Tick control on individual farms is complicated since farmers not participating in the KDPG program rarely apply acaricides to their

animals. The anthelmintics are currently administered at three month intervals. The response by farmers, and the other stakeholders including the extension staff, towards ensuring the multiplication and production of the KDPG has been remarkable. The farmers have formed networks for sale of young male KDPG offspring to raise money for household use and for purchase of veterinary drugs. Because of the fear of presumed misuse of antibiotics by farmers that may lead to appearance of residual antibiotics in milk produced for human consumption, treatments requiring use of antibiotics are done by a veterinarian or by an animal health assistant under the supervision of a veterinarian. Whenever milking does are treated with antibiotics, the farmer is informed of the duration for which milk must be withdrawn from human use. This is to ensure that the children do not get residual antibiotics in the milk. The on-farm activities are monitored by community based animal health assistants with assistance from the veterinarians.

Progress: The animal health management strategies initiated on-farm have helped to drastically reduce the mortality in KDPG from the initial 67% in adult does and 33% in kids in 1994 to below 1% in all the age groups. This improvement has led to a rapid increase in the KDPG from those kids that were born on-farm and their off-springs. The population growth in Kilifi and Machakos has been slow mainly due to abortions, stillbirths and kid mortality associated with poor management and chronic trypanosomiasis. Investigations on how to halt this trend were implemented. To increase the cost-effectiveness of the animal health management, it is now clear that seasonal occurrence of the various

diseases in each agro-ecological environment should be determined so that known strategic interventions can be done to reduce costs. When diseases still occur after the implementation of known interventions, more complex disease investigations are needed.

Activity: *Conduct a field trial using the lyophilized contagious caprine pleuropneumonia (CCPP) vaccine and a field evaluation of the latex agglutination test for serodiagnosis.*

Problem statement and approach: Even though over one million doses of CCPP vaccine have been distributed in Kenya, there is still a demand by farmers for the vaccine which has not been met. Since the vaccine has not been tested in a large field trial, it was our plan to do such a trial. It was anticipated that data from such a trial could provide the incentive for greater vaccine production by private companies or government agencies in the various countries where the disease occurs.

Progress: Studies on the field evaluation of the protective efficacy of the lyophilized vaccine to Mycoplasma F38 were started in October 1995 in collaboration with staff from the Kenya Veterinary Vaccine Production Institute (Drs. Litamoi and Wachira). The study sites included farms in Kajiado, Narok and Baringo districts and were selected on the basis of frequent outbreaks of CCPP in goat herds. A total of 970 goats were eartagged and bled for serum (Table 1). The serum samples collected were assayed for agglutinating antibodies to the Mycoplasma F38 polysaccharide using a latex agglutination test. The number of sero-positive animals varied with the

regions. Approximately 50% of the seronegative goats in each herd were given 1.0 ml of the reconstituted CCPP vaccine subcutaneously, while the other 50% of sero-negative goats were left as non-vaccinated control groups. In all three

modulates infection in the herd. During continued monitoring of these goats, there was still no disease outbreaks in the non vaccinated goats making determination of the vaccine benefit for this experiment difficult.

Table 1: Field evaluation of CCPP vaccine in Baringo, Narok, and Kajiado districts.

| <i>District</i> | <i>Number that were seronegative/total tested</i> | <i>Number vaccinated</i> | <i>Number of controls</i> |
|-----------------|---|--------------------------|---------------------------|
| <i>Baringo</i> | <i>214/264</i> | <i>103</i> | <i>102</i> |
| <i>Narok</i> | <i>258/299</i> | <i>139</i> | <i>108</i> |
| <i>Kajiado</i> | <i>195/407</i> | <i>104</i> | <i>81</i> |

Note: On one farm in the Kajiado district, only 10 of 199 goats were seronegative. This farm was not used in the vaccine trial.

regions, the goats were monitored for sero-conversion and also for clinical CCPP every two months. During the course of the ongoing experiment, two outbreaks of CCPP were reported in goat herds from farms neighboring the experimental herds. No active cases of CCPP were observed in the experimental goats but 19% and 1% of the nonvaccinated goats from the Narok and Kajiado farms respectively, seroconverted as detected by the latex agglutination test. In the Baringo district, no major outbreaks of CCPP were reported in goats from two farms involved in the experiment, although the farmers reported that infected goats were camped in the region while in transit to livestock markets. In each of the two Baringo district farms, 16% and 15% of the nonvaccinated goats were found to have seroconverted. Seroconversion in the nonvaccinated goats indicates infection, however it is not clear why there were no clinical signs of infection. It is possible that having 50% of the herd vaccinated

Activity: Clone and express vaccine genes from Nairobi sheep disease virus (NSDV).

Problem statement and approach: NSDV is a member of the bunyavirus group of negative strand, segmented RNA viruses. The strategy is to clone relevant genes of the virus, particularly the M segment that encodes the surface glycoproteins 1 and 2 of the virus and to make a cDNA expression library with this segment. A cDNA library of the three genome RNA segments of NSDV was developed and the library screened for the expression of viral antigens in recombinant *E. coli* using hyperimmune sera. Because of the problems associated with RNA degradation, especially with increased manipulations, this strategy was not successful. Therefore, the next strategy was to start with total viral RNA rather than trying to isolate M segment from RNA separated on agarose gels. While this strategy worked very well, it made identification of the clone for the M segment difficult.

Progress: Bacterial clones containing cDNA inserts derived from total RNA of NSDV were induced with IPTG to express recombinant proteins. Total bacterial proteins were separated by SDS-PAGE and screened in a Western blot assay using a cocktail of monoclonal antibodies to the 110 kDa viral protein. A positive clone has not been identified. SDS-PAGE analysis of membrane fractions obtained after treatment of purified virus with 1% Triton X-100 and centrifugation in 10-60% (w/v) sucrose density gradients at 39,000 rpm for 3 h identified a 110 kDa protein as the major viral membrane protein and a 31 kDa protein as a minor membrane protein based on the intensity of staining with Coomassie brilliant blue. These two proteins represent the G1 and G2 of NSDV. The viral nucleocapsids of NSDV were purified and a 45 kDa protein shown to be the nucleoprotein. Viral RNA was isolated from purified nucleocapsids and separated by electrophoresis in 1.2% formaldehyde agarose gels and stained with ethidium bromide. A 4.2 kb RNA was identified as the viral M segment RNA. The RNA has been recovered from agarose gels by electrophoresis; however, following isolation and re-electrophoresis in 1.2% agarose gels, much RNA degradation was observed. As a result of this degradation into short oligonucleotides, the eluted RNA could only be used as radiolabelled probe for screening a new cDNA library derived from RNA isolated from highly purified virus. In addition, production of hyperimmune antisera to purified 110, 31 and 45 kDa was done and together with the radiolabelled nucleic acid probes of M segment RNA, identification of clones expressing the G1 and G2 of NSD virus should be made. Using synthetic primers,

the 5'-end extensions of M segment cDNA were synthesized in a PCR reaction (in collaboration with ILRI) to generate full length viral gene. Screening of these libraries is still in progress.

TRAINING

All training involved degree candidates and there was no non-degree training this year.

Francis Karanu, a KARI employee and a WSU graduate student, was funded by SR-CRSP until Oct. 1, 1995. He was funded by a USDA project belonging to his major professor Doug Jasmer. This USDA project had objectives related to his research. He completed his PhD. thesis in December 1996 at WSU and is preparing to return to Kenya and his position at KARI.

Reuben Soi is a PhD. candidate in the WSU Department of Veterinary Microbiology and Pathology. He is completing his research in Kenya with his salary being paid by KARI. SR-CRSP pays his research costs because he is a KARI collaborator and is working on the rCPV-RVFV vaccine construction and testing.

ENVIRONMENTAL IMPACT AND RELEVANCE

The principal impact that multivalent virus-vectored vaccines can make on the environment is to make small ruminant production more efficient. The use of effective vaccines should reduce the number of animals needed to produce the required amount of milk, meat and fiber.

AGRICULTURAL SUSTAINABILITY

It is difficult for small ruminant production to be sustainable if deaths and production losses due to diseases exceed a fairly low threshold. By developing vaccines and diagnostic tests that can be used to decrease losses due to diseases, their application could result in a decrease in the number of animals required by individual farmers to sustain current levels of production. SR-CRSP has continued close collaboration with Kenya institutions involved in animal disease diagnosis and control including the Kenya Agricultural Research Institute, the Ministry of Agriculture, Livestock Development and Marketing, the International Livestock Research Institute, and the University of Nairobi Veterinary School. By developing an inexpensive, reliable and effective multivalent virus-vectored vaccine for sheep and goats, the project aims at improving production of small ruminants in Africa and other parts of the world.

CONTRIBUTIONS TO U.S. AGRICULTURE

A primary contribution of this research to U.S. agriculture is in the area of haemonchosis research. Research on vaccines for *H. contortus* has a similar benefit for U.S. producers as it does for other countries. In addition, SR-CRSP has funded research over several years on ovine and caprine retrovirus-induced diseases (OvLV, OPC, CAE) that are of considerable economic importance to U.S. agriculture. Results from this research have provided diagnostic tests and information for vaccine development.

CONTRIBUTIONS TO HOST COUNTRY

Contributions of this project to the host country are in degree training for host country scientists, developing research facilities, seeking vaccines for diseases of small ruminants that occur in several countries including the host country, and assisting the host country in developing related projects. Virus vectors are of interest to ILRI, Nairobi, Kenya and scientists from ILRI have been collaborating with us on the CPV vector development. Also, scientists from ILRI have participated in the training of SR-CRSP graduate students.

SUPPORT FOR FREE MARKETS AND BROADBASED ECONOMIC GROWTH

If effective vaccines are developed they should be made and distributed by private companies in the countries in which they are used.

CONTRIBUTIONS TO AND COMPLIANCE WITH MISSION OBJECTIVES

The Mission officials have stated on many occasions that they support small ruminant development in Kenya. Our research on disease control has enabled that goal in the past and will continue to do so in the future.

CONCERN FOR INDIVIDUALS

This is reflected in our successful relationships with host country farmers, students, scientists and administrators.

SUPPORT FOR DEMOCRACY

We try to contribute to this issue by example.

HUMANITARIAN ASSISTANCE

Our efforts have been based on the belief that training host country people is one of the long-term contributions we can make to the area of humanitarian assistance. Also, improving the health of sheep and goats helps farmers with small land holdings.

COMMENTS

The SR-CRSP research on Nairobi sheep disease, haemonchosis, and ovine lentiviruses has been enhanced by grants from other agencies. The Nairobi sheep disease has additional support from a three-year PSTC grant to develop a diagnostic test based on monoclonal antibodies and recombinant antigens. Haemonchosis research also has support from a USDA competitive grant and the ovine lentivirus research also has support from USDA and NIH competitive grants.

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SOCIOLOGICAL ANALYSIS OF SMALL RUMINANT PRODUCTION SYSTEMS: KENYA MULTIVALENT VACCINE

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NARRATIVE SUMMARY

Two activities were conducted in year 17 by the Kenya Agricultural Research Institute and the University of Missouri in social science research related to animal health. The first is the study of vaccine production and distribution, which was conducted in collaboration with the Kenya Veterinary Vaccine Production Institute (KEVEVAPI). Three specific objectives were: to determine the economic costs of production of the Contagious Caprine Pleuropneumonia (CCPP) vaccine in liquid and lyophilized forms; to develop a profile of users of the vaccine, identified through sales by KEVEVAPI, sole producer of Caprivax; and to determine the level of competition in use of facilities, equipment, and labor in the production of Rinderpest Caprivax and Contavax vaccines. Costs of production were analyzed and recommendations to increase efficiency proposed. Sensitivity analysis was conducted to determine levels at which current prices would be economically efficient. The analysis of competition shows that given current vaccine production levels there would not be competition in the production of lyophilized CCPP vaccine. The market profile highlights the declining role of government as main buyer of the vaccine

and the increasing participation of private individuals and non-governmental organizations (NGOs) as consumers in this market.

The second main activity was to study the demand for animal health services, with an emphasis on CCPP vaccine as a case study. We conducted this study with the collaboration of the Kenya Veterinary Field Services Office. A study was conducted on the availability and use of animal health delivery services at the sites where the Kenya Dual Purpose Goat is being tested. The report appears in the 1995 SR-CRSP annual report. After an appraisal of the knowledge of animal health delivery services for small ruminants we decided to conduct a study to determine the demand for these services and for CCPP vaccines, specifically. A survey was developed and field tested with the farmers participating in the testing of the lyophilized CCPP vaccine. Three sites were selected to conduct the study, Koibatek (pastoral production systems), Kitui (agropastoral production systems), and Kajiado (pastoral production systems). All are CCPP endemic areas. Preliminary data analysis from the Koibatek study shows that farmers are

not aware of the existence of the vaccine. Demand estimations for the liquid and lyophilized vaccines will be conducted in 1997. Further information on this project can be found at the MU Social Science web site. Reports and publications from this component are also available. The URL is: <http://www.ssu.missouri.edu/ssu/srcrsp>.

RESEARCH

Since the early 1980s, the SR-CRSP animal health research component has focused its research on the development of vaccines for small ruminants. A Caprine Pleuro Pneumonia vaccine was produced in the 1980s, in liquid and freeze dried forms, and development of multivalent vaccines for small ruminants continues. At present, changes in government policies affecting the Veterinary Field Services are affecting animal health delivery, from production to consumption. The activities reported by the socioeconomics project concentrate on two specific areas of the delivery system and focus on CCPP vaccine as an example, the production of CCPP vaccines (liquid and freeze dried) by KEVEVAPI and the use of vaccines and animal health services by the smallholder livestock producers.

Activity: *Vaccine Production Distribution and Use.*

Problem Statement and Approach: The original intent of socioeconomic research on the CCPP vaccine was to measure the impact, or potential impact of small ruminant diseases and the savings that vaccines can provide. Measuring this impact requires an

understanding of the costs of production and delivery of vaccines, as well as the costs of the disease to producers in the absence of the vaccine. Elements required for this assessment are the activities carried out this year, both on the production and delivery of vaccines, as well as the characteristics of producers, and the potential buyers of vaccines. The potential economic impact of vaccine research by the SR-CRSP on CCPP required information on current and past reported outbreaks, animal treatments and losses due to this disease, and cost savings to producers. Comparisons of treatment costs vs. vaccinations are made to determine unit cost reduction in the production of small ruminants. Two levels of impact may be measured, the first the result of the production of CCPP vaccines, the second the cost reduction result of the freeze dry processing stage of the vaccine.

The approach used was outlined in our workplan: to determine the feasibility of a returns to research study on CCPP, sondeo type interviews will be conducted at each step of production distribution and user chain. KEVEVAPI officials will be interviewed to determine current production conditions and who the buyers are. Interviews with health service providers, and agencies funding vaccination campaigns will be conducted. This rapid appraisal informs of the need for further study of the demand for animal health preventive services. Costs of vaccine production will be calculated, when collaboration with KEVEVAPI is established. Outbreaks will be documented through government records. Appropriate methods to assess the impact of the vaccine will be selected. Absence of

epidemiological research on CCPP makes measurement of potential returns to research difficult.

Progress: The review of methodologies to measure the impact of vaccine is complete and is part of a technical report: "The Small Ruminant Industry in Kenya: Assessing Returns to Animal Health Research and Vaccines, A Review" that will be available in February of 1997.

Collaboration with KEVEVAPI was established to achieve three specific objectives: a) to identify the buyers of Caprivax at KEVEVAPI; b) to estimate and compare the production costs of both types of Caprivax (CCPP vaccines), liquid and lyophilized; and c) to establish whether there is competition for machinery between Caprivax and the two other vaccines that are produced at the Muguga production unit, namely Rindervax and Contavax.

To determine if there was need to study the causes affecting the delivery of animal health services and CCPP vaccines, several interviews were conducted, "sondeos," at the research institutions (domestic and international), the production centers for vaccines (KEVEVAPI), the extension services working on the delivery of health services, and with the district and

division veterinary officers at various sites. The purpose of the study was to understand what is known about the presence and effects of CCPP on smallholder flocks and the animal health delivery system for small ruminant producers.

Officers from ODA, ILRI, KEVEVAPI, and the Veterinary Field Services were interviewed. A common response was that there was not enough information on the reasons for lack of use of the vaccine and constraints to the delivery. Statements from the Veterinary Field Services indicated that farmers did not want or were unable to pay for the vaccine. Information on outbreaks reported by the Veterinary Field Services would record initial mortality when reporting outbreaks but not the total mortality nor morbidity rates associated with them. Therefore it was not a good indicator of the pattern of the disease. The outbreaks would be lower boundary indicators, since not all were officially reported.

Demand For Vaccines: KEVEVAPI

A first approximation of the demand for vaccines was through the sales by KEVEVAPI, the sole producer of the vaccine (Caprivax). A market profile was developed to determine the users of the vaccine within in the past five years.

Table 1: Sales of CCPP Vaccines by KEVEVAPI 1991-1995 (number of doses).

| Buyers of Caprivax (CCPP vaccine) | | | | | | | |
|-----------------------------------|---------|---------|--------|--------|----------|------------|---------|
| Year | Govt. | Private | NGO | Export | Research | Parastatal | Total |
| 1991 | 127,500 | 1,009 | 0 | 0 | 0 | 0 | 128,500 |
| 1992 | 44,400 | 17,400 | 46,400 | 10,000 | 4,600 | 200 | 122,000 |
| 1993 | 150,150 | 41,950 | 0 | 0 | 3,300 | 2,000 | 160,400 |
| 1994 | 80,000 | 68,600 | 3,300 | 0 | 2,000 | 0 | 153,900 |
| 1995 | 22,850 | 39,250 | 600 | 0 | 1,700 | 0 | 64,400 |

Source: An Economic Analysis of the Production of CCPP Vaccine, 1996.

| Year | Batches | | Doses produced | Average Yld/batch | Average Cost (liquid) | Average Cost (freeze) |
|---------|---------|--------------|----------------|-------------------|-----------------------|-----------------------|
| | Total | Efficiency % | | | | |
| 1992 | 17 | 53% | 66,100 | 3,889 | 11.60 | 16.20 |
| 1993 | 31 | 97% | 180,450 | 5,821 | 5.50 | 8.34 |
| 1994 | 43 | 58% | 171,500 | 3,989 | 7.21 | 10.20 |
| 1995 | 22 | 41% | 67,800 | 3,082 | 11.83 | 17.30 |
| Average | 29 | 66% | 121,463 | 4,300 | 7.59 | 11.16 |

Table 2: Production efficiency and average cost in Kenyan Shillings of CCPP vaccine (Caprivax) at KEVEVAPI.

Source: "An Economic Analysis of the Production of CCPP Vaccine".

Sales are summarized for the period 1991 through 1995 in Table 1. Data indicate that the government was the most important customer at the beginning of the 1990s, with a decreasing participation as cost recovery policies are introduced. The export and NGO markets are thin, and volatile. The number of private individuals purchasing the vaccine directly are increasing but have not been able to substitute for the main buyer, the government. Sales in 1995 were 50% lower than in 1991. As a consequence, KEVEVAPI reduced the production of vaccines. The decrease in government purchases, the reduction in vaccination campaigns, and the market volatility have led, in 1996, to a situation where outbreaks are taking place, and KEVEVAPI is having difficulties filling the increased demand, both from the private and NGO sectors (see Technical Report: An Economic Analysis of the Production and Distribution of CCPP Vaccine).

Cost Analysis of CCPP Vaccine Production

Production costs were estimated using the vaccine formula (variable inputs) as well as assigned fixed capital and labor. Costs were calculated for 1991 to 1995, allowing for measurement of changes in productivity which have direct impact on

the average cost of production. Sensitivity analysis was carried out to assess production conditions of CCPP vaccine that are economically efficient. Results on productivity indicate that KEVEVAPI was not operating in previous years to full potential. This is reflected in the doses per batch, the maximum potential being 20,000 doses per batch.

Table 2 presents the costs of production calculated for Caprivax using actual production data for the period from 1992 to 1995. Current yields are lower than the potential level, especially because of recurrent losses of the culture through contamination, as the efficiency indicator shows. Sensitivity analysis measured the effect of improved production processes that minimize frequency of culture media contamination.

Table 3 presents an average yield based on production between 1992 and 1995. Sensitivity analysis modifies productivity to increase towards maximum potential. Only with yields of 10,000 doses per batch or more does the cost of production equate the price set by the government. Details of the analysis and scenarios can be found in the technical report "An Economic

Table 3:
Sensitivity analysis with different yield levels.

| Year | Total batches | Yield/batch | Cost/unit (liquid) | Cost/unit (freeze) |
|-----------------|---------------|------------------------|--------------------|--------------------|
| Aggregate 92-95 | 113 | 1 ^a = 4,300 | 5.53 | 11.34 |
| | | 2 ^b = 7,000 | 3.40 | 5.06 |
| | | 3 ^c =10,000 | 2.38 | 3.93 |
| | | 4 ^d =12,000 | 1.98 | 3.49 |

Key:
a is the actual yield/batch obtained,
b,c,d are sensitivity analysis with three higher levels of yield per batch
Source: Ibid.

Analysis of the Production of CCPV Vaccine.” As a result of the study, recommendations were given to KEVEVAPI to reduce losses in the production process. Both the liquid and freeze dry vaccine costs were calculated, as well as the competition for equipment.

We still need to understand the discrepancies between the numbers quoted in the vaccination campaign record and the production of the vaccine, because the latter is lower than reported vaccination campaign numbers. We also found from the analysis that there is no competition in machinery nor labor in the production of CCPV vaccine, both in the liquid and lyophilized forms, at the present production levels of Rinderpest and Contavax.

Demand of Animal Health Services

This is also an important part of the research in the following Activity. Based on a rapid appraisal, interviews with decision makers and researchers, the project decided to conduct a study of animal health delivery and demand services. This would inform KEVEVAPI and animal health providers of the market conditions and potential for vaccines, and the constraints faced by users (household producers) in the delivery of CCPV vaccines and other animal health services. Because production decisions for several

economic activities are joint (substitution and complement effects exist), especially in livestock production, information on the production system, demographic and cultural characteristics of the household producers were included in the study.

Four different ethnic groups involved in livestock, specifically goat production were chosen: Maasai, Kalenjin, Bantu, and Hamites. Districts for each ethnic group were identified and chosen: the Maasai in Kajiado, the Kalenjin in Koibatek, the Bantu in Kitui and the Hamites in Marsabit. During 1996 the Kalenjin in Koibatek were surveyed. The Bantu and the Maasai will be studied in 1996-1997. Marsabit, a small ruminant camel production system, will be studied by KARI social scientists. Production system characteristics, ethnicity, agroecological/rainfall zones, and market integration were the variables selected to characterize distinct groups, which may influence decision making. It was required that all production systems be in CCPV endemic areas, and that vaccination campaigns be conducted in provinces and specific districts chosen. Support from the Veterinary Field Services Offices in Kabete, districts and locations was obtained for this study. It was also required that the sites selected reflect the characteristics of the production systems where the lyophilized form of the vaccine was

being tested (Suswa, Mogotio, Ngong and Kajiado). In order to assure this, the questionnaire was field tested with the farmers participating in the vaccine experiment. The questionnaire elicited information on the household production systems, animal herd composition, economic activities, livestock composition, animal health problems, and small ruminant diseases.

In order to develop the survey, a literature review of methodologies was completed during 1995, a questionnaire was developed and field tested for two months during 1996 and applied to sixty farmers at the first site selected, Koibatek. This was formerly part of the Baringo district, where the Kalenjin live in pastoral production systems with some crop production for home consumption, as the survey results indicated. In July 1995, just before the creation of Koibatek from the Baringo, the district had the second largest goat population (732,000 head in 1994) after Kajiado (875,000).

Previous reports indicated that this was not only an endemic site with outbreaks, but that it had also experienced heavy vaccination campaigns financed by the government. Mogotio was the division selected, and two locations identified, Mugurin and Koibos. A sample frame was developed with the assistance of local chiefs, sub-chiefs, and a veterinary officer, and applied to 60 farmers selected at random. The data was processed and cleaned, and a code book developed. Data analysis is on-going, and will be completed in 1997, as will data collection and analysis of additional sites with a contingent valuation model.

Farmers were asked to identify and rank animal diseases, for all livestock and for goats and sheep. They were also asked current methods to treat or deal with diseases, as well as experience with vaccines and animal health providers. Production and income information by economic enterprises was also gathered. A section on CCPP disease sought to understand outbreak patterns in households' flocks, prevention and treatment methods used by producers, and associated costs. The purpose was to look at the level of risk, probability of occurrence, and treatment expenditures as well as to identify economic losses. Distance to animal health delivery and awareness of the existence of vaccines was critical to the contingent valuation study. Information on willingness to pay information was identified by stating the value in terms of goats and cash income of vaccinating the flock. Some interesting results of the preliminary data analysis indicate that although this is an area of outbreaks where vaccination campaigns against CCPP have taken place, the majority of farmers were not aware of the existence of the vaccine.

Two other sites will be researched in 1996-1997; Kitui, an agropastoral semi-arid district in Eastern Province, and Kajiado, a pastoral setting (Maasai people) in the Rift Valley.

Activity: Animal Health Services and Use at the Household Level.

If the animal health project conducts the testing of the CCPP vaccine on farm, socio-economics will participate in collecting social and economic information on the targeted producers,

the costs of vaccination, reported presence of other animals and diseases and their occurrence.

Problem Statement and Approach: Identification of prevalent animal health problems perceived by producers in the Machakos and Coast sites; current treatments and practices reported by the sample; costs, availability, and farmer's use of veterinary services for the KDPG.

Progress: In Machakos and the Coast, a survey has been conducted on the prevalence of animal diseases, use of animal health services, and practices used by farmers. This was reported in the Annual Report 1994-1995. Records on services provided to KDPG by the vet will be recorded. The costs incurred by the farmer were recorded as well when the information was available and has been used to calculate the net value of the KDPG enterprise (see KDPG Component section in this annual report). A baseline report on animal health diseases and practices used by producers was developed. Data gathered and processed on the costs of treatment of small ruminant prevention and treatment of diseases was calculated and used in the evaluation of the KDPG.

Another level of analysis at the household level was initiated. It consisted of the analysis of smallholder production systems and their expenditures on animal health according to animal species and disease problems. This is on-going research conducted in Koibatek, Kitui and Kajiado, as well as the CCPP testing sites. This has been partially reported under "Demand for Animal Health Services." Data in Koibatek was gathered during 1996.

Sixty Koibatek farmers were interviewed and the information has been entered and cleaned and is being analyzed. The Kitui sites have been identified and the sample frame developed. Surveys which have been field tested will be conducted here in January of 1997. Sixty Kitui farmers will be interviewed and an additional 60 will be interviewed in Kajiado towards April. The five farmers participating in the CCPP vaccine testing experiment were also interviewed.

Koibatek, according to the responses obtained, is an area where CCPP is considered a problem by farmers, ranked first as the most frequently mentioned. East Coast Fever was second. It was also interesting that although Koibatek is a district (formerly part of Baringo) experiencing vaccinating campaigns, 60 percent of the farmers were unaware of the existence of the vaccine for CCPP. Fifty percent of the farmers had participated in vaccination campaigns for other diseases. Valuation questions as well as current costs to deal with CCPP were also elicited. Mortality, morbidity and frequency of outbreaks have been recorded. Farmers currently deal with CCPP by using antibiotic treatments which they tend to administer themselves.

TRAINING

No training activities were supported with SR-CRSP funding. The University of Missouri, along with a scholarship from Winrock International, supports the doctoral studies of *Ms. Dekha Sheikh*, co-investigator from KARI, who actively participates in animal health

research in the U.S. Her doctoral program started in January of 1995, she has successfully completed her qualifying exams. She remains a KARI employee and is co-investigator in our project. Her research focuses on methodologies for returns to research evaluation of CCPP and estimation models for demand of health services. She also collaborated in the U.S. with data analysis of the Bolivia SR-CRSP project.

ENVIRONMENTAL IMPACT AND RELEVANCE

Research on animal health is targeted at improving the productivity and feed use efficiency of small ruminants.

AGRICULTURAL SUSTAINABILITY

Loss of efficiency resulting from animal health problems is high, and prevention can reduce mortality and morbidity that result in economic losses. To contribute to sustainable livestock production systems, animal health is a necessary condition.

CONTRIBUTIONS TO U.S. AGRICULTURE

Experience in interdisciplinary research is crucial to sustainable production systems design in the U.S.

CONTRIBUTIONS TO HOST COUNTRY

Animal health delivery systems are being transformed in Kenya, a result of reforms and privatization. The present studies contribute to an understanding of

how animal health services are currently being delivered and the economic impact of diseases on the flocks of livestock producers in semi-arid and arid environments. Collaborative research with KARI scientists strengthens both U.S. and Kenyan research institutions.

LINKAGES

Linkages are being established with NGOs such as Heifer Project International. Linkages with Kenyan Veterinary Vaccine Production Institute and the Veterinary Field Services Offices have been established to provide information useful to institutions dealing directly with the producers.

GENDER ANALYSIS

Our household level analysis always incorporates gender questions regarding decision makers and, when possible, identifies income domains by gender.

COLLABORATION

The Sociology project bases its research on collaboration between Kenyan and U.S. scientists, and the component has a multidisciplinary approach. Collaboration with KEVEVAPI members and with veterinarians in the field have been part of our approach to research.

SUPPORT FOR FREE MARKETS AND BROAD-BASED ECONOMIC GROWTH

Increasing net in-kind and cash income, through efficiency in production, contributes to the welfare of families and enables them to accumulate and diversify to other economic activities,

facilitating the development of demand, all of which are crucial in economic development.

CONTRIBUTION AND COMPLIANCE WITH MISSION OBJECTIVES

Private sector development is being emphasized by the USAID Kenya Mission. Our research is looking into privatization and community organizations, as well as safety-net mechanisms that will allow producer participation in markets.

CONCERN FOR INDIVIDUALS

The focus is on peasant household families, and the purpose is to increase their welfare. Some current practices of treating animals directly by the producers may have impact on family members if knowledge about the antibiotics is not known and products are

consumed from treated animals. We are researching the knowledge of farmers regarding appropriate handling of antibiotics.

SUPPORT FOR DEMOCRACY

Improving the economic and nutritional well-being of families through increases in efficiency provides support for democracy.

COMMENTS

Activities in Animal Health Research at the user level started this year. This research is on-going and the main focus of activities in 1996-1997 when 180 household producers will be interviewed to study the health delivery services available in semi-arid and arid regions of Kenya. Resources from the National Agricultural Research Project KARI will fund activities in the Kitui site.

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|---|----|
| HAIR SHEEP PRODUCTION SYSTEMS: GENETIC IMPROVEMENT OF SHEEP AND GOATS | 63 |
| ECONOMICS OF SMALL RUMINANT PRODUCTION SYSTEMS AND MARKETS | 69 |
| FEED RESOURCES AND NUTRITION OF SMALL RUMINANTS | 78 |

HAIR SHEEP PRODUCTION SYSTEMS: GENETIC IMPROVEMENT OF SHEEP AND GOATS

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NARRATIVE SUMMARY

As reported in 1995, a composite population of sheep based on imported and local breeds (25% Barbados Blackbelly, 25% St. Croix, 50% Sumatran), with substantially greater productivity per ewe than the local breed, has been developed at the Sungai Putih Research Station in North Sumatra by the SR-CRSP breeding project. Work in 1996 has involved: 1) expansion of the composite (M) population to a 300-ewe nucleus flock and initiation of a selection program for its further improvement; 2) continuation of smaller (50+) ewe flocks of St. Croix (H) and Barbados x Sumatran (BC) flocks at the Station to provide rams for off-station multiplication units; and 3) establishment of multiplication programs to produce M sheep on farms of the region.

The M, H and BC groups at the Station are being selected for weight of lamb weaned per ewe, lamb growth rate, and decreased wool cover. Data are also being recorded on measures of parasite resistance (EPG, worm eggs per gram of feces, and PCV, packed blood cell volume) for investigation of sources of variation in parasite resistance, and for possible future use in selection.

Mean performance levels of sheep in this flock declined some from the previous two years, due to lack of adequate funds to purchase supplementary feed, and reduced grazing time due to less funding for labor. Thus there is some concern about the prospects for maintenance of this flock over the long term without external funding, although there is widespread interest in Indonesia in this resource and its potential contributions to improved sheep performance in the tree cropping agriculture of the region.

Three multiplication units of 35-50 ewes each of the M population were set up with farmers of the region in late 1995 and early 1996. These flocks consist of HC (St. Croix x Sumatran) ewes from the station flock, mated to BC (Barbados x Sumatran) rams also from that flock. Numbers in these flocks were expanding rapidly and the condition of the sheep in the best of the flocks was excellent during the last visit of the Principal Investigator (PI) in May 1996.

A larger multiplication unit based on local ewes mated to H rams from the Station, with the female progeny to be mated to BC rams, was being set up in late 1996.

These nucleus and multiplication flocks, if appropriately maintained, will provide a source of improved sheep breeding stock for Indonesia and, potentially, other countries of the region.

RESEARCH

Activity: Maintenance of nucleus flock of Sei Putih Hair Sheep at the IP2TP station.

The program this year consisted primarily of expansion of numbers of the composite population (25% St. Croix, 25% Barbados Blackbelly, 50% Sumatran, designated "M") in the IP2TP nucleus flock, along with maintenance of St. Croix (H) and Barbados x Sumatra (BC) groups to provide rams for off-station multiplication flocks. To make room for the expanded M flock, the local (Sumatran-S) ewes in the IP2TP station flock were distributed to farmers in cooperating projects, and the HC (St. Croix x Sumatra) crosses were distributed, along with BC rams, to farmers contracting to participate in the production of M breeding stock. Three such multiplication units involving farmers in the Sungai Putih area who had participated in the CRSP ORP (Outreach Research Project) were set up between November 1995 and March 1996. A staff member from IPT2P provides technical support.

The M population in the nucleus flock was expanded to 300 breeding ewes during the year. The oldest M ewes produced their first lambs in December 1995, so lambs born during 1996 included both first generation 3-way crosses (HC x BC and reciprocal) and

"F₂" progeny resulting from intermating HC x BC progeny. This composite population, which substantially outperforms the local Sumatran sheep in growth rate and total weight of lamb weaned per ewe per year, is the foundation stock for a potential new breed (Sei Putih Hair Sheep), although at this early stage it is not yet a new breed. Development of a breed from this foundation will require several years of selection for defined phenotype and performance levels.

With regard to the target phenotype, the consensus decision was to breed for rams without horns, but not at this time to favor a specific color pattern; the base population includes white, light brown, blackbelly pattern and a few black and spotted animals. Ignoring color will permit more intense selection for performance traits. Selection will be directed towards increasing weight of lamb weaned per ewe per year (which is determined by fertility, prolificacy, lamb survival, milk production and lamb growth potential) and freedom from wool. Some additional selection for growth rate will result from selecting individual rams for weight-for-age. Selection against wool is being practiced because wool is not a commercially valuable product in this environment and wool-free sheep suffer less heat stress and avoid the labor of shearing. Growth rate is of interest because of its contribution to sale weight and there is a market demand for heavier carcasses.

To effect this selection, data are routinely recorded on mating dates, birth dates, ewe mating and post-partum weights, lamb weights at birth and at 2-week intervals to weaning (at 90 days), 6-

month and 12-month weights. Wool scores (degree of cover and density) are recorded at 3, 6, and 12 months of age, and annually thereafter. Data on worm eggs per gram of feces (EPG) and packed cell volume (PCV) are recorded on lambs at weaning and at 6 and 12 months. The latter data are used to study genetic and environmental factors affecting parasite loads - a major constraint to production in this warm, humid environment. Some rams have also been artificially challenged with known numbers of *haemonchus* larvae to further evaluate genetic differences.

Activity: Assistance in development of private sector multiplication flocks.

The multiplication program consists of two components:

1. Farmer flocks (50±) ewes, obtaining HC ewes and BC rams from the Station flock to produce 3-breed composite (M) animals for sale to other farmers.
2. Larger (government agency or large commercial operator) flocks (100-1,000) ewes. Since the nucleus flock cannot at this time produce enough ewes to initiate breeding units of this size, these flocks will acquire local (S) ewes which will be mated to St. Croix (H) rams, with the female progeny (HC) mated to Barbados x Sumatran (BC) rams. The H and BC rams will come from flocks of 50+ ewes maintained in the IP2TP flock for this purpose.

Three of the smaller units have been established, the first in November 1995, and more are planned.

The first of the larger flocks (500 ewes) was initiated in late 1996. IP2TP staff are providing technical assistance to the owners/managers of these flocks.

OVERVIEW

In general, all goals set out in the 1995-96 workplan have been accomplished. IP2TP staff are maintaining the performance recording and selection activities in the M, H and BC station (nucleus) flocks and monitoring the multiplication units. Unfortunately, with termination of CRSP funding, there have been shortages of funds for needed supplementary feeds and for labor, with the result that mean animal performance, e.g. lamb weaning weights, in the station flock decreased in 1996 compared to 1990-95. There is a great deal of interest, on the part of government agencies in Indonesia (and other southeast Asian countries) and of producers, in expanded sheep production. The sheep developed at Sei Putih appear to be the most productive stock available for the tree crop production systems of the region. It is hoped that the interest in sheep production can be translated into support to maintain, improve and expand this stock for the benefit of the region's farmers and consumers.

TRAINING

One IP2TP staff member, *Melinda Hutauruk*, was funded to attend a parasitology course/workshop in Thailand in January, 1996, to learn additional techniques in evaluating small ruminant parasite loads.

Ismeth Inounu of the RIAP staff in Bogor had been supported earlier by this project for M.S. and Ph.D. studies at IPB, Bogor. He was awarded the Ph.D. in September, 1996.

Aron Batubara, a project participant, is being funded for M.S. studies at the Prince Leopold Institute for Tropical Medicine in Antwerp, Belgium, by the European Economic Community (EEC) project, directed by Dr. V. S. Pandey, with which the SR-CRSP has collaborated for several years. Mr. Batubara will be using SR-CRSP data for his thesis.

Djoko Pitono of the Sei Putih staff is using SR-CRSP data for his Ph.D. dissertation on "Genetic Analysis of Tropical Sheep Production and Reproduction" at the University of New England, Australia. The breeding project Principal Investigator will serve as an external examiner.

AGRICULTURAL SUSTAINABILITY

As described in previous annual reports, the grazing of sheep under tree crops reduces the need for chemical herbicides and diversifies sources of income for smallholder producers. Thus, it contributes to both environmental and economic sustainability of the region.

CONTRIBUTIONS TO U.S. AGRICULTURE

Direct benefits to U.S. agriculture are probably quite limited. However, this project represents one of the more comprehensive evaluations of hair sheep

done anywhere in the world to date. Sheep production in southern, especially southeastern, U.S. is very limited because of lack of adaptability of temperate wool breeds to the warm, humid conditions. There is interest in expanding sheep production in that region through use of hair sheep. Data from this project provide good information on two important hair sheep breeds.

CONTRIBUTIONS TO HOST COUNTRY

Contributions to the host country are very substantial. As indicated earlier, expansion of sheep production in Sumatra is a high priority for local, national and international (Golden Triangle) government agencies. The SR-CRSP has introduced two new breeds, evaluated them for growth, reproduction and health through two generations, and shown the crosses to be significantly superior to local sheep in efficiency of production. We have initiated production of a new population to permit a logistically straightforward utilization of this genetic material, outlined a plan for its improvement, and helped train local scientists. We have also assisted in organizing off-station breeding stock multiplication units.

LINKAGES AND NETWORKING

The project has collaborated with the EEC in research and training activities and has assisted in sponsoring a number of international conferences, the latest in May, 1996, at Parapat, North Sumatra, on "Small Ruminant Production Systems: Recommendations for Southeast Asia."

SUPPORT FOR PRIVATE ENTERPRISE AND ECONOMIC GROWTH

The multiplication program, a major feature of this year's project activities, is contributing directly to economic activity of smallholder farmers. It is anticipated that within a relatively short time (one to two years), this activity can bring substantial economic benefit to the participating farmers, as well as provide for more rapid expansion of numbers of breeding animals for other farmers. It is also expected, assuming present indications of success are realized, that the number of participating farmers will expand fairly rapidly.

COMMENTS

This project has been remarkably successful in achieving the goals defined in the 1990-95 plan. We have introduced three hair sheep breeds to North Sumatra (one by artificial insemination) and evaluated their crosses with the local sheep through the second generation. We have shown two of the crosses to be distinctly superior to the local sheep and to the third crossbred, created a composite population based on the two superior crosses, and helped develop a flock of 300 ewes of the new composite. We have contributed to training of local staff, helped develop a long-term breeding plan for the composite population, and helped initiate a multiplication program for the new stock involving local farmers. This has been achieved in a six-year period (five years since actual introduction of two of the test breeds) in spite of a one-year hiatus in USAID funding and a two-month early termination of the final year activities in country.

The success of the program is due in large part to the combined efforts of two exceptionally capable resident scientists, Ruth Gatenby and, in 1995-96, Roger Merkel, and the dedicated input of the many IP2TP participants. The success in introducing new germ plasm was undoubtedly helped by the fact that we chose tropical breeds rather than breeds of temperate climate origin.

The information developed, the composite stock and the selection and multiplication plan provide the potential for a substantial contribution to more efficient animal production in tree-crop systems of Southeast Asia. Whether this potential is reached depends now on the local institution, which is a relatively young institution with young staff and limited experience in managing a project of this nature. It is unfortunate that the SR-CRSP was unable to make provision for an extension of the project, or at least for some linkage activities to provide assistance with the multiplication and extension phases just barely beginning as we leave. It is hoped that the host country scientists can carry on the project and realize the potential provided by the CRSP research and development achievements.

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Iskander Mirza

RIAP, Bogor:

Subandriyo (Ph.D.)

PUBLICATIONS

(Note: Since this is the final report for this project, some "in press" publications are included.)

Gatenby, R.M., G.E. Bradford, M. Doloksaribu, E. Romjali, A.D. Pitono and H. Sakul. Comparison of Sumatra sheep and three hair sheep crossbreds. I. Growth, mortality and wool cover of F₁ lambs. *Small Ruminant Research* (in press).

Gatenby, R.M., M. Doloksaribu, G.E. Bradford, E. Romjali, A. Batubara and I. Mirza. Comparison of Sumatra sheep and three hair sheep crossbreds. II. Reproductive performance of F₁ ewes. *Small Ruminant Research* (in press).

Romjali, E., V.S. Pandey, A. Batubara, R.M. Gatenby and A. Verhulst. 1996. Comparison of resistance of four types of rams to experimental infection with *haemonchus contortus*. *Veterinary Parasitology* 65:127-137.

PRESENTATIONS

Bradford, G.E., Subandriyo, M. Doloksaribu and R.M. Gatenby. 1996. Breeding strategies for low input systems. *Proc. Conf. on Small Ruminant Production Systems*, ed. R. Merkel. Parapat, Indonesia, May 12-15, 1996 (in press).

ECONOMICS OF SMALL RUMINANT PRODUCTION SYSTEMS AND MARKETS

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NARRATIVE SUMMARY

The Economics program in Indonesia focuses on research, technology transfer, commercial agriculture and institution building. The program works with farmers who raise sheep in conjunction with plantation tree crops or food crops through on-farm research and evaluation. Evaluation of integrating sheep into farming systems, the establishment of commercial sheep farms and gender analysis are main activities.

The integration of small ruminants into transmigration schemes involving oil palm and food production can be accomplished in the same manner used for schemes involving rubber production. Sheep can graze oil palm plantations at an earlier tree age than rubber areas as the animals cannot harm the tougher trunks found on oil palm trees. Cost benefit ratios were favorable for both oil palm and food production areas. The Indonesian government is now considering transmigration schemes where small ruminants would be the main income component.

The demand for the new composite breed developed by the SR-CRSP program is high. To increase the number

of animals and to establish production in the private sector, seven multiplication farms were started with smallholder farmers. Releasing this new breed into private production moved research results from government experimental station control to on-farm production. The larger size of this breed compared to local sheep and its potential ability to meet export quality standards ensure its expanded use and future as a valuable component of the livestock industry.

The resources and potential of women farmers in Indonesia are underutilized. By extending sheep packets to women farmers the potential benefits and increased production can be evaluated. Interest by women farmers in receiving sheep packets and technology is high. Their enthusiasm for the project and willingness to upgrade their animal husbandry skills illustrates the importance of considering women as farmers and including them specifically in livestock development projects.

RESEARCH

Problem statement and approach: In many areas of the world's humid tropical lowlands agricultural development has emphasized the production, by both commercial estates and smallholders, of monocultures of commercial tree crops, such as rubber, oil palm, coconut and cocoa. These areas contain vast quantities of potential feed resources for ruminants in the form of forages growing in plantation understory. Cash flow is a barrier to successful smallholder production of tree crops between the time of establishment and initial harvest, a period of, at minimum, several years. Small ruminant production is one means of increasing cash flow during this time period and beyond, and reducing risk through the use of the underutilized feed resource.

The long term goal of the economics component in Indonesia is to contribute to the development of integrated production systems to benefit smallholders raising sheep or goats in conjunction with tree crops or other farming systems. To accomplish this, the economics program focused on evaluation of integrated production systems, the establishment of farms to multiply a suitable sheep genotype for production in North Sumatra and the extension of sheep packets to women farmers.

Activity: Integrated production systems.

In addition to transmigration programs involving rubber, other programs provide two hectares of land for oil palm or food crop production. Small ruminants can be integrated with these

cropping systems in the same way they are integrated with rubber. Integration with oil palm has the advantage that, unlike rubber trees, oil palm trees are not harmed by sheep and grazing can commence at a younger tree age, two years. In 1992 the SR-CRSP along with the Sungai Putih Research and Assessment Installation for Agricultural Technology (RAINAT) introduced sheep packets into one area of oil palm (Sosa II Transmigration Area, South Tapanuli) and one area of food crop production (Subulussalam, South Aceh). After three years of production, the number of farmers involved in the program increased by 68% and 37%, respectively, due to the revolving scheme employed. Economic analysis of sheep production showed benefit to cost ratios of 3.2 (Sosa) and 2.7 (Subulussalam). In Sosa, the area of oil palm production, monthly income was increased by 62% for the time period studied while in Subulussalam, food crop production area, income increased by 129%, with the increase mainly due to sheep production. In a separate study of sheep integration with oil palm at Bah Jambi PTP VII, the benefit cost ratio was 1.5. It was also found that regular anthelmintic use was required to control internal parasite infestation and decrease mortality.

The introduction of sheep into rubber plantation areas can be beneficial in reducing costs as well as increasing revenue. Research showed that grazing sheep in rubber plantations is a low cost and effective method of controlling weeds compared to herbicides or manual weeding, reducing costs by up to 22%. Using sheep as weed control agents is also an environmentally friendly

method, reducing the amount of chemical herbicides sprayed onto plantation areas. Sheep convert the nutrients trapped in the understory forage to valuable animal products such as meat or hide, and also aid in recycling of said nutrients into chemical forms that are useful to the tree crop.

Activity: *Hair sheep multiplication units.*

During the last six years the SR-CRSP, in collaboration with scientists from the Central Research Institute for Animal Science of Indonesia and RAINAT, have developed a new breed of hair sheep called the Sei Putih Hair Sheep, or Domba Sei Putih, along with the feeding, housing, health care and other management technologies required for sheep production. The new breed of sheep is the result of crossbreeding experimentation using the local Sumatra sheep and two imported breeds, the Virgin Islands St. Croix and Barbados Blackbelly. The future goal of the sheep industry in North Sumatra demands an annual production of three million slaughter animals with many of them export quality to enter the Malaysian and Middle Eastern markets. Export quality animals must obtain a liveweight of 35 to 40 kg. This weight is not obtainable by local stock but can be reached by the new composite breed. Thus, the demand for the Domba Sei Putih is expected to be great, not only for export but also to fill the growing domestic demand for small ruminant meat and meat products. In order to meet this demand the number of farms producing this breed must be increased.

To facilitate the needed increase in Sei

Putih Hair Sheep production, multiplication farms (units) were established with smallholder farmers. The founding of these multiplication units fulfilled two goals, increasing the number of Sei Putih Hair Sheep and moving this breed from being produced solely by the government to also being produced by the private sector. The long term success and sustainability of this breed will depend upon its acceptance by producers and its market value. Research by the breeding and nutrition components have shown that the Domba Sei Putih has good reproductivity, larger body size and faster growth rate than the local Sumatra sheep. Due to these characteristics, the increasing demand for meat and the potential for export, the Domba Sei Putih should become a valuable component of the livestock industry in North Sumatra and the surrounding provinces in the future.

Multiplication farms were established in two production clusters, one near RAINAT in the Sei Putih area and the second in Membang Muda, site of the Outreach Project Membang Muda. The advantages of developing clusters of Sei Putih Hair Sheep production are 1) ease of supervision and provision of extension services, 2) the areas become known as sources of the new breed and 3) inputs, such as anthelmintics, can be organized more easily. Farmers were selected on the basis of their previous experience with sheep, available forage supply for grazing and cutting to supply additional feed, their animal husbandry skills as determined by farm visits to evaluate their existing flocks and the financial and management resources the farmers could put towards the successful rearing of this new breed. In the Sei

Putih cluster four units were established with a total of approximately 170 ewes. In Membang Muda a further three units were started with an additional 140 ewes. These units were established in a revolving scheme so that, in the near future, young ewes would be available for other farmers to receive. This will help ensure the rapid expansion of the Sei Putih Hair Sheep.

Activity: Gender analysis.

An extension project aimed at women was begun with the formation of the Women in Livestock Development (WILD) project on Pulau Gambar, North Sumatra. Seven co-operators were chosen to receive five ewes and one crossbred ram each with the stipulation that within three years, ten ewe lambs should be returned by each collaborator in a revolving fund with other interested women receiving those lambs. Included in this project were monthly visits by scientists and extension personnel from RAINAT. These visits were done by members of all disciplines, forage, nutrition, breeding, management, health and economics. During these visits questions were answered, recommendations given and at times demonstrations held such as the making of mineral block, treatment with anthelmintics and planting of introduced forages. The co-operators received a barn supplement as well as medicines from the project. Each person received a copy of the extension booklet published by the CRSP in Bogor. The co-operators also prepared a small plot of ground to plant introduced forages as a demonstration. Gliricidia tree seedlings were also given to the co-operators.

The WILD co-operators as well as farmers of multiplication units also participated in a one-week training in sheep production conducted by RAINAT scientists. The training combined theory as well as hands-on experience. The co-operators made contacts with the multiplication unit farmers in their area and also those from Membang Muda. On the final day a field trip was taken to visit each co-operators farm in the area. The WILD co-operators are all very enthusiastic and willing to upgrade their animal husbandry skills. This bodes well for the continued success of this program.

TRAINING

Mr. Elianor Sembiring completed an M.Sc. degree in agricultural economics at the Bogor Agricultural University (IPB). His schooling was totally funded by the SR-CRSP.

Mrs. Juniar Sirait completed an intensive English course at the University of Central Arkansas, Conway, Arkansas from June through August, 1996. In addition to improving her English, Juniar upgraded her computer skills. During her time in Arkansas she traveled to Heifer Project International where she learned more about their Women in Livestock Development program. She also submitted a proposal to Heifer Project for funding of the women and livestock project started by the SR-CRSP Economics component in November, 1995.

Short courses:

From June 11-15, 1996 a short course for multiplication unit farmers and the women in livestock development program was held at the Sungai Putih RAINAT taught by scientists at the institution. There were a total of 27 participants, seven multiplication unit farmers, seven co-operators in the women and livestock project, one extension agent, ten additional farmers who were to receive sheep packets in another project and two private individuals. Areas covered included breeding, nutrition, management, health and economics. Practical experience was gained by working visits to the sheep barns and forage plots.

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Elianor Sembiring, Economist
Setel Karokaro, Socioeconomist

PUBLICATIONS

As this is the last year of the project, publications that are in progress, review or in press are also listed:

De Boer, A.J., F.E. Walters and M.A. Sharafeldin. 1996. Impacts of the policy reforms on livestock and feed production, consumption and trade. In: L.B. Fletcher (ed.). *Egypt's Agriculture in a Reform Era*. Iowa State University Press, Ames, IA. pp. 112-147.

Farmers Manual on Small Ruminant Production. 1996. Revision of Ludgate, P. 1989. On Farm Research on Small Ruminants. Text version. mimeo. (in progress).

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Karokaro, S. 1996. Sheep development program in nuclear estate areas (NES): Case of OPMM project. Paper presented at the National Livestock Seminar of Indonesia. November 5-11, 1996. Bogor, Indonesia.

Karokaro, S. 1996. The economic value of sheep grazing to manage weeds in rubber plantations. SR-CRSP Working Paper No. 171.

Karokaro, S., J. Sirait and A. Misniwati. 1996. Economic analysis of sheep production in the transmigration nucleus estate smallholders in North Sumatra. 8th Veterinary Congress and meeting of the Malaysian Veterinary Society. August 22-25, 1996. Ipoh, Malaysia.

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Karokaro, S., J. Sirait and A. Misniwati. 1996. Economic analysis of sheep production of the transmigration nucleus estate smallholder in North Sumatra. SR-CRSP Working Paper No. 169.

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- Misniwaty, A., S. Karokaro and J. Sirait. 1996. Animal health delivery network for sheep and goat smallholders in North Sumatra. In: R.C. Merkel, T.J. Soedjana and Subandriyo (eds.). *Small Ruminant Production: Recommendations for Southeast Asia. Proceedings of a workshop held in Parapat, North Sumatra, Indonesia. May 12-15, 1996.*
- Nerlove, M. and T.D. Soedjana. 1996. Slametans and sheep: Savings and small ruminants in semi-subsistence agriculture in Indonesia. SR-CRSP Working Paper No. 168.
- San, N.N. and B.J. Deaton. 1996. Feasibility of integrating sheep and crops to smallholder rubber plantation in Indonesia. The Second Conference of the Asian Society of Agricultural Economists. August 6-9, 1996. Bali, Indonesia.
- San, N.N. and H. Knipscheer. 1996. A dynamic supply response model for sheep and goat industry in Indonesia. The Second Conference of the Asian Society of Agricultural Economists. August 6-9, 1996. Bali, Indonesia.
- San, N.N. and J. De Boer. 1996. Changing role of goats in dynamic world agriculture. VI International Conference on Goats, May 6-11, 1996. Beijing, China.
- San, N.N., B.J. Deaton, J. Sirait and A. Misniwaty. 1996. Selected characteristics of smallholder rubber producers in Aceh Province, Indonesia. SR-CRSP Working Paper No. 170.
- San, N.N., T. Soedjana and A.J. De Boer. The Asian Experience. Chapter 4 of FAO book "The Potential of Small Ruminants to Enhance Food Production and Rural Income". In press.
- Sirait, J., S. Karokaro and A. Muljadi. 1995. Credit requirements and sources of fund analysis. SR-CRSP Annual Report 1994-1995. SR-CRSP, Galang, North Sumatra, Indonesia. pp. 6-19.
- Sirait, J., S. Karokaro, A. Misniwaty and R. Merkel. 1996. On farm performance of small ruminant technologies in OPMM and ORP farmers in North Sumatra. mimeo.
- Soedjana, T.D. 1996. Economic analyses of small ruminant production for low and high input systems. In: R.C. Merkel, T.J. Soedjana and Subandriyo (eds.). *Small Ruminant Production: Recommendations for Southeast Asia.*

Proceedings of a workshop held in Parapat, North Sumatra, Indonesia. May 12-15, 1996.

Webb, S.H., N.N. San, J. Sirait, A. Misniwaty, S. Karo Karo and A. Muljadi. 1996. The contribution of women to rural household income: Case study of the Sosa transmigration unit in North Sumatra. SR-CRSP Working Paper No. 166.

PRESENTATIONS

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Karokaro, S., J. Sirait and A. Misniwaty. 1996. Economic analysis of sheep production in the transmigration nucleus estate smallholders in North Sumatra. 8th Veterinary Congress and meeting of the Malaysian Veterinary Society. August 22-25, 1996. Ipoh, Malaysia.

Karokaro, S., J. Sirait and A. Misniwaty. 1996. Economic analysis of a sheep production system in oil palm plantations. In: R.C. Merkel, T.J. Soedjana and Subandriyo (eds.). Small Ruminant Production: Recommendations for Southeast Asia. Proceedings of a workshop held in Parapat, North Sumatra, Indonesia. May 12-15, 1996. Poster presentation.

Knipscheer, H.C., N.N. San, S.H. Webb and S. Karokaro. Economic potential of small ruminant agribusiness in Southeast Asia. In: R.C. Merkel, T.J. Soedjana and Subandriyo (eds.). Small Ruminant Production: Recommendations for Southeast Asia. Proceedings of a workshop held in Parapat, North Sumatra, Indonesia. May 12-15, 1996.

Merkel, R.C., S. Karokaro, J. Sirait and A. Misniwaty. 1996. Persistence of technology introduced by Small Ruminant Collaborative Research Support Program outreach projects. In: R.C. Merkel, T.J. Soedjana and Subandriyo (eds.). Small Ruminant Production: Recommendations for Southeast Asia. Proceedings of a workshop held in Parapat, North Sumatra, Indonesia. May 12-15, 1996.

Misniwaty, A., S. Karokaro and J. Sirait. 1996. Animal health delivery network for sheep and goat smallholders in North Sumatra. In: R.C. Merkel, T.J. Soedjana and Subandriyo (eds.). Small Ruminant Production: Recommendations for Southeast Asia. Proceedings of a workshop held in Parapat, North Sumatra, Indonesia. May 12-15, 1996. Poster presentation.

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- smallholder rubber plantation in Indonesia. The Second Conference of the Asian Society of Agricultural Economists. August 6-9, 1996. Bali, Indonesia.
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- Soedjana, T.D. 1996. Economic analyses of small ruminant production for low and high input systems. In: R.C. Merkel, T.J. Soedjana and Subandriyo (eds.). Small Ruminant Production: Recommendations for Southeast Asia. Proceedings of a workshop held in Parapat, North Sumatra, Indonesia. May 12-15, 1996.

FEED RESOURCES AND NUTRITION OF SMALL RUMINANTS

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NARRATIVE SUMMARY

The successful integration of genetically improved sheep into the farming systems found in Southeast Asia required that adequate nutrition, along with proper management and health care, be provided. Systems have been developed and tested for the integration of sheep into both tree crop plantation and food crop producing areas. This encompasses both large scale commercial production in an agribusiness environment and small scale production by limited resource farmers. Nursery evaluations of forages adapted to the soil and climatic conditions found in North Sumatra resulted in the selection of grass and legume species appropriate for both grazing and cut and carry situations. In addition, high producing tree legumes have been tested and, through the generosity of the Oxford Forestry Institute, three high producing lines of *Gliricidia sepium* have been made available for farmers.

The use of *Gliricidia sepium* in conjunction with an energy supplement made of inexpensive by-products was found to increase growth rates of grazing lambs. By using tree legumes, which a farmer can plant, and inexpensive by-products, increased rates of gain and

faster turnover of production resulting in increased profits can now be practiced by smallholder farmers with few resources to put towards animal production.

RESEARCH

Problem statement and approach: Sheep in Indonesia are integrated into farming systems of smallholders and on the island of Sumatra are integrated into tree crop (rubber and oil palm plantations). In highly populated areas and in many villages, sheep are kept by limited-resource farmers with little to no land. In some cases the sheep are allowed limited grazing and in other cases are confinement fed in a cut and carry system. For families employed by or families living near tree crop plantations, sheep are becoming integrated to utilize the forage under the tree canopy thereby reducing cutting and herbicide costs. The sheep are often cared for by children in the afternoon, after school. The critical need is to develop systems of management which will improve productivity and sustainability within the existing farming and family system. Lack in quantity and

quality of feed is one of the major problems in all systems.

The introduction of hair sheep germplasm with increased size and growth potential may also change the feeding systems required. Potential local feed resources need to be identified and developed if sheep production is to be sustainable and economical.

Activity: *Nursery evaluation of forages.*

In May 1994 a nursery, containing forage species that were potentially useful in the climate and soil conditions found in North Sumatra, was established at the Sungai Putih Research and Assessment Installation for Agricultural Technology (RAINAT), North Sumatra. Included in the 66 species of herbaceous forages and 18 species of tree legumes were local species and introduced species from collections of the Centro Internacional de Agricultura Tropical (CIAT) and Commonwealth Scientific and Industrial Research Organization (CSIRO). The objective of the trial was to determine those species that performed best in the edapho-climatic conditions found in North Sumatra for further use and testing by farmers.

Three blocks were used with each forage species present in each block. Every two weeks measurements were made on growth form, establishment, insect and pest susceptibility and seed production. After establishment, harvests for dry matter production were made every 42 days for the grasses and legumes and every 84 days for the tree legumes. Plots were intentionally left unfertilized. In May and November 1995 samples of

each plot were taken for future chemical analysis. These samples are presently being analyzed for nitrogen, neutral detergent fiber contents and *in vitro* dry matter disappearance. Tree legume leaf samples were harvested in November 1995 and May 1996, and freeze dried at the Rubber Research Center, Sungai Putih. These samples are presently being analyzed for tannin and phenolic content.

Of the grass species planted, the two highest producing were *Andropogon gayanus* and two lines of *Paspalum atratum*, BRA 9610 and Pantaneira. These species are suitable for cut and carry fodder with *A. gayanus* which is also appropriate for grazing situations. Other species for grazing that performed well were the *Brachiaria* species, *B. humidicola*, *B. brizantha* and *B. dictyoneura*. The *Brachiaria* species are very persistent once established. While photosensitisation problems have been reported with *B. decumbens*, no such problem exists with *B. humidicola*. *B. humidicola* requires heavy grazing in order to control the amount of stemmy material and maintain nutritive quality.

A selection of *Arachis glabrata* and *A. pintoi* were also evaluated. *Arachis glabrata* outperformed *A. pintoi* in terms of dry matter production. *Arachis pintoi* is more suited to grazing situations due to its persistence under shade and ease of establishment whereas *A. glabrata* is more suited to cut and carry conditions. Of the other herbaceous legumes tested the highest producers were of the genus *Stylosanthes*. The highest producer was *S. scabra* followed by various accessions of *S. guianensis*. *S. guianensis* is of more interest than *S. scabra* due to the higher quality forage produced. A small plot

of *S. guianensis* has been planted at RAINAT for seed production.

Of the tree legumes, the highest producers were three lines of *L. leucocephala* along with *Cassia siamea*. Acceptability of *C. siamea* by livestock is low while the quality and performance of ruminants fed leucaena has been well documented. At present psyllid resistant lines of leucaena are being tested at RAINAT as part of a larger worldwide project involving the Oxford Forestry Institute. *Calliandra calothyrsus* and *Paraserianthes falcataria* also performed well. High tannin levels in *C. calothyrsus* may limit its potential use while *P. falcataria* is characterized by slow regrowth after pollarding. While *G. sepium* dry matter production was not as high as other species, its use by farmers continues to grow due to the ease of establishment from stakes, ease of management and low incidence of disease or pest problems. Introduced "elite" lines developed by the Oxford Forestry Institute outperformed the local variety. Seed of three top producing lines, Monterrey, Belen Rivas and Retahuleu, was obtained from the Oxford Forestry Institute. Over 6,000 seedlings were grown in polybags for distribution to farmers, future use in growth and dry matter production trials at RAINAT and for planting around pastures at RAINAT to provide a source of high quality fodder for the hair sheep population and a source of future planting material.

In order to further propagate these best producing forage species and make planting material available to farmers, a plot of land was prepared for future establishment of the above mentioned

grasses and legumes. Selected species to plant and release for farmer use included: *P. atratum*, *A. gayanus*, *S. guianensis*, *A. pintoii*, *B. himidicola* and *B. dictyoneura*. Due to the popularity of *G. sepium*, its high quality and ease of establishment, it will remain as the main tree legume species recommended to farmers. In the higher elevation, more acidic soils areas of North Sumatra, *C. calothyrsus* may be more suitable.

Activity: *Growth potential of the Sei Putih Hair Sheep.*

The Small Ruminant Collaborative Research Support Program (SR-CRSP) has worked with the Center for Research in Animal Sciences of Indonesia (CRIAS) to develop larger, faster growing sheep breeds with less wool cover. A crossbreeding program was started utilizing two imported Caribbean breeds, the Virgin Island St. Croix and Barbados Blackbelly. When crossed with the local sheep, the resulting progeny of both breed crosses have proven productive in the tropical climate found in North Sumatra. As a final step of the breeding program, the 50% crosses of St. Croix x Sumatra (HC) and Barbados Blackbelly x Sumatra (BC) were mated to develop a composite breed containing inheritance from all three breeds: 25% St. Croix, 25% Barbados Blackbelly and 50% Sumatra

Reports on birth and weaning weight of the new composite breed versus Sumatra and other crossbreeds have shown that the composite breed has higher birth weight than Sumatra and that weaning weight is equal to the other crossbreeds and higher than the Sumatra. The objective of this research was to measure

the potential maximum growth rate of the new composite sheep versus not only the direct parental crosses, HC and BC, but also the local Sumatra sheep and the Virgin Island St. Croix.

The research was carried out at the Sungai Putih Research and Assessment Installation for Agricultural Technology (RAINAT). Twenty-five lambs from five genotypes were used in a 90-day growth trial. Five lambs each from the following genotypes were used: Virgin Island St. Croix x Sumatra (HC), Barbados Blackbelly x Sumatra (BC), local Sumatra (S), Virgin Island St. Croix (H) and the three breed composite (25% St. Croix, 25% Barbados Blackbelly, 50% Sumatra) referred to as "Domba Sei Putih" (M). Animals were individually housed and fed in a raised barn with slatted floors. Lambs were seven to eight months of age at the beginning of the trial with initial weights ranging from 9.8 to 23.8 kg. Concentrate was fed free choice with forage, *Brachiaria brizantha*, supplemented at approximately 0.7% body weight, adjusted weekly. Concentrate consisted of palm kernel cake (36.0%), soybean

meal (17.0%), molasses (17.0%), cassava meal (15.0%), rice bran (8.3%), fish meal (1.2%), limestone (2.5%), urea (0.5%), salt (2.0%) and a mineral mix (0.5%) containing 20% Ca, 25%P, 22% Na and 0.15% Cu. Feeding occurred each morning. Forage was hand harvested leafy material and was cut into 20 cm. for feeding. Individual animal intakes were measured. Lambs were weighed weekly during the 90-day study with individual body scores recorded from week four through the end of the trial. During the trial one BC lamb sustained a leg injury forcing its removal from the experiment. Data from that animal is not included in the statistical analysis. Average daily gain was determined by linear regression. The experiment was analyzed as a completely randomized design with least square means calculated due to the unequal numbers found among the breeds. Laboratory analysis reported concentrate chemical composition of 18% CP, 37% NDF and 4.1 kcal/g GE. Forage contained 8.5% CP, 64% NDF and 4.3 kcal/g GE.

Average daily gain of Sumatra (S) lambs

| Genotype ¹ | End wt. kg | ADG g/d | Intake | | | Efficiency g gain/kg feed |
|-----------------------|--------------------|-------------------|-----------------------------|--------|-------|------------------------------|
| | | | Concentrate g/kg BW 0.75 | Forage | Total | |
| BC | 40.6 ^a | 209 ^a | 68.4 | 10.1 | 78.5 | 197 |
| H | 38.3 ^{ab} | 196 ^a | 71.9 | 9.3 | 81.2 | 193 |
| M | 35.6 ^b | 192 ^a | 67.9 | 9.0 | 76.9 | 190 |
| HC | 34.5 ^b | 179 ^{ab} | 64.7 | 9.2 | 73.9 | 197 |
| S | 28.0 ^c | 155 ^b | 71.8 | 9.7 | 81.6 | 208 |
| CV | 8.77 | 12.60 | 6.78 | 8.70 | 6.15 | 8.73 |

Table 1: Ending weights, average daily gain (ADG), average concentrate and total intakes and efficiency of gain for five genotypes of sheep, least square means.

¹ BC- Barbados Blackbelly (25%) Sumatra (25%), H- St. Croix, M- Barbados Blackbelly (25%) St. Croix (25%) Sumatra (50%), HC- St. Croix (25%) Sumatra (25%), S- Sumatra. Column means with unlike superscripts differ, P<0.05.

155 g/d, while not significantly different ($P>0.05$) from St. Croix crossbreeds (HC) 179 g/d, was lower ($P<0.05$) than Barbados Blackbelly crossbreeds (BC) 209 g/d, St. Croix (H) 196 g/d and the three breed composite Domba Sei Putih (M) 192 g/d (Table 1). Daily gains seen in this trial are the highest ever recorded by crossbred sheep genotypes at the Sei Putih research site. Previous trials using a corn: soybean meal concentrate fed at 70% intake supplemented with *P. dilitatum* to BC, HC and S lambs resulted in gains of 185, 161, and 125 g/d, respectively. In a second experiment using the same diet, S lambs gained at a rate of 150 g/d, similar to that found in the present trial. In the present experiment concentrate intake accounted for approximately 88% of total feed consumed. The higher proportion of concentrate consumed led to increased nutrient intake and to the higher gains seen here. Gains seen in the present experiment reflect the genetic potential of these genotypes when fed a high quality concentrate diet.

The widest range in individual animal daily gains was recorded in the new three breed composite group with the top animal gaining at a rate of 235 g/d, the highest individual rate of gain seen in the experiment, and the lowest at 156 g/d. A large variability in potential is to be expected initially from this genotype due to the new combination of genes. Variability in growth and other traits will allow breeders to make significant progress in productive traits through selection. It is hoped that the Domba Sei Putih will become the major breed type produced in North Sumatra as it is further developed and refined.

Intake of concentrate, forage and total intake did not vary among the genotypes with total intakes averaged over the trial ranging from 76.9 to 81.5 g/kg BW^{0.75}. Feed efficiency, recorded as grams gained per kilogram of feed consumed, was also not different among genotypes ranging from 189 to 208 (or 4.8 to 5.3 kg feed/kg gain).

Activity: *Tree legume supplementation to grazing ewe lambs.*

Tree legumes are a low cost supplement which can be planted and utilized by smallholders without the resources to purchase supplementary feeds. In addition to being a valuable source of protein and minerals, tannins in some tree legumes may aid in the bypass of nutrients from ruminal fermentation through binding feed proteins which may be released in the small intestine. In North Sumatra several tree legumes have proven useful and have excellent potential for expanded use as an animal feed. Both *Gliricidia sepium* and *Calliandra calothyrsus* have proven productive in the Sumatran soil and climatic conditions. Psyllid resistant *Leucaena leucocephala* varieties are now being produced which would once again allow for the widespread use of leucaena, the best known tree legume species. *Paraserianthes falcataria* is one of the world's fastest growing trees and is very palatable to livestock. Its drawback is very slow regrowth after cutting.

This trial evaluated the use of three tree legumes as supplements to grazing ewe lambs. Forty-eight ewe lambs, six to seven months old, were randomly divided into eight groups of six lambs

each representing eight pen replicates. Pairs of pen replicates were then assigned to one of four treatments, supplementation at 1% BW with *Gliricidia*

sepium, *Calliandra calothyrsus*, *Paraserianthes falcataria* or a standard concentrate. Lambs, with initial body weights ranging from 13 to 22 kg, were housed in a wooden raised slatted floor barn. The trial was conducted for 91 days following a four week adaptation period. Mature legume trees were cut at one meter height each morning and leaves were stripped from the branches, weighed and fed fresh before 8 a.m. Concentrate was fed at the same time. Any refusals from the previous day's feeding were weighed with samples of both fed and refused feed taken thrice weekly and composited by week for analysis. Animals grazed from 10 a.m. to 4 p.m. daily in a pasture under rubber trees which had been transplanted three years ago. The pasture was predominately *Brachiaria humidicola* cv Tully with small amounts of *Paspalum notatum*, *Imperata cylindrica*, and weeds. Hand plucked samples of pasture forage were taken by following the animals and sampling plant parts comparable to those consumed. All lambs had access to water and mineral block. Concentrate consisted of palm kernel cake (49.9%), cassava meal (28.4%), rice bran (11.8%), fish meal (2.4%), limestone (3.9%), urea (0.8%), salt (1.5%), and a mineral mixture containing 20%Ca and 25%P (1.3%). Lambs were weighed weekly with a hanging scale and pen weights used to adjust the amount of leaves or concentrate fed.

| | % CP | % NDF |
|----------------------------------|------|-------|
| <i>Gliricidia sepium</i> | 23 | 43 |
| <i>Calliandra calothyrsus</i> | 19 | 40 |
| <i>Paraserianthes falcataria</i> | 18 | 50 |
| Concentrate | 13 | 45 |
| <i>Brachiaria humidicola</i> | 8 | 72 |

Table 2: Crude protein and NDF contents of *Gliricidia sepium*, *Calliandra calothyrsus*, *Paraserianthes falcataria* and concentrate.

Average daily gain was determined by linear regression. Upon evaluation of daily gain data, two animals were removed from further analyses due to abnormal growth patterns characterized by loss of weight during the last third of the experiment. Analysis of variance for this completely randomized design was done using a general linear models procedure. Least square means were employed to separate treatment means.

Brachiaria humidicola averaged a low crude protein (CP) value of 8% with high levels of neutral detergent fiber (NDF), 72%, for samples collected over the length of the trial (Table 2). Tree legumes contained higher crude protein and lower NDF values. Grazing management used at the Sei Putih research site allows for pastures to be spelled from grazing for 12 weeks. This is due to the high potential level of *Haemonchus contortus* infestation. The pasture in the present experiment was spelled for approximately four months before the adaptation period started. This resulted in a mature sward that, as evidenced by chemical analysis, was of a lower than desired nutritional quality. This pasture was selected as it was of uniform species composition and would ensure a homogenous diet for all animals.

Concentrate supplements were completely consumed throughout the length of the trial. Animals fed *gliricidia*

Table 3: Average daily gain, least square means, standard error and range for three tree legumes and a concentrate supplemented to growing lambs.

| Treatment | ADG g/d | SE | Range g/d |
|-----------------------|-------------------|------|--------------|
| Concentrate | 69.1 ^a | 3.14 | 43.9 - 90.9 |
| <i>P. falcata</i> | 49.1 ^b | 3.28 | 38.4 - 62.7 |
| <i>G. sepium</i> | 48.8 ^b | 3.28 | 32.6 - 65.3 |
| <i>C. calothyrsus</i> | 45.4 ^b | 3.14 | 20.4 - 56.5 |

Column means with unlike superscripts differ $P < 0.001$.

in replicate one steadily increased their consumption from 0.76 to 0.93% BW throughout the first five weeks of the trial while those in replicate two ate at or above 0.95% BW throughout the trial. Calliandra fed animals also required more time than the four week adaptation period to consume their total ration of leaves. In replicate one the level of intake increased from 0.67 to 0.9% BW and in replicate two intake fluctuated from 0.87 to 0.8 to 0.94% BW during the first five weeks.

Lambs receiving concentrate supplementation had higher average daily gain, 69.1 g/d, ($P < 0.001$) than lambs receiving any of the three tree legumes, 45.4 to 49.1 g/d (Table 3). The higher gains seen in concentrate supplemented lambs is due to the higher energy content in the concentrate compared to the tree leaves and to the energy's readily digestible form. Gains seen in this trial were lower than were expected. This is attributed to the low quality of the grazed forage, *Brachiaria humidicola*, as discussed above. The low protein content and high NDF level indicate the probability of a low level of digestibility with a high level of rumen fill. The levels of readily available carbohydrates from the basal forage would be low. Thus, even though both

the tree legumes and concentrate were supplying additional energy to the diet, the more readily available energy found in the concentrate had a more beneficial effect upon the animals in terms of converting dietary energy and protein into growth.

The supplementation of tree legumes alone did not provide for daily gains equal to those obtained with a concentrate supplement. This indicates that additional energy is needed in the diets of small ruminants grazing pastures under rubber. Tree legumes will remain an important part of smallholder feed supplies as a source of additional nitrogen and additional dry matter in locations where either grazing time or available forage may be limited due to labor or climatic constraints. Tree legumes are an ideal supplement for smallholder farmers due to their low cost and longevity. The use of tree leaves for all animals in the flock with additional supplementation provided to growing lambs and other animals in high nutrient demand status, i.e. ewes in late gestation or early lactation, can be a beneficial and sustainable practice.

Activity: *Supplementation with Gliricidia sepium and energy.*

The SR-CRSP has promoted the use of several tree legumes by smallholders, the main species extended being gliricidia. *Gliricidia sepium* has qualities of high protein levels (>20%) and high degradability. The rapidity with which gliricidia is degraded in the rumen may lead to inefficient use of released nitrogen by ruminal micro-organisms with the result that feed nitrogen is wasted. Some researchers recommend that a source of energy be fed along with gliricidia to provide a carbohydrate source for ruminal microbes to utilize the rapidly released nitrogen.

From evaluating the preliminary results of the tree legume supplementation trial described above it was decided to test the effect of energy supplementation coupled with *G. sepium* upon the growth rate of lambs. Gliricidia was selected as the tree legume to test due to its popularity with local farmers, its low tannin content compared to calliandra and its better regrowth characteristics as compared to paraserianthes. The energy supplements used included a combination of rice bran and tofu by-product, both being feedstuffs used by smallholder farmers near the research site.

Thirty-two ram lambs, with initial weights of 11 to 20 kg, were randomly assigned to one of eight groups of

four lambs each. Pairs of groups, representing pen replicates, were then assigned to one of four treatment combinations arising from *Gliricidia sepium* supplementation at 0.25 and 0.5% BW paired with either a low or high energy concentrate fed at 1% BW. Animals were housed, by replicate, in a raised concrete barn with slatted floors. All animals had access to water and mineral block. *Gliricidia sepium*, eight to twelve week regrowth, was harvested and leaves were fed fresh each morning at 7:30 a.m. followed by concentrate feeding. Tofu by-product, the main concentrate component, was received each morning and mixed with the other ingredients. Composite samples of gliricidia and tofu by-product were taken weekly for analysis. Concentrates were samples at each mixing. Concentrate supplement composition is seen in Table 4. Calculated energy levels varied, however, protein level was equal in both concentrate mixtures. After an initial two week adaptation period, both gliricidia and concentrate were totally consumed. Lambs grazed from 10 a.m. to 4 p.m. under coconut in a mixed

| Ingredient | High energy | Low energy |
|-----------------|-------------|------------|
| Tofu by-product | 65 | 54 |
| Rice bran | 8.5 | 41 |
| Limestone | 1 | 3 |
| Salt | 2 | 2 |
| Cassava meal | 15 | 0 |
| Molasses | 8.5 | 0 |
| CP | 15.3 | 15.4 |
| ME | 3.11 | 2.71 |
| Ca | 0.77 | 1.33 |
| P | 0.33 | 0.72 |

Table 4:
Composition of concentrate energy supplements, % composition on a dry matter basis and calculated chemical composition

Table 5: Average daily gains, least square means, standard errors, range and contrasts on treatment means for four treatment combinations of *G. sepium* and energy levels fed to growing lambs.

| Trt | <i>G. sepium</i> level | Energy level | ADG g/d | SE | Range g/d |
|--------------------|---------------------------|-----------------|------------|------|--------------|
| 1 | 0.5 | High | 95.8 | 5.21 | 72.6 - 109.7 |
| 2 | 0.5 | Low | 102.0 | 5.58 | 87.1 - 121.6 |
| 3 | 0.25 | High | 114.6 | 5.58 | 79.0 - 137.8 |
| 4 | 0.25 | Low | 105.8 | 5.21 | 80.9 - 120.7 |
| Contrasts | | | Pr > F | | |
| T1 vs T3 | | | 0.02 | | |
| T2 vs T4 | | | 0.62 | | |
| Low vs High energy | | | 0.82 | | |

pasture with the main species being *Brachiaria* sp., *Ottlochloa nodosa*, *Paspalum* sp. and *Imperata cylindrica*. Lambs were weighed weekly throughout the 84-day trial with previous weeks' pen weights used to determine amount of supplementation. All animals were dosed with anthelmintics at the beginning of the trial. During the trial two animals died from causes unrelated to the treatments applied.

Average daily gain was calculated by linear regression. Analysis of variance for the 2 by 2 factorial treatment arrangement in a completely randomized design was conducted using general linear models procedures. Orthogonal contrasts were employed to test level of gliricidia supplementation within both low and high energy supplements and low energy versus high energy supplementation. Due to unequal animal numbers, least square means were calculated.

No differences were found between the high versus low energy supplementation groups (T1&T3 vs. T2&T4) or between

level of gliricidia feeding in the low energy supplemented groups (T2 vs. T4) as seen in Table 5. A difference was seen between levels of gliricidia feeding in lambs supplemented with high energy concentrate ($P < 0.05$) as lambs receiving gliricidia at 0.25% BW (T3) recorded a higher daily gain, 114.6 g/d, than lambs receiving 0.5% BW of gliricidia (T1), at a gain of 95.8 g/d. As no difference was seen between gliricidia levels in the low supplement or between low and high energy supplements, this result may be due to animal variation rather than a true treatment effect. The range in individual ADG seen between the fastest and slowest growing lambs in groups T1, T2 and T4 were 37.1, 34.5 and 39.8 g/d, respectively, while the range seen in T3 was 58.8 g/d. Treatment 3 had the two fastest growing animals in the trial, 137.4 and 137.8 g/d. While a difference was seen in this trial further testing is necessary to determine if this result is repeatable.

Average daily gains seen in this trial were higher than that seen in the tree legume supplementation trial. This was due to

the increased energy levels fed in the present trial and also due to the pasture mixture and quality. In this trial the pasture was not dominated by a single species but rather was a mixture of *Brachiaria* sp. plus other native grasses, legumes and forbs allowing the lambs a greater range of species from which to select their diet. Chemical composition of sampled pasture grasses returned a CP value of 14.6% and NDF 54.2% indicating a higher quality sward than that grazed in the tree legume supplementation trial.

The lack of an effect on energy level may be due to higher than calculated protein contents in the supplements. The crude protein levels found in composite samples of tofu by-product were higher than the level used to formulate and balance the diets. Laboratory analysis indicated N levels equal to 30.7% CP whereas a value of 21.6%, obtained from the literature of previous experiments with similar material, was used to balance the supplements. This discrepancy led to higher levels of CP in the supplements, approximately 21 and 20.3% for the high and low energy supplements, respectively. Excess consumed protein, above requirements for growth and maintenance, would have been used for energy thus contributing to overall energy content of the supplements.

Supplementation of gliricidia and concentrates to grazing lambs resulted in rates of gain above 95 g/d. Whereas all four supplement mixtures resulted in good rates of gain, of special interest for use by smallholder farmers is the low energy supplement. The advantage of this mixture over palm kernel cake/

molasses based by-product concentrates previously used to achieve similar gains is that neither palm kernel cake nor molasses are used in this mixture. Both palm kernel cake and molasses are difficult to obtain for smallholder farmers in Indonesia. Palm kernel cake is usually purchased in large quantities directly from the factory. Due to the competition for the manufacture of human foodstuffs, molasses is difficult to obtain and must be bought in bulk. Farmers without the financial resources to purchase in bulk nor the resources to store several tons of molasses or palm kernel cake must find alternative feedstuffs. Tofu by-product and rice bran are two feedstuffs that are readily available in many areas of North Sumatra and are relatively inexpensive. Many villages have small tofu factories that produce by-product daily which farmers can purchase in plastic fertilizer bags. For both this trial and the tofu by-product/rice bran supplementation trial discussed below one large bag of tofu by-product, costing roughly US\$ 1.05, was sufficient for use each day, supplementing a total of 60 animals at varying levels. Rice bran is available throughout North Sumatra from small village rice mills or from larger milling facilities. The levels of daily gliricidia feeding in this experiment were chosen to be within the capabilities of a farmer who has planted gliricidia or has access to gliricidia such as those used as shade in cocoa plantations. The SR-CSR has made gliricidia seedlings of elite high producing lines, grown from seed generously supplied by the Oxford Forestry Institute, available to farmers in North Sumatra.

Activity: *Combinations of tofu by-product and rice bran fed to grazing ewe lambs.*

Most farmers in North Sumatra, Indonesia graze or stall feed their animals providing no supplementary feeding other than additional cut forage. The identification of a low cost, readily available supplement that these farmers could use to increase production would be a valuable addition to North Sumatran

ground with the “milk” extracted and used for tofu manufacture. The resulting ground soybean waste is still a highly digestible, protein rich feedstuff. As not all farmers have access to land for planting legume trees, a trial was designed to evaluate varying combinations of rice bran and tofu by-product fed as a supplement to growing ewe lambs.

In this trial 40 ewe lambs, five to six months old with initial weights ranging from 9.6 to 15.2 kg, were divided into

four groups of ten lambs. Each group was divided into two replicates of five animals each and assigned to one of four treatments. Treatments consisted of supplements varying in combination of tofu by-product

| | Treatment | | | |
|------------------|---------------------------------|------|------|------|
| | T1 | T2 | T3 | T4 |
| | % composition, dry matter basis | | | |
| Tofu by-product | 98 | 64 | 31 | 0 |
| Rice bran | 0 | 32 | 62.5 | 93 |
| Limestone | 0.5 | 2.5 | 5 | 5.5 |
| Salt | 1.5 | 1.5 | 1.5 | 1.5 |
| ME, kcal/g | 3.14 | 2.82 | 2.49 | 2.23 |
| Crude protein, % | 21.2 | 16.7 | 12.3 | 8.4 |
| Ca, % | 0.62 | 1.12 | 1.94 | 2.02 |
| P, % | 0.27 | 0.63 | 0.96 | 1.30 |

Table 6: Treatment supplement mixtures and calculated energy, protein, calcium and phosphorus levels.

farming systems. The SR-CRSP has worked with the Agency for Agricultural Research and Development of Indonesia to increase the productivity of small ruminants in North Sumatra since 1984. In addition to conducting a crossbreeding program designed to increase the size and growth rate of the local sheep, research has been conducted on supplementary feeding strategies. Low cost supplements available to farmers include both tree legumes and rice bran. Recently, tofu by-product, the waste from tofu manufacture has gained popularity as a small ruminant feedstuff. Soybeans are mixed with water and

and rice bran ranging from roughly 0 - 100% tofu by-product mixed with 100 to 0% rice bran. The composition of treatment supplements can be seen in Table 6. The large amounts of limestone seen in T3 and T4 were needed to balance the Ca:P ratio due to high amounts of P contained in rice bran. Tofu by-product has been reported to contain 22% CP, 37% NDF, 0.46% Ca, and 0.28% P. Supplements varied in protein and energy contents. Tofu by-product was received from the factory each morning and mixed by hand with the other ingredients and fed at 1.25% pen body weight by 8 a.m. Lambs went

out to graze a pasture of *Brachiaria humidicola* cv Tully each day from 10 a.m. to 4 p.m., the same pasture used in the tree legume

supplementation trial described in previous section. At night animals were penned, by replicate, in a raised wooden barn with slatted flooring. All animals had free access to water and mineral block. One animal was injured during the trial and was removed with that replicate having only four animals. Anthelmintics were administered at the beginning of the trial. All animals were weighed weekly with pen weights used to adjust the amount of supplement fed.

No statistical difference was found among treatment means which ranged from 42.4 g/d for T4, 93% rice bran, to 55.0 g/d in T1, 98% tofu by-product (Table 7). In looking at the range in daily gains per group, a large animal to animal variation was seen. With additional replication a difference may have been found among treatments. The results do,

however, appear to point towards increased gains with increasing levels of tofu by-product inclusion in the dietary supplement.

Average daily gains in this experiment were also much lower than expected, especially in light of the gains in excess of 100 g/d seen in the gliricidia/energy experiment where a tofu by-product:rice bran supplement was fed to lambs receiving gliricidia. In this experiment, as in the tree legume supplementation trial, the pasture grazed was *Brachiaria humidicola* cv Tully which, as was discussed earlier, had low crude protein and high NDF levels. Gains in the present experiment would be expected to increase if a pasture was grazed that had similar nutritive quality to the pasture under coconuts used in the gliricidia/energy trial.

| Treatment | ADG g/d | SE | Range g/d |
|-----------|------------|------|--------------|
| 1 | 55.0 | 3.98 | 36.1 - 76.1 |
| 2 | 51.5 | 4.21 | 33.9 - 64.1 |
| 3 | 47.6 | 3.98 | 18.0 - 70.1 |
| 4 | 42.4 | 3.98 | 22.6 - 67.7 |

Table 7: Average daily gain, least square means, standard error of the mean and range in ADG for four tofu by-product:rice bran combinations fed to growing ewe lambs.

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TRAINING

Simon Ginting completed a Ph.D. in Nutrition from North Carolina State University in May, 1996. Simon conducted his research at Sei Putih in the area of nutrition/grazing/parasite interactions.

ENVIRONMENTAL IMPACT AND RELEVANCE

Utilizing sheep to graze in tree crop plantations reduces the use of herbicides which has both economic and ecological significance. Sheep grazing under tree crops also improve nutrient cycling and reduces soil erosion without affecting soil compaction.

Agro-industrial by-products are utilized as feedstuffs for sheep and thereby reduce disposal problems and provide needed nutrients to sheep. The utilization of tofu by-product in sheep rations is an example.

Traditional cover crop species used under tree crops are slow to establish and are usually established at the beginning of the rainy season when soil erosion risks are greatest. Some of the improved forage species, such as those tested in the nursery evaluation, establish more rapidly and reduce risks of erosion.

AGRICULTURAL SUSTAINABILITY

Sheep are an integral part of the farming systems in Asia. They consume materials not used by humans and by-products of food and agriculture, many times reducing the need for disposal. Incorporating sheep grazing into the tree cropping system also diversifies income for both the limited resource farmer and large plantations. Manure collected from underneath the barns is efficiently utilized for fertilizing crops and ornamentals or is sold for extra income. Without the use of sheep manure, the system would require more inorganic fertilizers to maintain productivity. Organic fertilizers such as animal manures are more environmentally friendly to soils than chemical fertilizers. Manures provide organic matter, promote the growth of beneficial soil organisms and reduce potential soil degradation by buildup of salts or acidity due to chemical fertilizer application. Sheep also utilize weeds and unwanted vegetation thereby reducing the need for mechanical weeding or the use of herbicides which can expose soil and cause higher soil erosion. By planting and using tree legumes for feed, farmers can aid in reducing soil erosion, have a source of fuelwood and promote long term system sustainability.

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SMALL GRANTS



| | |
|---|-----|
| SUSTAINABLE AGROPASTORAL SYSTEMS OF MARGINAL LANDS: RANGE ECOLOGY AND RANGE ANIMAL NUTRITION | 97 |
| BANKING LIVESTOCK CAPITAL FOR PASTORAL RISK MANAGEMENT AND URBAN DEVELOPMENT IN ETHIOPIA | 104 |
| AN EVALUATION OF THE RUKWA VALLEY FOR SMALL RUMINANT CRSP RESEARCH: RESULTS FROM PRELIMINARY ANALYSIS | 110 |
| EVALUATION OF THE IMPACT ON WORLD MEAT MARKETS OF THE RECOGNITION OF ARGENTINA AND URUGUAY AS FREE OF FOOT-AND-MOUTH DISEASE, WITH EMPHASIS ON LOW INCOME COUNTRIES | 124 |
| PRELIMINARY ASSESSMENT OF THE PREVALENCE OF DISEASE VECTORS WITHIN KATAVI NATIONAL PARK | 127 |
| THE LESSER OF THREE EVILS: MODELING PASTORAL RESOURCE USE UNDER CONDITIONS OF DROUGHT, DISEASE, AND CONFLICT: A SUMMARY | 136 |

SUSTAINABLE AGROPASTORAL SYSTEMS ON MARGINAL LANDS: RANGE ECOLOGY AND RANGE ANIMAL NUTRITION

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NARRATIVE SUMMARY

Year 17 was the final year in which the SR-CRSP had a field presence in Bolivia. An American graduate student, Ms. Lita Buttolph, collected her last six months of field data from January through July at the community of Cosapa, a high-elevation locale on the Altiplano where campesino (peasant) households specialize in production of alpaca and llama, with a minor emphasis on criollo sheep. Alpaca production is made possible because of extensive wetlands (bofedales) fed by springs and glacial runoff; this yields large patches of perennially green forage required for alpaca nutrition. Llamas and sheep more typically utilize drier upland sites. The exceedingly dry and cold climate allows Cosapa to retain comparative advantages for camelid production compared to crop agriculture or production of other livestock such as criollo cattle or improved breeds of sheep. Cosapa has received considerable attention in recent years from the Association Integral de Ganaderos en Camelidos de los Andes Altos (AIGACAA), a grass roots organization devoted to enhancing alpaca production. The AIGACAA has used large grants to bring an alpaca fiber processing plant on-line in Bolivia during 1995, as well as providing

communities like Cosapa access to a variety of production inputs. Inputs include grants to improve water resources and irrigation, credit to purchase alpaca with highly marketable fiber features, fencing to improve range management, and subsidies to provide veterinary care and livestock nutritional supplements. One goal of AIGACAA is to increase and stabilize the population of alpaca at Cosapa; in essence AIGACAA seeks to have the campesinos specialize and intensify their production system. In this context, the SR-CRSP, through Ms. Buttolph's project, has provided a research capability to make a preliminary assessment of the likely short- and long-term impacts of AIGACAA's interventions. Prominent questions include things like: Does the fencing and subsequent deferred grazing regime improve forage production and diversity relative to traditional practices? Is fencing compatible with maintaining the social fabric of the community? Have interventions enhanced alpaca productivity, and could this enhancement ultimately victimize the campesinos if they reduce production of llama and sheep? Is livestock species diversity required for sustainability in an uncertain

ecological and economic situation? The global issue, therefore, is whether specialization and intensification are compatible with sustainability in a risky environment. Various trials were conducted to measure effects of interventions on native vegetation, and an extensive socio-economic survey was also conducted among 50 households to ascertain how interventions alter traditional production strategies. Data collection was concluded by July 1996. Remaining time has been spent in lab analyses of soil samples as well as data entry. The final results will not be available until 1997. Contributions of this activity to the social, political, and economic agenda of USAID are also reviewed.

RESEARCH

Activity: Environmental and socio-economic implications of expansion of the alpaca wool economy at Cosapa, Bolivia.

Problem Statement, approach, and progress: The Bolivian Altiplano is a harsh environment due to low and highly variable annual precipitation, drought, chronic risk of frost, and low soil fertility. Due to climatic constraints on crop cultivation most of the Altiplano has thus been devoted to livestock production. Following the Spanish Conquest in the 1500s, sheep, cattle, and donkeys replaced much of the indigenous livestock which had consisted of llamas and alpacas. Despite attempts by the Spanish to eliminate native livestock species, camelid production still persisted on the Altiplano as an important source of meat and fiber for home use and sale.

Currently in Bolivia some development projects on the Altiplano have refocused their efforts to promote camelid production of meat and fiber, as the economic and ecological benefits of camelids have gained wider recognition. For example, compared to flesh of other domestic ungulates, llama meat has been found to be higher in protein and lower in fat and cholesterol. International demand for alpaca wool has also substantially increased in recent years. Camelids have been postulated to be less damaging to the environment as compared to sheep or cattle because camelids have relatively lower forage requirements, padded feet that minimize trampling damage to vegetation and soil, and a manner of forage utilization that tends to snip-off plants above-ground rather than a grazing technique of cattle and sheep that results in plants being yanked out of the ground with damage to root systems.

In 1991 the United Nations Development Program (UNDP) and others awarded a \$4.6-million dollar grant to the AIGACAA. The purpose of the grant was to create a project to increase the sustained productivity and economic value of alpaca wool among producers who belonged to AIGACAA in the Bolivian high Andes. The activity was named "Project Alpaca." The driving force for the suite of interventions was the establishment of a fiber-processing plant near the city of La Paz. Brought on-line in 1995, the plant produces washed, carded, and combed fiber for sale in national and international markets. Financial and technical assistance for alpaca producers was also provided; this included credit to purchase alpacas and materials to construct

watering troughs, pumps, fenced enclosures to improve and conserve forage production, as well as supplemental alfalfa hay. Veterinary services were also provided to producers at a cost.

A major goal of this SR-CRSP research activity was to evaluate the success of the UNDP project. This required information to be collected concerning traditional livestock management and any changes in management which have resulted from promotion of interventions. The high-elevation region of Cosapa in the southwestern Altiplano was selected for this research because it is a center of activity for Project Alpaca. The campesinos have readily embraced many of the interventions listed above in the past few years. Prominent are efforts to fence off formerly-communal grazing land by individuals using fencing materials made accessible by Project Alpaca. Veterinary extension is also very active in the area. The Cosapa site is different from San José Llanga, which was the focus of research for dozens of SR-CRSP research projects from 1991 to 1995 (see previous SR-CRSP Annual Reports for details). The fundamental question at Cosapa is: Are efforts by Project Alpaca to enhance camelid productivity compatible with maintaining the long-term sustainability of the production system? Using the fencing intervention as an example, let us suppose that fencing wetland and upland areas results in higher forage production and an improved cover and composition of vegetation as compared to adjacent sites which have been continuously grazed under communal management. Is this fencing also compatible with maintaining a diversity

of campesino households in the area, or not? Could not some households be excluded from resources during times of stress? Specific objectives of our studies at Cosapa were to determine:

- How traditional use and management of natural resources has allowed campesinos to maintain pastoral livelihoods over many generations;
- How traditional management practices impact the local environment;
- To what extent Project Alpaca has altered traditional management strategies, and;
- Ecological and socio-economic implications accruing from changes in traditional management enacted since Project Alpaca began a few years ago.

The field portion of this research was conducted over a two-years from 1994 to 1996. The community of Cosapa is located in the Province of Sajama in the Department of Oruro. The main town of Cosapa is located to the southeast of Mt. Sajama, Bolivia's highest mountain (with a summit at about 6,500m elevation). Another part of the Cosapa community lies within the boundaries of Sajama National Park. A paved highway connecting La Paz to Arica, Chile, was recently constructed in the area. This highway will further alter the economy of this remote area in the near future.

Research conducted during 1996 in Bolivia consisted of field work in Cosapa from January through the end of July. Primary efforts involved studies of the

impacts of the fenced enclosures on forage production and plant community composition, determining vegetation composition and soil moisture dynamics in key wetland sites for camelid production called bofedales, measuring diet composition and habitat use for different livestock species at different seasons, and implementing a comprehensive household questionnaire concerning resource use and management and camelid productivity. Some methodological details are provided below.

- *Enclosure effects:* To determine impacts of fencing by campesinos on the vegetation on bofedales and upland sites measurements were made of cover composition and biomass of plant species on paired sites inside and outside fenced areas. Soil samples were collected to verify the validity of site pairings and to illuminate how vegetation patterns were related to soil features. Clipped plot samples for biomass estimation were oven-dried and weighed at the Patacamaya Experiment Station, operated by the Instituto Boliviano de Tecnología Agropecuaria (IBTA). Preliminary procedures to prepare soils for chemical and physical analysis were also conducted at the Patacamaya Experiment station.
- *Use, management, and productivity of bofedales:* To determine the importance of these key resources, vegetation composition and biomass was measured in three different bofedales having varied durations of greenness throughout the year. Measurements were made at four different seasons. Timing and

intensity of grazing use of bofedales by livestock was determined through animal counts and formal household interviews using a questionnaire.

- *Livestock diet composition and habitat use:* Studies to determine diet, habitat use, and possible forage competition among llama, alpaca, and sheep were conducted with daily bite-count measurements during wet and dry seasons. Randomly selected animals were followed for an entire day, and bites of forage were counted for a period of one-hour, four times per day. Herds were selected from different zones that included the three bofedales mentioned above. Animal location, with reference to vegetation type, was recorded every half-hour. Household surveys (below) supplemented information on resource use by livestock.
- *Household resource use and intervention impacts:* In order to further evaluate success of Project Alpaca, and to determine specific management practices and livestock productivity, a survey was conducted with 50 sample households using a standardized questionnaire. Information obtained from the survey includes examination of the following attributes "before and after" Project Alpaca came onto the scene: livestock management, use of veterinary services, livestock morality and natality rates, location of grazing pastures, stocking densities in different types of grazing pastures, and changes in livestock numbers over time.

Upon return to the U.S. in August, lab

work on soils was also conducted at Utah State University. Soil samples were analyzed for organic carbon content, electrical conductivity, and pH. Further analysis of nitrogen, phosphorus and potassium will be carried out in 1997. Data entry was also conducted from September through December. Final results are not available at this time. Results will be published in 1997 in a Ph.D. dissertation and reported in the SR-CRSP Annual Report 1997.

TRAINING

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ENVIRONMENTAL IMPACT AND RELEVANCE

This project will improve our understanding of how camelids use wetlands and uplands at higher elevations of the Altiplano. It will provide information on the possible beneficial ecological effects of fencing (i.e., privatization) of wetland and upland parcels for deferred use versus traditional use on a communal, continuous-grazing basis. The project

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will also provide information as to whether or not fencing is compatible in a socio-economic sense with regards to sustaining the community of herders at Cosapa.

• AGRICULTURAL SUSTAINABILITY

This project will improve our understanding of environmental, social, and economic constraints for enhancing camelid production in a place like Cosapa, and how development interventions could alleviate (or exacerbate) such constraints. This project will also provide information on how the traditional system of pastoral production has persisted in the area, and the degree to which various internal and external forces can undermine system sustainability. See below for more discussion of agricultural sustainability with regards to U.S. agriculture.

CONTRIBUTIONS TO U.S. AGRICULTURE

Many of the interventions involved with Project Alpaca at Cosapa involve efforts to better sustain livestock production under conditions of declining per capita access to resources by making intensified use of key resources and increasing reliance on external inputs. Our work will illuminate the efficacy of such an approach. In contrast to efforts by AIGACAA, risk mitigation for producers in rangeland environments is thought to be better promoted by promotion of opportunism and resource diversification. Whether sustainability is indeed better promoted by strategic intensification or diversification is also an important question faced by U.S.

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livestock producers. This is especially true for cattle and sheep producers in the western states where access to public lands is under threat of increased restriction and producers are forced to sustain their operations on smaller parcels of higher value privately owned land. Loss of public land constitutes a declining per capita resource base; some producers respond to the squeeze by increasing investments on private lands. While perhaps a viable short-term strategy, the long-term viability of investments for intensification may be questioned given high ecological and economic uncertainties.

CONTRIBUTIONS TO HOST COUNTRY

The Project Alpaca embodies empowerment of indigenous groups by helping maintain their livelihood as pastoralists producing native camelids. Our research project therefore supports such a goal by association under the banner of AIGACAA. Our project has primarily benefited from linkages and networking among AIGACAA,

Appropriate Technology International (ATI), and IBTA. We have had no link, however, with either International Agricultural Research Centers (IARCs) or other CRSPs. In terms of gender, our project will illuminate roles of youths and females in camelid production in the high Andes. Some local campesinos (including youths of both sexes and young women) were trained and hired as field assistants on this project.

SUPPORT FOR FREE MARKETS AND BROAD-BASED ECONOMIC GROWTH

The AIGACAA Project Alpaca is devoted to development of free markets, private enterprise and promotion of market access at the level of campesino households. Project Alpaca is a humanitarian organization to a large extent in terms of its strategies and tactics; Project Alpaca as a case-in-point is explicitly designed to channel more opportunities for human empowerment and deliver benefits of market development to the rural poor; this in turn should broaden the base of economic opportunity within Bolivia.

Our research is intended to help guide AIGACAA to elaborate the best possible strategy to achieve its goals. Given this link, our research is therefore contributing to the broader national initiatives and goals listed above.

COMPLIANCE WITH MISSION OBJECTIVES

The USAID Mission in La Paz is concerned with economic development of Bolivia as a whole, with special attention to mitigating outflows of people from economically depressed areas, such as the Altiplano, to coca-growing areas in the lowlands. The SR-CRSP thus falls under the umbrella of the Mission's "alternative development" program. The SR-CRSP is one of only a few USAID programs addressing the immediate needs of the Altiplano. The Mission has endorsed the SR-CRSP presence in Bolivia by approving PL 480 (Title III) funds to support it in past years, although PL 480 funds have not been used in support of this particular activity. This activity is essentially the last remnant of SR-CRSP work in Bolivia.

CONCERN FOR INDIVIDUALS

Biological or ecological research conducted on agricultural experiment stations tends to ignore the production unit, i.e., the individual household or enterprise. It is usually up to the economist, sociologist, or extension agent to place the results of technical research within an applied framework. The SR-CRSP, however, has always worked with individual producers in this and past activities on the Altiplano.

SUPPORT FOR DEMOCRACY

In so far as the SR-CRSP research program supports the integrity of self-sustaining rural communities on the Altiplano, it enhances political stability in the region. Self-sustaining rural communities help mitigate emigration of potentially unemployable people to urban areas; these are people who ultimately could become flashpoints for social unrest.

HUMANITARIAN ASSISTANCE

The general objectives of the SR-CRSP are concerned with the welfare of people who live in uncertain environments. We seek to find ways, based on fundamental aspects of resource use and external intervention, to mitigate problems faced by such people. The SR-CRSP, therefore, embodies principles of humanitarian assistance.

PRESENTATIONS

Lita Buttolph gave two exit seminars during July 1996, in Bolivia. These seminars were a summary of her research conducted at Cosapa. One seminar had more of a popular orientation and was given to community members at Cosapa. The other seminar had a more technical orientation and was given to staff at the Patacamaya Experiment Station.

BANKING LIVESTOCK CAPITAL FOR PASTORAL RISK MANAGEMENT AND URBAN DEVELOPMENT IN ETHIOPIA

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NARRATIVE SUMMARY

Pastoral societies in East Africa are experiencing drops in economic well-being. This is commonly due to growing human populations attempting to subsist on a resource base that is declining on a per capita basis. Using the Borana pastoralists of southern Ethiopia as a case-in-point, it has been postulated that the Borana society is now in a vicious "boom and bust" cycle of rapid growth and precipitous crashes in the regional cattle herd. Losses of 50% of the herd occurred in the mid-1980s and in 1991. These crashes are due to the coincidence of three key events: periodically high stocking rates, permanent losses of traditional fall-back grazing areas to over-population, and modest dips in annual rainfall. As a result, the utility of livestock as the sole means for investment and wealth storage is now open to question. This project deals with prescribing an optimal portfolio combination of investment for the Borana based on risks and returns to cattle and risks and returns to keeping assets as cash in simple savings accounts in banks. The premise is that under most contemporary conditions, the Boran would be better off keeping a portion of their assets as cash and the rest as livestock rather than everything in

livestock as has been traditionally done. If this optimal asset mix indeed exists, then constraints will be identified that keep the Boran from accessing the commercial banking system. Banks exist in several key rangeland towns, but are under-utilized. These constraints may be as simple as a lack of knowledge, or as complex as traditional social mores. If alternative investment is viable as another form of wealth storage, then such banked funds could be important in stimulating rural financial activity and commerce in a self-sustaining mode. In 1996 ancillary funds from the SR-CRSP Small Grants Program were used to leverage operating monies from the Rockefeller Foundation, Utah State University, and the International Livestock Research Institute (ILRI) to get this research program off the ground in southern Ethiopia. Research is being conducted by Mr. Solomon Desta, a doctoral candidate at Utah State University. In 1996 a target population of over 7,000 Borana households was identified within 25-km of four towns in the southern Ethiopian rangelands; this target population is comprised of about 7% "wealthy", 37% "middle-class", and 56% "poor" pastoral households in terms of livestock

holdings. About 13% of all heads of households are women. This target population has been stratified based on wealth and locale and has been sampled for implementation of three surveys; over 330 households will be profiled in terms of household economy and alternative investment tactics, 60 of these will be studied in terms of herd dynamics (risks and returns). Twenty of the sixty will then be studied in terms of their risk aversiveness. No results are available at this time as most data collection is currently underway. Contributions of this activity to the social, political and economic agenda of USAID are also reviewed.

RESEARCH

Activity: Banking livestock capital for pastoral risk management and urban development in Ethiopia.

Problem Statement, Approach, and Progress: Like many other East African pastoral societies, the Boran of southern Ethiopia appear to have recently entered a period of decline in terms of per capita production and accumulation of livestock. This translates into an increased likelihood of widespread poverty, famine, and an unraveling of the social order. The main causes of this decline are two-fold: (1) the human population has steadily increased, with little apparent emigration of people out of the system; and (2) the livestock population, dominated by cattle, is increasingly limited by loss of drought reserves and other fall-back zones due to overflow human settlement. The overall result is an increasingly unstable cattle population in response to

perturbations such as annual fluctuations in precipitation; losses of the regional cattle herd on the order of 50% have occurred in 1984 and 1991. It has been proposed that one of the only feasible solutions to this dilemma, given poor livestock market integration and a low level of regional economic development, is creation of alternative wealth storage options to livestock for pastoral investment. The idea is simple: If pastoralists had access to other reliable means to periodically store wealth in addition to their drought-vulnerable cattle, it would provide a means to better store wealth, mitigate poverty, provide purchasing power during droughts that is currently non-existent, and it could allow tactical reductions in stocking rates to mitigate large crashes of cattle herds in drought years. Currently in southern Ethiopia there are no readily accessible, non-pastoral alternatives to cattle other than banking with Commercial Bank of Ethiopia (CBE). Although a few Boran have been banking for a number of years, it is expected that the vast majority of Boran have virtually no knowledge of banks or how banking works. Our approach, therefore, is to contrast cattle holding with banking in terms of economic risks and returns to investment and to prescribe a mix of the two that mitigates against unfavorable events in either the pastoral sector (herd loss) or banking sector (inflation). What is desirable is to have investments in which risks and returns co-vary. The optimal mix between cattle and banking is ultimately defined by risk tolerance of individual households. If a substantial volume of investment could come from pastoralists into the Ethiopian financial sector, it is also possible that increased investment could have favorable impact

on loanable funds and thus entrepreneurial activity in rural towns.

During 1996 our first research goal was to identify a target population of Borana households that resided within 25-km of four towns (settlements) in the southern Ethiopian rangelands. These towns were located in the northern portion of the southern rangelands and were selected for study because they were accessible and varied in size and access to banking services. It was expected that populations residing near towns having banks would be more knowledgeable about banking than those residing near towns without such services. The towns included: (1) Yabelo (population of about 8,000 with a branch of Commercial Bank of Ethiopia (CBE); (2) Mega (population of about 5,000 with no bank services); (3) Arero (population of about 1,000 with no bank services); and (4) Negele (population of about 30,000 with a branch of CBE). Target populations needed to be identified in order to design a proper sampling scheme and describe bounds of statistical inference. Target populations were to be delineated based on informant interviews, tax roles, and other public information. Our second goal was to begin to implement social and economic surveys once a representative sample of households was selected. There are two surveys intended to be filled-out via household interviews. The first quantifies aspects of the household economy and familiarity with alternative investments; the second quantifies livestock dynamics at the household level to allow us to calculate risks and returns for holding cattle. A fourth survey will deal with aspects of

the financial sector. The bulk of data collection will occur in 1997.

We have met our goals for 1996. A total target population of 7,007 households were identified with 2,617 around Yabelo, 2,087 around Mega, 906 around Arero, and 1,397 around Negele. The target population is comprised of 510 "wealthy" households (i.e., those having >100 head of cattle), 2,605 "middle-class" households (i.e., those having from 51 to 99 head of cattle), and 3,892 "poor" households (i.e., those having <50 head of cattle). The total number of households headed by women is 901 (or 13%), with the other 87% headed in a traditional fashion by males. We have stratified the target population by locale and wealth class for data collection, which will involve 336 households overall for the first survey. Another 60 of these households will be used for the second survey, while about 20 of the 60 will be used for the utility function analysis. Gender x wealth class interactions on household management and alternative investment tactics will be analyzed using case studies.

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TRAINING

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ENVIRONMENTAL IMPACT AND RELEVANCE

If a socially and economically viable package of banking and cattle investment can be found among the Boran, this has large implications for reduction of heavy grazing pressure in these semi-arid rangelands. For example, previous work has indicated that the magnitude of a rainfall-induced crash in the Borana cattle population is related to the stocking rate of cattle as well as the deficit in precipitation. If alternative investment is viable, this means that the people would have an economic rationale to reduce cattle numbers prior to droughts occurring. It is expected that a major use of alternative investment would occur in the form of entire communities de-stocking to some degree in anticipation of an up-coming dry year, therefore mitigating large crashes in household herds throughout the community. What needs to be determined is whether or not de-stocking that mitigates herd crashes would also mitigate overgrazing. It is expected that the motivation of producers to engage in alternative investment at a community level would be more related to reducing the likelihood of herd crashes and loss of capital; improved range management, if it occurred, would be an ancillary benefit.

AGRICULTURAL SUSTAINABILITY

Productive output of a system can be sustained only if optimal combinations

of land, labor, and capital can be maintained. The only long-term solution to sustaining per capita output of livestock products in a system like Borana is encouraging permanent emigration of people out of the system. Alternatively, for a short- to medium-term solution, the presence of viable alternative investments would help sustain the system by better storing wealth and therefore mitigating poverty. Poverty mitigation is the key to preserving the social fabric. Alternative investment could also provide internal capital reserves to re-stock herds following calamitous perturbations, and cut reliance on external agencies to assist with relief and restocking programs. If alternative investments could lead to regional development of towns and settlements, this also promotes sustainability of pastoralism by strengthening a local, urban-based demand for milk, butter, and meat, completing a cycle of mutual interdependence between pastoral areas and the growing towns they serve.

CONTRIBUTIONS TO U.S. AGRICULTURE

In essence, this project is about risk management in a variable environment. It will reveal methods to better analyze how livestock producers should distribute their investments among complementary options to reduce the likelihood of catastrophic asset losses. This principle, surprisingly, has not been exploited to its full advantage for U.S. livestock agriculture. Recent surveys among range-livestock producers in Utah, for example, illustrate that while most producers use improved technology they are quite unskilled and

unknowledgeable concerning financial management, alternative investments and risk management. Insights from this African project therefore have direct relevance in how we better analyze and design policy interventions for U.S. livestock production systems.

CONTRIBUTIONS TO THE HOST COUNTRY

Our project embodies empowerment of indigenous groups by ultimately providing information to help people store wealth in a more diverse fashion. We have an eclectic assortment of linkages to indigenous ethnic groups as well as to research, development, and financial organizations. These include the traditional (Gada) leadership of the Boran, the International Livestock Research Institute (ILRI), CARE-Ethiopia, the Rangelands Department of the Ethiopian Ministry of Agriculture, and Commercial Bank of Ethiopia. In terms of gender, our project will illuminate the changing roles of youths and females in Boran society with regards to herd management and alternative investment.

SUPPORT FOR FREE MARKETS AND BROAD-BASED ECONOMIC GROWTH

Development of stronger, freer cattle and grain markets would be a key component to enhance impact from our project. The link between free markets, alternative investment, and development can be established on the basis of our research. If alternative investment can be channeled to stimulate entrepreneurial activity in rangeland towns, economic growth that would accrue from such activity would have a broader base than it does at present in Ethiopia.

CONTRIBUTIONS TO AND COMPLIANCE WITH MISSION OBJECTIVES

Improving the basis for rural finance in Ethiopia has been one of the important operational goals of the USAID Mission in Addis Ababa in recent years. This project directly supports this goal.

CONCERN FOR INDIVIDUALS

This project operates at the level of individuals and households. It will only achieve impact if individuals are empowered and better-informed regarding alternative investment tactics and options.

SUPPORT FOR DEMOCRACY

In this project we believe that alternative investment for pastoralists is a key to mitigate poverty and famine and would therefore help sustain such communities under conditions of declining per capita access to resources. Creating new options for alternative investment would help maintain democracy in an indigenous culture like that of the Boran, which has a tradition of community assembly and consensus-building. The other option is an unraveling of the social order and polarization of the society into "haves and have-nots." Rural finance would also best operate in a climate of decentralized government, regional political autonomy and democracy.

HUMANITARIAN ASSISTANCE

Because the results of this project would help pastoral households better control their own destiny and better procure food and other basic essentials, it clearly falls into the realm of "humanitarian assistance".

COMMENTS

Funds from the SR-CRSP Small Grants Program were used to augment funding from other sources to make this project possible. The other sources of funding were the Rockefeller Foundation, Utah State University, and the International Livestock Research Institute.

PRESENTATIONS

Solomon Desta has held two workshops in the southern rangelands regarding the research project. Research and development personnel have attended these.

COLLABORATING PERSONNEL

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AN EVALUATION OF THE RUKWA VALLEY FOR SMALL RUMINANT CRSP RESEARCH: RESULTS FROM PRELIMINARY ANALYSIS

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PURPOSE AND METHODS

This report evaluates the Rukwa Valley, Tanzania as a potential field site for research under the Small Ruminant CRSP. The objectives of this report are:

- 1) to examine the extent to which disease interactions constrain livestock production and land use in the area, and evaluate potential research questions pertaining to such interactions;
- 2) to identify (if any) the indigenous husbandry practices used to minimize or mitigate the effects of disease on livestock, and to identify potentially related research questions;
- 3) to assess the extent of habitat overlap between wildlife and livestock, and to identify potential research questions; and
- 4) to evaluate the logistical considerations (roads, access to markets, hospitals, local politics, etc.) that would affect day-to-day research in the area.

Data presented here (unless otherwise cited) were collected from August 1995 to July 1996. The results are from preliminary analysis only. Complete analysis will continue for the next few months, and fieldwork will resume in the fall of 1997. Observations were centered

in three villages which were chosen as representative for land-use and agricultural production systems practiced in the Rukwa Valley. All three villages are in Mpimbwe Division, Mpanda District. National, regional, and district representatives were consulted during a workshop held in Katavi National Park in November 1995 and during informal meetings that occurred throughout the study period.

Data was collected on livestock movements and habitat use during 73 full-day herd follows spread evenly between 24 focal households. During each follow the movements of herds were recorded and the vegetation community in which the herd was found was recorded five times per hour¹. Intake rate was recorded (as determined from bite rate and estimated bite size) at the same interval.

In each household visited a detailed household survey recording the history of the household, all persons present, agricultural practices, and livestock holdings was conducted. Before each follow, a brief interview was conducted covering any changes in herd size (including births, deaths, sales,

slaughters, and exchanges) and the presence of any diseases.

Because many of the research objectives one through three (above) overlap, all potential research objectives relating to these sections are presented in a single section following the Wildlife and Livestock Habitat Overlap section.

BACKGROUND

Ecological Background: The Rukwa Valley is located in Rukwa Region in southwestern Tanzania, and is actually part of the western Rift Valley. It extends from Lake Rukwa north to the Mpanda District. The Ufipa plateau separates the Rukwa Valley from Lake Tanganyika and represents its western boundary. Soils in the area are a mixture of sandy, well-drained, and poorly drained black cotton soils. Regionally, these are classified as Utric Nitosols and Orthic Ferrasols².

The seasons are broken into a single rainy season and a long dry season. Rain falls from mid to late October until mid April. As in all of East Africa however, the beginning and end of the rainy season can be highly variable. In 1995, the first rains did not begin until December, and substantial rainfall began in January of 1996. Total annual rainfall is generally between 850 to 1000 mm.

Miombo woodland covers most of the Rukwa Valley. Where undisturbed, *Brachystegia* and *Julbernardia* and *Combretum spp.* dominate the woodlands. Virtually all low lying areas flood seasonally and are dominated by tall grasses (*Themeda triandra*, *Sporobolus pyramidalis*, and

Echinochloa pyramidalis) and have no woody canopy. In woodland and bushland areas, *Panicum maximum* and *Cynodon dactylon* are common, and disturbed areas such as fallow fields and heavily grazed or trampled areas are often dominated by *Cynodon dactylon*, annual grasses, and forbs. *Acacia spp.* are quick to colonize disturbed areas, and constitute most of the woody canopy cover in and around human settlements and cultivated areas.

Human Population: As of 1988, the human population of the Region was just under 695,000³. The Rukwa Valley lies within Mpanda district, Rukwa's largest and second most populace district with 256,487 people or 37% of the regional population. Of these, nearly 110,000 people live in urban wards (associated with Mpanda) or in the Katumba Ward north of Mpanda where Burundian refugees from the 1980's have settled. Rukwa and Lindi Regions have the lowest human population densities in Tanzania, at 10 people/km².

Historically the people living in the Valley were primarily from the Mpimbwe ethnic group, with some people from the Rungwe and Fipa ethnic groups. Between 1978 and 1988 Rukwa region's human population grew at 4.3% annually, over one and one half times the national average⁴. A large fraction of this increase is due to immigration from Shinyanga, Mwanza, and Tabora Regions. Most of these immigrants are members of Tanzania's largest ethnic group, the Sukuma. In fact, with the steady flow of Sukuma during the last twenty years, they now represent over 50% of the inhabitants of the Valley⁵. Many Sukuma are leaving their

traditional homeland and spreading to all parts of Tanzania. The “Sukuma expansion” has reportedly reached as far as Zambia as people look for adequate pasture and farmland.

Livestock, Agriculture and Other Land Uses:

Despite the relatively low human density, Rukwa region is already experiencing the land shortages and problems of degradation common to much of Africa. One reason for this may be that while the area of the region is large, only a portion of this is available for cultivation and livestock keeping because large tracts are infested with high densities of tsetse flies and thick bush.

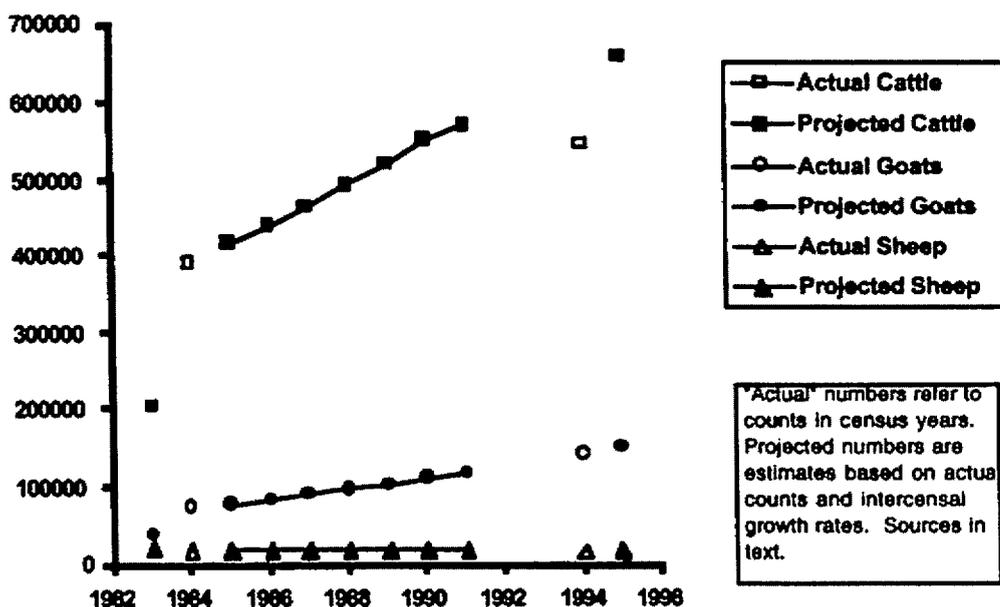
Mpimbwe are primarily horticultural and keep very few livestock, relying mostly on hunting to provide bush meat for protein. The Sukuma on the other hand, are strongly agropastoral and livestock play an important role in their household economy. As a result, cattle populations have mirrored the increases the human

population. National livestock census data show regional cattle numbers increasing almost threefold from 1983 to 1994^{6,7,8} (fig. 1).

Sukuma land use is regarded by many in Tanzania as destructive and not sustainable. Many believe that the Sukuma expansion is being driven by environmental degradation in traditionally Sukuma areas and that similar degradation is certain to follow wherever they go. Natural resource management personnel from district and regional government and from Tanzania National Parks (TANAPA) have identified pastoral land use and the management of livestock as the most important natural resource issue facing the Rukwa Valley^{9,10}.

Most Sukuma households own cattle. The number of cattle per household varies from none to thousands in some cases¹¹. At any given Sukuma homestead there is usually an “access herd” of around 20 to 60 animals. Any household with more than about 100 cattle keep

Figure 1: Livestock Numbers, Rukwa Region



Actual numbers refer to counts in census years. Projected numbers are estimates based on actual counts and intercensal growth rates. Sources in text.

them in herding camps. Some of these camps are within 5-10 km of the primary homestead, while others are as far away as Morogoro (600 km). When the herding camps are within a few days walk of the homestead, cattle are often rotated between the herding camp and homestead during the year in order to allow access to lactating females. When herding camps are too far to shift cattle seasonally, sons stay with the herds subsisting mostly on milk and meat and occasionally selling animals to buy maize flour, rice and other foods.

Goats and, to a lesser extent, sheep, are widely kept in the Rukwa Valley. Again, most of these animals belong to Sukuma, but members of other ethnic groups do keep some animals, usually for an upcoming event or for fattening. As fig. 1 shows, goat numbers have increased substantially in the last decade, but sheep numbers have remained constant and low. Reasons why sheep are not preferred are discussed under "Livestock Disease and Land Use." It is also worth noting that while many pastoralists^{12,13,14} are known to take advantage of goats and sheep's fecundity by breeding and trading them for cattle, few Sukuma herd owners used goats and sheep in this way.

Maize is the dominant food crop grown in the Rukwa Valley; virtually all producers grow at least some maize. Millet is grown by many, but generally in smaller quantities than maize. Many Sukuma grow rice in seasonally flooded areas. Sukuma also grow peanuts and sweet potatoes for subsistence. Sunflowers and finger millet are sometimes grown for cash, and cassava is occasionally grown as a drought resistant crop. Most, if not all, cultivated

fields serve as pasture after harvest, and fallow fields are also grazed.

Also within the Rukwa Valley is Katavi National Park (KNP) and the Rukwa Game Reserve (RGR). KNP supports large concentrations of buffalo (^a45,000), hippopotamus (^a4000), and the full compliment of other plains game species. It was upgraded from a Game Reserve in 1974 and has recently been extended to the east and south to cover an area of over 4,000 km². The area acquired by KNP has been (and likely still is) used by Sukuma for herding camps, but cultivation in the area was minimal. The Rukwa Game Reserve was gazetted in 1995 and extends eastward from KNP's eastern boundary and south to Lake Rukwa.

LIVESTOCK DISEASE AND LAND USE

Trypanosomiasis, theileriosis (East Coast Fever), contagious bovine pleuropneumonia (CBPP), and bacterial infections of the skin (lumpy skin disease) are the most common and significant diseases affecting livestock in the area. Each herd owner was asked what diseases (if any) were present in the herd before each of 73 days of herd follows. The diseases reported are given in Table 1.

Trypanosomiasis

Most herd owners vaccinate cattle with Samarin or Novidium, which are available from District Livestock Officers. Sukuma generally vaccinate animals themselves, and Livestock Officers' roles are rarely more than salespeople for medicines. Vaccinations are given sporadically throughout the

Table 1: Number of reports of each disease.

| Disease | no. of reports | Disease | no. of reports |
|-----------------|----------------|------------------------|----------------|
| CBPP | 30 | Foot and Mouth Disease | 2 |
| Unknown | 12 | Worms | 2 |
| Lumpy Skin | 9 | Black Quarter | 1 |
| Trypanosomiasis | 3 | Brucellosis | 1 |
| Theileriosis | 3 | | |

Numbers here reflect presence or absence of disease in herds, not the number of individuals with the disease.

year, and during each bout only a few animals in the herd are vaccinated. Most herd owners intend to vaccinate the whole herd each year, but this project collected no data on individual animals, so it is not clear whether this is the case. Goats and sheep are not vaccinated against trypanosomiasis.

The density of tsetse flies is low in areas routinely used by livestock. In the 252 grazing areas visited, tsetse flies were present in only seven. In all areas where tsetse flies were observed, tsetse challenge was estimated by counting the flies landing on a focal animal during a three minute sample¹⁵. Sampling continued as long as tsetse flies were present, and sampling was stopped when three, 3-minute samples in a row recorded no tsetse flies. In all seven areas where tsetse flies were observed, none of the 3-minute counts recorded a fly.

These data taken together with data on intake rates and vegetation communities used by cattle may explain the role of tsetse flies and trypanosomiasis in constraining land use. If the occurrence of preferred vegetation communities and intake rates are higher as herds move farther from homesteads (toward tsetse infested areas), then it seems likely that herders are effectively being excluded from high quality grazing areas by tsetse flies. Intake rates and the occurrence of preferred vegetation communities

showing no or a negative spatial relationship to tsetse infested areas would imply that these areas are simply not highly rated herding areas. If this latter situation is the case, trypanosomiasis can be regarded as a secondary influence on land use. If the former case is true, however, trypanosomiasis is likely to be a strong determinant of land use patterns in the area. Further analysis of data already collected should answer this question.

Cattle do, however, encounter high densities of tsetse flies when crossing thickly bushed or wooded areas going to and coming from seasonal herding camps. Also, most of the herding camps are in areas where the vegetation is less disturbed by agriculture and tsetse densities are higher. As a result, trypanosomiasis is not uncommon among cattle in the Rukwa Valley.

Goats and sheep receive little to no veterinary attention, so herd owners were not likely to observe or report trypanosomiasis. Goats and sheep are almost never transferred between homesteads and herding camps, and they are often herded with calves or allowed to roam unherded. This allows them to stay near homesteads and avoid tsetse flies entirely. Herd owners did report that sheep were hit especially hard when exposed to trypanosomiasis and were, in general, less hearty than goats, which is

why few people have bothered with them.

Theileriosis

Theileriosis is common in the cattle of the Rukwa Valley. Tick loads are highest in the late dry season. During this time of year most cattle are herded in harvested fields (where there are fewer ticks). As these fields are depleted, however, herders move back into undisturbed rangeland or fallow fields, both of which have higher densities of ticks. This switch coincides with the time when the body condition of most cattle is at its lowest, making them more susceptible to disease. Some wealthier households own sprayers used to apply acaricides, but most go unused due to the expense of buying acaricide solution. Dips built in the 1980s have all been abandoned because of leakage.

Contagious Bovine Pleuropneumonia

All local livestock auctions ("minada" in Swahili) in western Tanzania were closed from April to November of 1995 in an attempt to contain an outbreak of CBPP. The epidemic apparently started in Musoma, in northwestern Tanzania, spread south through Kigoma and the Rukwa Valley, then moved north and east through Usangu, Mbeya, and Morogoro. Minada were reopened before the disease was eliminated, and herders still report significant losses due to CBPP. Mpanda District livestock officers vaccinated for CBPP twice in the first half of 1995 and intended to vaccinate once more in December, but as of July 1996, no final vaccinations had been given.

Most herd owners when asked about how their cattle became infected with CBPP answered that it came from bad weather. This may explain why even during the height of the CBPP outbreak, herd owners made no effort to keep their herds separate from others or to isolate infected individuals. As a result, all cattle continued to congregate at water-points and use common grazing areas throughout the course of the epidemic.

INDIGENOUS HUSBANDRY PRACTICES TO MINIMIZE DISEASE

Sukuma herd owners reported few ways in which they could reduce disease within their herds. Few of the practices reported here are peculiar to Sukuma, and most are widely suggested by livestock extension officers. A few herbal treatments were given to cattle during the study period, but in general, these are rare. Most Sukuma households are relatively well-integrated with the cash economy, and most traditional medicines have been abandoned for western drugs available through livestock officers. Often these drugs are misused. Incomplete courses of antibiotics and lower than recommended doses are the rule in order to save money or treat more animals. As mentioned earlier, livestock officers are, for the most part, salespeople and are rarely consulted for dosage or to treat animals. One reason for this is that many herd owners feel they know what is best for their animals, and while the livestock population has climbed steadily, the number of extension officers has remained the same.

Birley¹⁶ reported Sukuma in northern Tanzania using heavily grazed areas in

order to decrease standing vegetation biomass and minimize tick loads. While many Sukuma in the Rukwa valley concentrated their cattle in relatively small areas during the wet season, no herders reported this as a means to limit tick loads. It seems more likely that the concentration of cattle is to maintain lower standing biomasses and inhibit the establishment of unpalatable tall (up to 4m) grasses.

Most herders avoid trypanosomiasis simply by avoiding tsetse flies. As mentioned above, tsetse flies were encountered in only seven of 252 grazing areas, and in these areas they were at low density. As with tick loads, disturbed areas (e.g. fallow and harvested fields) have lower densities of tsetse flies, but few herders reported this as the reason they use these areas. When asked if any measures such as burning or bush clearing were undertaken to eradicate tsetse flies, herd owners responded that it was not necessary because tsetse flies and wildlife (particularly buffalo and elephant) "followed each other" and with low densities of wildlife in the area, they were not a problem.

Many herders deal with CBPP by selling animals as soon as they become ill. By doing so, the owner gets something out of an animal that will likely produce little else. This practice however, makes the livestock auctions centers for disease transmission, and because all animals

that are sold are driven through KNP to Mpanda, it may threaten wildlife populations as well. The 45,000 buffalo in KNP are at high densities during the dry season and constitute a substantial and important component of the herbivore biomass, so a severe epidemic could have serious consequences for The Park.

Herders go to great lengths to minimize (mostly macro-) parasitic infections by providing water. Each family digs its own well for livestock during the dry season. These wells are either shallow wells, generally in dry river beds, or deep wells dug in a low lying flood plane. Cattle drink directly from shallow wells, and water is hauled up from deep wells and poured into a trough. Each family uses its own well, and must get permission to use that of another family. This practice is intended to restrict the passage of parasites (mostly worms) between herds. However, because wells tend to be concentrated in river beds or on flood plains, cattle are still found at very high densities in these areas. This could be significant in passing infectious diseases between herds. To limit transmission of parasites within herds, barricades are erected in shallow wells to keep cattle from standing in and fouling the water; dung is removed from the area immediately around wells, and calves are watered first. Also, because Sukuma cattle are watered every day, the area that can be used by a given herd is restricted by the availability of water.

Table 2:
Frequency of wildlife recorded in patches used by cattle.

| Small Antelope | Elephant | Giraffe | Hyena | Civet | Tsetse | Vervet Monkey | Others |
|----------------|----------|---------|-------|-------|--------|---------------|--------|
| 39 | 24 | 22 | 11 | 8 | 7 | 3 | 6 |

Numbers are records of use by each species; in most cases records reflect use by more than one individual of the species listed. Small antelope include: duiker, steinbok, bushbuck, dik dik and impala, and are lumped due to the difficulty in distinguishing dung between species. Others include: bush pig, aardvark, zebra, and hippo.

With the onset of the rainy season, water is available virtually anywhere, and the constraint of watering is removed. This is particularly significant at the beginning of the rainy season when localized storms produce flushes of green grass, and herders travel as far as 25 km during the course of the day to use these areas.

WILDLIFE AND LIVESTOCK HABITAT OVERLAP

During the course of the year wild herbivores and livestock have opposite patterns of habitat use. The wild ungulates of KNP and surrounding areas demonstrate a classical pattern of dry season concentration and wet season dispersal¹⁷. Livestock, on the other hand, are most concentrated in the wet season and range farthest in the dry season. Analysis of these data is underway, but not yet complete. In general, however, herds stay within 500 m to 1 km of home in the wet season. In the late dry season herds tend to range between 5 and 8 km away from home, but herds were recorded as far as 12 km away.

Despite these differences in habitat use, there is some overlap between livestock and wildlife. Table 2 shows the number of grazing patches in which wildlife use was recorded. Wildlife species were recorded as using a patch if they were observed in the patch, or if their dung or tracks were observed. All sightings were recorded ad lib during full day follows of cattle herds.

These numbers represent very conservative estimates of use by wildlife, particularly during the wet season when dung and tracks disappear quickly and

were often hidden by tall grass. Also, with the exception of tsetse flies, these data are limited to larger, more conspicuous mammal species. Tanzania Wildlife Conservation Monitoring¹⁸ data has recorded roan antelope and topi in the areas where follows occurred, and roan, waterbuck, and lions have been sighted in the same area. These species are not listed here however, because they were not recorded during follows.

Of the 120 records listed in Table 2, only 18 were animals actually seen. All other records were from tracks or dung. Similarly, Yeo et al¹⁹ found that mule deer showed a preference for areas used by cattle but used these areas when cattle were not present. In areas dominated by tall grasses, grazing species may prefer new growth in areas grazed by livestock but may actually be disturbed by the presence of livestock. This implies that significant spatial overlap is occurring, but that wildlife and livestock remain temporally segregated. Such a pattern of habitat use may not be completely beneficial for wild herbivores however. Grootinuis²⁰ found that cattle carry a disproportionately large portion of tick loads on a mixed livestock and wildlife range. If this is the case, high densities of cattle may create a larger ecto-parasite burden for the wildlife that use the same area.

POTENTIAL RESEARCH OBJECTIVES

The research objectives listed here were chosen based on two criteria: first, those questions that are well suited to be studied in the area; and second, those questions that would be socially and ecologically beneficial for the area. Clearly, with Rukwa Region's high

human population growth rate, increases in livestock numbers, and increasing land scarcity, research on land use issues has great potential for positively affecting the area. The precarious situation of the Mpimbwe and related food security issues are outside the realm of land use, but because they are critical to the long term well being of the inhabitants of the Rukwa Valley, and because this type of issue is within the emphasis of USAID and the SR-CRSP, they are discussed below.

The research objectives outlined below fall into four broad categories: 1) the ecological effects of livestock grazing; 2) the social and ecological effects of livestock disease and disease management; 3) the ecological effects of water availability; and 4) human subsistence and food security issues centered on livestock and animal products.

LIVESTOCK GRAZING

The area south of KNP is one of a decreasing number of areas where livestock and wildlife can be found together. More importantly, the Rukwa Valley is facing the land related issues that confront most of Africa, so findings in the area could have far reaching benefits.

Now that areas used by livestock have been identified, the next step is to obtain detailed data on the state of the vegetation in these areas. This data would: 1) provide a baseline against which to compare changes associated with future land uses and changing livestock numbers; 2) show differences between areas used by, unavailable to,

and avoided by livestock and wildlife; and 3) provide information on the availability of resources in order to help establish the importance of resource competition, interference, and disease in shaping wildlife and livestock interaction in the area.

More fine grained analysis of habitat use by wild herbivores, particularly in the presence and absence of livestock, would be extremely helpful to the wildlife management agencies in the area (TANAPA and Game Division). Unfortunately, this data will be difficult to collect. Seasonal flooding and a lack of passable roads make most of the areas used by livestock and wildlife accessible only on foot from December to May. Because wildlife are at low densities during this time, research on foot would yield data very slowly. Aerial censuses seem the only (but unfortunately a very expensive) solution to this problem.

Disease and Disease Management

As with land related issues, the livestock disease problems present in the Rukwa Valley are similar to those throughout Africa. Identifying the diseases present among Rukwa's cattle and offering solutions would have conservation as well as social value. Relief from disease could allow more intensive use of livestock and eliminate the need for such large herds, and the movement of herds to and from seasonal herding camps. Additionally, by decreasing the number of diseased livestock, the likelihood of transmission to wildlife in KNP and RGR is also decreased.

A variety of different herding situations are found within the Rukwa Valley.

Livestock can be found living at high and low densities, in large and small herds and with varying degrees of habitat overlap with wildlife. This unusual situation offers an opportunity to study the prevalence of different diseases under these varying circumstances. By identifying the sub-populations of cattle most at risk, limited livestock extension resources can be more strategically used. It will also help to identify the mechanisms of disease transmission within and between domestic herds and between domestic and wild herds, and point to appropriate development goals to minimize disease transmission.

If the disease related research mentioned here is carried out in conjunction with the land use research mentioned above, additional opportunities arise. Recognizing the extent to which disease constrains land use and identifying which sub-populations are hardest hit by disease could provide a valuable opportunity to examine the ecological effects of the eradication of certain diseases. By sampling arthropod vectors for disease (most notably ticks and tsetse flies) across areas of different land use, research could establish the extent to which indigenous land uses and management can reduce the density of disease vectors and prevalence of the disease itself.

Water Availability

Water in the Rukwa Valley is available in a limited number of areas during the dry season. These areas are well-known and accessible to livestock and some wildlife. In other areas, no water is available, so dry season use by both wildlife and livestock is very limited.

Such a situation could be used to compare areas receiving varying amounts of use during the dry season, or to study the effects of water development in unused areas. As with disease research, conducting this research in conjunction with research on the constraints on land use would provide additional insights, specifically into the ecological effects of water development.

Livestock and Food Security

The final, and probably most compelling human issue in the Rukwa Valley is food security. With Mpimbwe and Sukuma living side-by-side and experiencing drastically different food security situations, one cannot overlook the opportunity to study how they have arrived at such different positions. The social benefits of such research are many and obvious.

Because Mpimbwe keep few livestock and have very limited participation in the cash economy, their only access to animal products is bush meat. The designation of the National Park and Game Reserve and increased enforcement during the last twenty years have left the Mpimbwe hurting. It is not clear why the Mpimbwe have been slow to adopt livestock husbandry, or what effect this could have on their current situation. A large portion of the livestock sold at auctions leaves the Rukwa Region, and Sukuma attempting to sell animals are subject to the national price fluctuations. Research examining household and village level economics and marketing of animals would be highly instructive in improving the food

security as well as the livestock marketing situation.

Finally, the Mpimbwe continue to practice subsistence hunting (which in most cases is now considered poaching under the law). With a community conservation program being started for KNP and RGR more research opportunities arise. The household economics and impact of subsistence hunting on wild populations would provide critical information to the Community Conservation Service. This situation also offers the opportunity to study the effectiveness of the community conservation program in reducing subsistence poaching.

SUMMARY

In short, the Rukwa Valley is experiencing many of the land and subsistence related stresses that are common to much of Africa. The influx of people and demographic changes occurring there provide the opportunity for a number of innovative research projects. Rukwa's remoteness is both a virtue and a difficulty. The access provided by small district and regional government make interaction and implementation easier. The price for this, however, comes through logistics (discussed below), which are certainly not impossible, but are more difficult than in more centralized areas in East Africa.

LOGISTICAL CONSIDERATIONS

Supplies, Communications, and Transportation: The nearest supply centers to the Rukwa Valley are Mpanda and Sumbawanga. Mpanda is about 75

km away; about a three and a half hour drive from the nearest villages in the Rukwa Valley. Seasonal vegetables, grains, and a limited supply of canned goods are available in Mpanda. Fuel and kerosene are available, but fuel supplies did run out once during November, 1995. Most spare parts for vehicles are available in Mpanda, but anything out of the ordinary generally has to be ordered from Dar es Salaam. Relatively simple vehicle repairs are usually possible in Mpanda, although no workshops have specialized equipment. All mail to Mpanda comes through Sumbawanga, and usually arrives on the only public bus or in a private vehicle, about three times per week. Telephone lines in and out of Mpanda are generally working, but there is no fax machine in town.

The primary transportation linkage between Mpanda and Dar es Salaam is the Tanzania Railway. A large portion of Mpanda's merchandise and supplies come on the train, but washed out bridges and poorly maintained tracks have left Mpanda isolated at times. Driving from Mpanda to Dar es Salaam is possible in three days (in a strong 4WD vehicle). The most difficult portion of the journey is from Mpanda to Sumbawanga, about 300 km. Roads are passable most of the year, but do deteriorate considerably and receive no regular maintenance during the wet season. Mpanda does have an all-weather airstrip.

Sumbawanga is the regional center and is about 180 km, or about a five hour drive from the Rukwa Valley. Most supplies for the Rukwa Valley come from Sumbawanga. Three buses and

numerous trucks run between Sumbawanga and Mbeya daily. Foods and fuel are, in general, more available and cheaper than in Mpanda. Phone and fax lines are reliable. Sumbawanga is 190 km from Tunduma and the Zambian border. The road from Sumbawanga to Tunduma has washed out in the past, but it has usually been passable again within 24 hours. The road from Tunduma to Dar es Salaam is paved and always passable.

There are two airstrips within Katavi National Park. One is used by the only tour operator in the park, and currently is only maintained during the dry season. It could be used throughout the year with proper maintenance, however. The other, at park headquarters, is sandy and unsafe. Since park headquarters is only 35 km from Mpanda most pilots choose to fly in and out of Mpanda.

Safety and Hospitals: There is a government hospital in Mpanda, and Sumbawanga has a government and a private hospital, but all are under-supplied and under-staffed. The only realistic option for urgent medical care is air evacuation. Flying Doctors, an air evacuation service, is reachable via short-wave radio and will evacuate patients to the Nairobi hospital. Also, a missionary hospital in Tabora is only a two hour flight from Mpanda and is reported to be well supplied.

Other safety concerns in the Rukwa Valley are those common to most of East Africa. Large mammals pose few problems outside the National Park. Spitting cobras and black mambas do occur in the area. Malaria is endemic and people taking paludrine have been infected; no one has used lariam in the area, so its effectiveness is unknown. Driving is safer than in other parts of East Africa, because far fewer vehicles are on the roads, but roads are poorly maintained and driving is often difficult.

Local Politics and Bureaucracy: One advantage of working in a remote rural area is the access to local government officials. The District and Regional Commissioners, as well as Natural Resource and Livestock Officers, are all accessible. After initial introductions, virtually all officials were cooperative and willing to interact with researchers. This proved very helpful for research clearance and bureaucratic procedures. Nevertheless, retrenchments and downsizing are common, so personnel changes come often and even regional officials are not immune. The remoteness and small staff of Katavi National Park also allows access to the Chief Park Warden and Community Conservation Wardens in matters concerning wildlife and livestock management. This interaction with local government and natural resource managers could make the implementation of research recommendations easier.

FOOTNOTES

¹ Because herds moved too quickly and continued moving throughout the day, detailed sampling of vegetation was not possible. This data will be collected in areas used by livestock starting next field season (1997).

- ² Tanzania Planning and Marketing Division (1989) Basic Data: Agriculture and Livestock Sector 1983/84 - 1987/88. Ministry of Agriculture and Livestock Development, Dar es Salaam.
- ³ All human population estimates from: Tanzania Bureau of Statistics (1988) Sensa 1988 Population Census: Preliminary Report. Ministry of Finance, Economic Affairs and Planning, Dar es Salaam.
- ⁴ Tanzania as a whole grew at 2.8% annually for the same period.
- ⁵ Pers. Comm. Ndegewilaya, Secretary, Mpimbwe Division.
- ⁶ Tanzania Bureau of Statistics and Planning Unit (1994) National Sample Census of Agriculture 1993/94, Tanzania Mainland. Tanzania Ministry of Agriculture, Dar es Salaam.
- ⁷ Tanzania Bureau of Statistics (1992) Basic Data: Agriculture and Livestock Sector 1985/86 - 1990/91. Tanzania Ministry of Agriculture, Dar es Salaam.
- ⁸ Tanzania Bureau of Statistics (1986) Basic Data: Agriculture and Livestock Sector 1983/84 - 1987/88. Tanzania Ministry of Agriculture, Dar es Salaam.
- ⁹ Anon (1995) "Katavi National Park and Surrounding Areas: Research Priorities." Proceedings of a Workshop held in Katavi National Park Nov. 21-22, 1995.
- ¹⁰ Pers. Comm. J. Chewa, Community Conservation Warden, Katavi National Park.
- ¹¹ Detailed data on household livestock holdings has been collected by M. Borgerhoff Mulder and is currently being analyzed.
- ¹² Homewood and Rodgers (1990) Maasailand Ecology. Cambridge Univ. Press.
- ¹³ Sieff, D.F.(1995) The Effects of Resource Availability on the Subsistence Strategies of Datoga Pastoralists of Northwest Tanzania. Ph.D. thesis, University of Oxford.
- ¹⁴ Mace, R. (1990) "Pastoralists Herd Compositions in Unpredictable Environments: A Comparison of Model Predictions and Data From Camel-Keeping Groups" Agricultural Systems 33: 1-11.
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- ¹⁶ Birley, M.H. (1982) "Resource Management in Sukumaland, Tanzania." *Africa* 52(2): 1-29.
- ¹⁷ Western (1975) "Water Availability and its influence on the Structure and Dynamics of a Savannah Large Mammal Community" *East African Wildlife Journal* 13:265-286.
- ¹⁸ TWCM performs aerial censuses every few years in the Rukwa Valley.
- ¹⁹ Yeo, J.J., Peek, J.M., Witinger, W.T., and Kvale, C.T. (1993) "Influence of Rest-Rotation Cattle Grazing on Mule Deer and Elk Habitat Use in East-Central Idaho. *Journal of Range Management* 46: 245-250.
- ²⁰ Grootinhuis, J. (1990) "Disease Research at the Livestock-Wildlife Interface in Kenya."

EVALUATION OF THE IMPACT ON WORLD MEAT MARKETS OF THE RECOGNITION OF ARGENTINA & URUGUAY AS FREE OF FOOT-AND-MOUTH DISEASE. EMPHASIS ON LOW INCOME COUNTRIES.

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NARRATIVE SUMMARY

Foot-and-Mouth Disease (FMD) is a highly contagious disease capable of causing severe economic losses in livestock herds. Countries that have eradicated FMD impose a sanitary barrier on imports of beef that are thought capable of communicating that disease. Segmentation of the market has resulted in a two-tier market, with prices in the FMD-free market roughly double prices in the FMD-endemic market. This situation has contributed to significantly different production strategies in FMD-endemic and FMD-free countries. However, changes are taking place that have potential to significantly affect international meat markets. These changes include:

- eradication of Foot-and-Mouth Disease (FMD) from Argentina and Uruguay;
- changes to trade rules introduced in the Uruguay Round that reduce the influence of non-tariff barriers to trade;
- modifications introduced in the trade policies of some major importers and exporters, such as changes in the EU's

Common Agricultural Policy (CAP) that are reducing subsidized exports;

- the opening of the Japanese and Korean markets to exports from all FMD-free countries, and the emergence of the United States as a major exporter, mainly of high-priced, grain-fed cuts;
- creation of major trading blocks that allow increased regional specialization in beef production;
- shift from trade in whole carcasses toward trade in cuts;
- growing international acceptance of the concept of FMD-free zones that allows countries that eradicate FMD to gain quicker and more secure access to FMD-free markets; and,
- emergence of new exporters in the FMD-endemic market.

In general, these changes will create a more competitive environment in world meat markets. Argentina and Uruguay will be allowed to sell in the FMD-free segment at a time when subsidized

exports by the EU have already been greatly reduced. Even though other large exporters remain in the FMD-endemic market, their export potential is not large enough to compensate for the supply reduction, and prices in this market will rise, benefiting beef exporting nations in the FMD-endemic market. Importing nations, which comprise the bulk of developing countries in this market, will be harmed. The simulations carried out in this study show that the largest effects on developing countries occur when the two markets remain segregated; conversely, the largest impacts on FMD-free markets occur when the markets become integrated.

The recognition of Argentina and Uruguay as free of FMD is unlikely to have a significant effect on world beef markets if access to FMD-free markets is limited to the quotas currently negotiated with the United States. If, however, Argentina and Uruguay are able to shift substantial amounts of beef from the FMD-endemic to the FMD-free market, there will be a sizable effect on world beef markets. To date, discussion of this possible event has focused on the potential impact of increased beef supply in the FMD-free market where Argentine and Uruguayan beef will compete with beef from Australia and New Zealand. However, the greatest effect is likely to occur in the FMD-endemic market because of its smaller size.

In the FMD-endemic market, the bulk of the effects will be felt by other developing countries. In most developing countries, however, beef consumption is low. Thus the welfare effects on consumers should be relatively

small, with somewhat greater effect on producers.

The international meat market remains regulated by tariff-rate quotas, long-term agreements and other barriers. The entrance of Argentina and Uruguay into the FMD-free market and the likely expansion of their meat supply will test the accommodation capability of the new WTO.

RESEARCH

We intended to analyze the effects of altered trade flows in international beef markets following eradication of FMD in Argentina and Uruguay. These altered trade flows were expected to change prices in the FMD-free and the FMD-endemic markets. Most developing countries import beef from the FMD-endemic market while only some export. Changes in the international price of beef influence beef prices in developing countries and thus the welfare of beef producers and consumers. We intended to collect information on past beef prices and trade flows and utilize this information to calibrate a model of international beef trade that could be used to analyze the welfare effects of changes in trade flows.

We were able to carry out this research as planned. In the process of the research, we discovered a number of other changes that are simultaneously taking place in the world beef market and we incorporated those changes into the model. We had hoped to provide additional country detail in the model and this proved impossible due to lack of time. We were able to determine the

approximate welfare effects on developing countries from the expected changes in beef products.

TRAINING

William Sutton, Ph.D. student in Agricultural and Resource Economics, received useful training while serving as a Research Assistant on the project during summer 1996 at the University of California, Davis.

OTHER CONTRIBUTIONS

This project was limited in scope and had few other contributions. It complied with and contributed to the Mission objectives by providing analysis of factors that will affect beef producers and consumers throughout the world, including those in the USA and those in developing countries.

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PRELIMINARY ASSESSMENT OF THE PREVALENCE OF DISEASE VECTORS WITHIN KATAVI NATIONAL PARK

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INTRODUCTION

The goal of this project is to make an initial assessment of the prevalence of disease vectors within Katavi National Park (KNP) and to investigate potential vector-borne diseases moving between wildlife and cattle in and around KNP. The report is based on an eight month study conducted in Tanzania. Due to the late onset of the rains, the data collected represents the dry season of 1995.

STUDY SITE AND BACKGROUND

The primary project site was Katavi National Park (1980km², Map 1) located in Rukwa Region, in southwestern Tanzania. The region's population is increasing due to a growing number of Sukuma pastoralist settlers immigrating from northern Tanzania. Based on estimates made in 1984, the Rukwa Region is experiencing a doubling of its cattle population (Chiomba 1987). More current demographic data is scheduled to be collected in the Region this summer to investigate this trend. KNP is crosscut by a major road that is a primary travel route for herders. Pastoralists and cattle dealers utilize this route heavily during all seasons. Herders are required to pay approximately \$.10 per head, but fees are not closely regulated. Herders are also

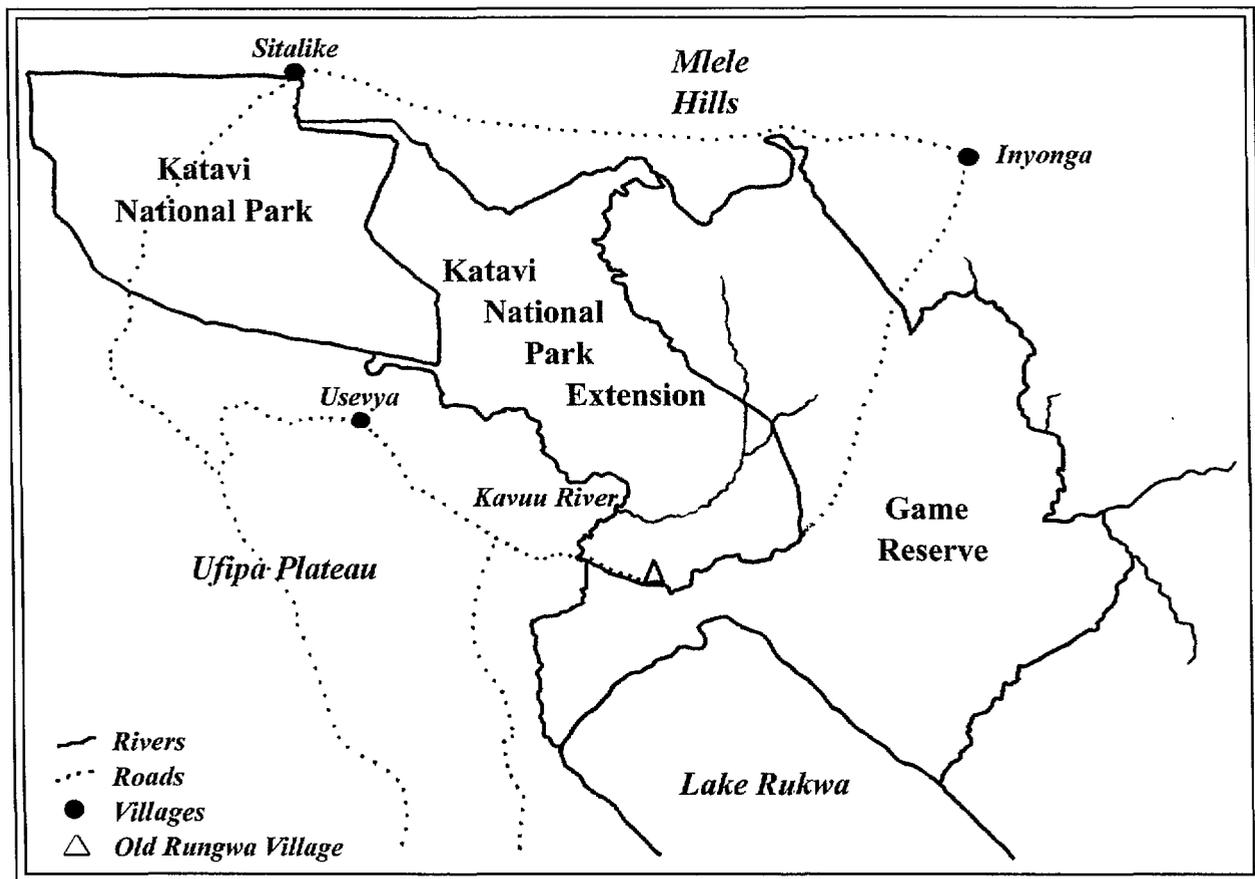
not permitted to graze animals within the Park beyond the edges of the road and are allowed to spend only night in transit through the Park, but these regulations are also not strictly enforced. As a result of livestock passing into the center of the Park, there is an accessible pathway for disease transmission between wildlife and cattle.

OBJECTIVES

The three objectives of the project were to: 1) contact Food and Agriculture Organization (FAO)/United Nations Development Program (UNDP) officials and local health officers, if established, to obtain information and data from previous studies on the prevalence of disease vectors, ticks and tsetse, in the Rukwa Region, specifically within KNP and its surrounding areas; 2) assess tsetse densities in KNP and its surrounding areas; and 3) collect ticks from buffalo carcasses within KNP to make an initial estimate of the transmission occurrence between buffalo and cattle.

Results: Objective 1

During the first month in Dar es Salaam, representatives of FAO were contacted to obtain documents and studies



Map 1: The proposed borders to the Katavi NP extension and the new game reserve in the north Rukwa area.

pertaining to disease vector densities and disease occurrence in the Rukwa Region. Based on an extensive literature search, several related documents and one proposal was located that involved the Rukwa Region. However, none included KNP and its surrounding areas. A joint official of the Ministry of Agriculture and FAO, E. Mwambembe, was the source for the documents. A proposal put forward in 1988 titled "Tsetse Control to Assist Migratory Pastoralists" represents the only field survey on vector densities that has been conducted in the Rukwa Region in conjunction with the Tanzanian government. The FAO/UNDP 1989-1991 project measured seasonal tsetse densities in a target area on the shores of Lake Rukwa, approximately 70

km to the south of KNP. F3 and Epsilon traps, designed by the Tsetse and Trypanosomiasis Control Branch Zimbabwe were used. Blood tests administered to 1,000 animals on the southeastern lakeshore yielded three positive cases of trypanosomiasis (0.3% infected). An additional 2,400 cattle were tested at the north of Lake Rukwa, a total of nine positives (0.3% infected). It is difficult to characterize the tsetse density of the region based on this data. The target area is believed to be at a border end of the "flybelt" in the region. Despite the proximity to the Park, the findings of the study may not be applicable to KNP.

Results: Objective 2

Previously, seasonal tsetse densities within Katavi National Park have not been measured. The initial objective was to set-up traps within the Park and the surrounding areas to estimate fly densities. Traps, in addition to measuring tsetse density, can significantly reduce local populations because of the fly's low reproductive rate. With a relatively long pupal and pre-adult period of approximately three to six weeks, and a maximum growth rate for a population of only 2% per day, trap catches can have an impact on local populations (Dransfield et al. 1991). Although the traps from the 1989-1991 FAO/UNDP project were in Mbeya, the political situation in KNP prohibited their use. Currently, the Tanzanian Parliament is approving a western extension of KNP and of the Rukwa Game Reserve, the protected area to the west of the Park (refer to Map 1). Supported by a significant contribution by Geselleshaft Fur Technische Zusammenarbeit (GTZ), the extension is in part designed as a strategy to halt the expansion of the Sukuma pastoralists in the region. Establishing traps within the Park is perceived not as means of estimating densities, but as an invitation to graze. Measuring vector densities within parts of the Park, Game Reserve and surrounding areas may be feasible once the extension has been approved in Parliament.

Results: Objective 3

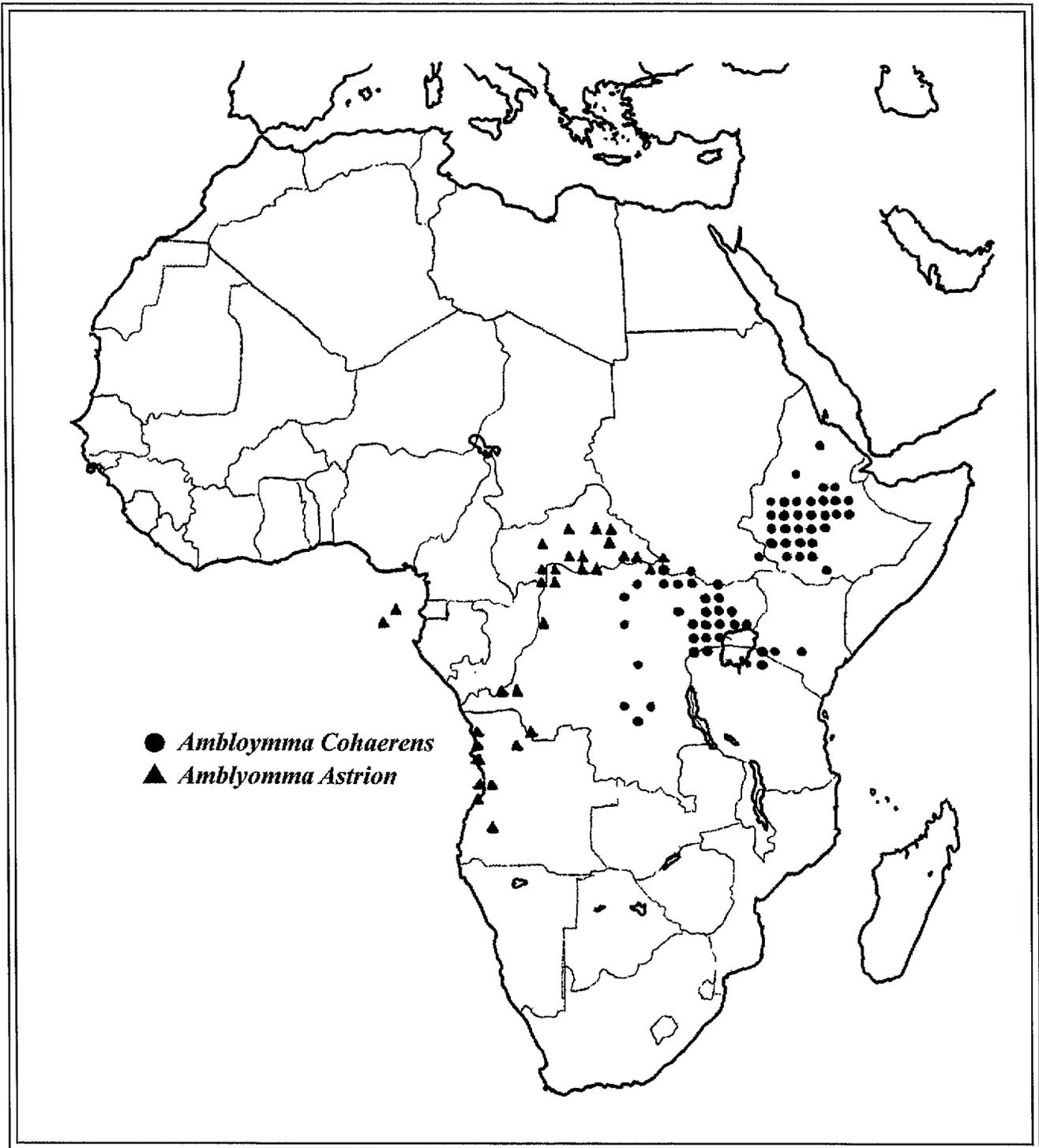
There are two major tick-borne pathogenic pathways that can be established between cattle and buffalo. The first is East Coast fever and corridor disease, caused by *Theileria parva parva*

| YEAR | FLY/DAY (Avg) | RANGE |
|------|---------------|-----------|
| 1989 | 1.97 | 0.85-3.77 |
| 1990 | 1.29 | 0.14-7.82 |

Table 1: Dry season tsetse trap yields/day at Lake Rukwa, TZ in 1989 and 1990.

Trap catches varied per month as well as between years: 1989 catch per day yielded peaks in August and October of three flies/day. Trap catches in 1990 were lower with an average of one fly/day and showed less defined peaks in August and October. Only two months of data collection for 1991 are available. The range variation in trap catch represents local abundances of tsetse.

and *Theileria parva laurencei* respectively, and carried by the tick, *Rhipicephalus appendiculatus*. The second is heartwater, caused by *Cowdria ruminantium*, and carried by *Amblyomma* tick species. Between October and November 1995, three buffalo (*Syncerus caffer*) carcasses were found on which ticks were still present. Ticks were preserved in alcohol and identified by Dr. B. Kimsey in the Department of Entomology, UC Davis. All specimens were identified as *Amblyomma cohaerens* Donitz, 1909. There are 20 *Amblyomma* species represented in Africa (Punyua 1992). *A. cohaerens* is most commonly found on buffalo, but not found throughout the range of its host (Petney et al. 1987, Map 2). Although buffalo are the most common host for *A. cohaerens*, in grazing areas with high past or present densities of buffalo, cattle can serve as an alternate host (Petney et al. 1987). *Cowdria ruminantium* can also infect sheep and goats. *A. cohaerens* like most of the *Amblyomma* genus, is capable of transmitting heartwater. Although *A. variegatum* and *A. hebraeum* are the most common and widely distributed vector of the disease (Walker 1987), *A.*



Map 2: From Walker and Olwage (1987). Note the distribution also represents collection efforts.

cohaerens, despite its limited distribution, can be as important as a heartwater vector locally (Petney et al. 1987). The mechanism of transmission by *Amblyomma* spp. is largely unknown since the actual infective stage in the blood has not been determined (Young et al 1988). Heartwater causes damage to the nervous system by attacking epithelial cells of the brain's blood vessels (Young et al 1987). *Amblyomma* species also transmit *Theileria velifera*, the agent of theileriosis and is widespread in cattle and buffalo (Young et al 1988) but is not pathogenic in cattle. *Rhipicephalus appendiculatus*, the tick vector for East Coast and corridor fever, was not found on the buffalo carcasses.

BUFFALO MORTALITY ESTIMATES FOR THE 1995 DRY SEASON

As carriers or reservoirs of diseases, many diseases are non-pathogenic for buffalo. However, some viruses effect both cattle and buffalo. To directly estimate the mortality of buffalo within the 1995 dry season, all fresh carcasses were recorded throughout the Park. Skulls were also collected to indirectly estimate past occurrences of diseases. Carcass and skull position was marked with GPS (UTM) coordinates.

Direct estimate: Of the ten buffalo carcasses found throughout the Park, six were along the road corridor. No other mortality data in previous years has been collected to use in comparison; however, Katavi Park wardens characterized the number of deaths as usual. An outbreak of bovine pleuropneumonia required a temporary cessation of all cattle sales; however, the proximity of the outbreak site to the Park is not known.

Indirect estimate: In addition to the ten fresh carcasses that were found, 38 buffalo skulls were found throughout the Park to approximate age classes that have experienced high mortalities in previous years. Age classification from skulls can be used to estimate past mortality pressures per age class. Age classes can be determined from dentine wear and tooth eruption (Grimsdell 1969). Twenty-nine of the thirty-four skulls showed high levels of tooth wear, both in dentine and crown height. Although disease might have influenced an animal's death, individuals with high levels of tooth wear die due to diet limitations because of advanced tooth wear and age. There was no evidence of a recent disease or virus outbreak.

CONCLUSION

In regions where complete eradication of tick and fly vectors is impossible, endemic stability of cattle within a region can be achieved using integrated control measures, if herds experience little regional movement (Young et al 1988). However, in an area, like the region surrounding KNP, in which cattle can be transferred in and out of the region, the susceptibility of naive individuals to disease and disease transmission will be higher. Tatchell and Easton (1986) reported cattle moving from the region surrounding Mwanza, by Lake Victoria, to as far as Mpanda, a town 75km north of KNP along the corridor road, to relieve grazing shortages.

Based on observational fly density data and ticks collected from carcasses, the buffalo within the Park are a reservoir for trypanosomiasis and heartwater. It would be useful to determine the

trypanosome strains that exist within the area, since different strains can potentiate the effect of another trypanosome and enhance susceptibility, particularly in naive cattle (Molyneux 1982).

Identification of *Amblyomma cohaerens* on cattle would support the existence of transmission pathways, as would the occurrence of heartwater and trypanosomiasis. Although the outbreak site of bovine pleuropneumonia is unknown, contraction of any virus requires close contact with animals carrying disease vectors. Both bovine pleuropneumonia and foot and mouth disease, of which buffalo are a vector, have been shown to often be transmitted at water sources (Plowright 1988). During the dry season, as water resources become scarce, cattle herds moving through the Park utilizing the restricted water source with wildlife may experience this close contact. Because of movement of cattle herds and the potential introductions of new hosts in nonendemic cattle, disease transmission and infectivity in and around KNP will be enhanced. In-depth work is necessary to investigate the effect of movement of herds within the Park.

RECOMMENDATIONS

Further work is necessary to investigate the transmission between cattle and buffalo in Katavi National Park.

1) Currently available facilities in the Park and within the Region require special consideration in planning future projects and testing methods. Based on an evaluation of the facilities and possibilities for storage of samples, testing buffalo and cattle for carriers and

infectivity can be conducted using a blood smear technique, in which blood is taken from animal, smeared on a slide and fixed with no additional storage necessary. Although blood smears are less sensitive than other available methods, such as enzyme-linked immunosorbent assays (ELISA) and DNA probes (Nyeko et al. 1990, Paris et al. 1982), current on-site facilities make it the most feasible. With reliable transportation, more precise measurements of disease infection would be possible utilizing facilities in a town 170km from the Park.

2) Use of satellite imagery of vegetation within an area along with basic climate variables (e.g. rainfall, temperature) has been shown to be useful in initially determining vector densities, but more importantly, a means of predicting changes in vector densities with changing climatological conditions (Rogers 1991, Rogers and Randolph 1993, Randolph 1994, Perry and Young 1995). Daily rainfall has been recorded in the Park for several years and daily temperatures for several months in 1995 and 1996. Normalized difference vegetation indices (NDVI), a measure of radiance, can also be included as a variable in determining vector densities. Satellite information and basic climatological data can be used to investigate both fly and tick disease vectors in and around KNP.

3) To insure that future project goals support the existing management goals of KNP, a close working relationship with Park wardens and Tanzania National Park officials is necessary. Park staff and officials willingly cooperated and proved to be an important resource.

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THE LESSER OF THREE EVILS: MODELING PASTORAL RESOURCE USE UNDER CONDITIONS OF DROUGHT, DISEASE, AND CONFLICT: A SUMMARY

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INTRODUCTION

This report addresses herder decision-making under conditions of drought, disease, and conflict in the Horn of Africa. It is based on data collected under two different research projects: a study of herder households and marketing from 1986 to 1988 in lower Jubba, Somalia, and a study of regional and cross-border livestock trade in northeastern Kenya during the summers of 1995 and 1996. Although the choices governing herder decisions in the East African Horn are complicated, they generally center around questions of drought, disease, and insecurity. Common components to each of these are issues of mobility and accessibility (access to key grazing and water resources); without these essential attributes, the herder is desperately constrained in responding to drought and other catastrophes.

STUDY REGION

The data from the Somalia/Kenya borderlands represent a unique opportunity to address herder decision making under conditions of drought, livestock disease, and conflict. Climatic instability and political insecurity are normal parameters in the area and there

are well-documented tsetse fly zones in two key dry season resources, the Jubba Valley and the coastal hinterlands of southern Somalia and northeastern Kenya.

The Lower Jubba Region of southern Somalia straddles the Kenya border and contains the largest number of cattle of any region in the former Somalia, as well as a sizable number of the country's camels and goats. Available data on regional and national livestock numbers (as of 1987) showed that approximately 25 percent of the national cattle herd or an estimated 860,000 animals were in the region: 214,000 camels or 3.53% of the national herd; 229,000 goats or 1.22% of the national herd; and 57,000 sheep or 0.51% of national herd (Janzen 1988; Hubl 1986). On the other side of the porous border with Kenya, there are an estimated 280,000 cattle, 240,000 goats and sheep, and 60,000 camels in Garissa District, Kenya (Kenya 1994:35). An informed estimate is that livestock herds in 1996 are at levels that are only 10 percent below those prior to 1991.

The Lower Jubba Region, at one time an administrative unit of southern Somalia bounded on the east by the

Jubba River and the Indian Ocean and on the west by Kenya, comprises 35,114 square kilometers of remarkably flat land, more than 90 percent of it classified as rangeland (Resource Management and Research 1984:40). Like other rangelands of Africa, the Kismayo region experiences considerable seasonal variation in the availability of fodder, a serious constraint to production and trade during the long dry season (the jilaal season).

ANALYSIS AND FINDINGS

The report suggests that just the single variable of mobility can explain much about why certain herding groups fare relatively well during extreme climatic variation, while others may lose up to 70 percent of their herds during droughts. Somali herders of the Lower Jubba Region generally were found to have fared better during recent droughts than have Kenyan herders. Even the civil strife of the past five years has not had a major disastrous impact on the region's livestock sector. The reasons for the resiliency of Somali pastoralism—especially in comparison to similar systems in Kenya—are the flexibility/mobility of the system and the relatively favorable access to key grazing and water resources that herders maintain.

Mobility and Seasonality: Herd movements in the region are strongly dictated by the different seasons, with the longest migrations taking place during the long dry and long wet seasons. In the rainy seasons (April-June and October-November), herders move their cattle to pastures located away from the coast and the Jubba River, especially to

areas west and northwest of Afmadow town, such as the Lag Dera and Jira plains. The Jira area, located approximately 50 kilometers from the Kenya border, is home to hundreds of herder families during the rains and is the most important wet-season grazing area for Afmadow pastoralists and their cattle. The most important dry-season grazing area for herders is Descheeg Wamo, the seasonally flooded wetlands west of the Jubba River. Kenyan herders frequently graze their animals in southern Somalia during the long dry season, moving with them as far as Descheeg Wamo.

During the past 20 years full-blown regional and/or national droughts have occurred about every eight years, while localized droughts take place about every three to four years. A localized drought means that at least some parts of the region or nearby accessible locations have experienced at least some rainfall while other sites have not. A regional drought, in turn, means that the long rains (gu season) have completely failed in the entire region; while a national drought means that the long rains have failed throughout the country. From April to July 1996 the long rains of central and northern Garissa District almost completely failed, with areas receiving about 30 percent of normal rainfall. Fortunately, the early rains in April were quite favorable across the border in Somalia and were above average in the southern portion of Garissa District during the later part of the season (May-June). Thus, herders in the locally affected zones were able either to move their animals across the border into Somalia or southward toward

Table 1: Average Herd Size and Composition Among Somali Herder Households

| | Kismayo District (n=46) | Afmadow District (n=42) | All Districts (n=88) |
|-------------|----------------------------|----------------------------|-------------------------|
| Livestock | | | |
| Cattle | 42.98 | 74.74 | 58.14 |
| Camels | 22.37 | 1.73 | 12.52 |
| Sheep/Goats | 6.54 | 8.26 | 7.36 |

Note: n = number of herders

the coast (the latter area being in the tsetse fly zone).

Since the outbreak of armed conflict in southern Somalia, the grazing patterns of 1991 and 1992 seemed to have been the only years that were seriously affected. During these two years, when clashes were widespread in the region and clan alliances were very unstable, some Somali herders moved their animals either to Kenya or to Ethiopia. Since 1993, regional grazing patterns have not been severely impacted, and normal dry and wet season grazing resources are being utilized. During 1995 and 1996 herders migrated with their cattle to their normal seasonal grazing resources around Lag Dera, Lag Jira, and Descheeg Wamo, although the construction of several permanent water points in central Garissa District, Kenya at the large refugee camps at Dadaab and Hagadera has attracted a large number of cattle and camels to that area (Kenya 1994).

Most households combine at least some goat and sheep production with cattle and camel raising, and certain households combine cattle and camel herding. Specialization in the production of particular animal types occurs most frequently among cattle producers, especially those of the Afmadow District. In the region, more than 90 percent of herders own cattle, 50 percent own camels, 34 percent own goats, and

14 percent own sheep. Table 1 shows differences in herd size and composition between households in two districts of the Lower Jubba Region, Kismayo and Afmadow. The most important contrast is the significance of camels in Kismayo and of cattle in Afmadow. The average number of camels controlled by herders in Kismayo District is more than ten times that of Afmadow herders who, in turn, own considerably larger cattle herds than do Kismayo households. Afmadow is one of the most important cattle-producing regions in the entire region.

Analysis of grazing patterns by different livestock species and by geographic location reveal several important trends. First, the average distances of seasonal herd movements vary considerably according to livestock type, but generally, movements are greatest for camels and cattle, followed by small stock. Movements of camel herds are greater than cattle only during the long wet season (gu season), when camels move well away from the seasonally flooded pastures around the Jubba river and Lags Dera and Jira. On the other hand, during the long dry season camels are not moved nearly as far as cattle, since they are able to use browse species away from the rivers and main water points. At that time small stock and cattle herds are moved an average distance of 70.22 and 61.18 km, while camels are moved only about 34.5 kilometers. In short, camels tend to

avoid the normal seasonal grazing areas of cattle and small stock which, in the case of Afmadow, tend to center around the Jubba valley and the seasonally flooded plains near the Somalia/Kenya border. Seasonal distances of small ruminant movements approximate seasonal cattle migrations for part of the year, except that they tend to remain with the main family residence whenever they move.

The mobility of herders of the Lower Jubba and their capacity to utilize distant pastures outside of their home regions are key reasons why they are more successful than Kenyan herders during droughts. In Baringo, Kenya, for example, Chamus Maasai herders do not normally migrate more than 70 kilometers even during the most severe droughts; while for the Samburu people seasonal herd movements are almost always less than 100 kilometers. In both cases, accessibility to drought reserve grazing areas is difficult because of the presence of large-scale commercial farms, ranches, and national parks in key dry-season grazing zones.

Marketing and Food Security: A herder's concern for food security also figure prominently into decisions about "where" and "when" to move livestock during the year (both in wet and dry seasons). At the onset of a drought, the herder can assume that climatic and livestock conditions will only become worse, so s/he will unload animals at the market—often at severely reduced prices—rather than take a chance by moving them to another grazing area. Since Somali herders are very dependent on grain consumption during dry seasons and droughts, it is necessary to sell

animals to purchase cereals. The distance to livestock and cereal markets will be factors influencing movements, as will be the terms-of-trade between livestock and grain items.

In terms of marketing strategies, herders confront several options at the onset of a drought. If the long rains do not come by early April, they can either sell some cattle immediately—probably fetching a relatively low price because of the poor condition of stock after the long dry season; dispose of small stock initially to maintain their cattle and camel assets; continue to graze their animals or move them to another grazing area and hope that the rains arrive; and/or make plans to migrate animals to markets in Kenya where livestock prices are higher. Since herders rely mainly on grain in their diet by the end of the dry season, the price of grain has an important effect on a herder's decision to sell. From observations of droughts in the region during the past 17 years, stress sales of cattle usually do not begin to take place in large numbers until about the fourth month after the long rains have failed (and up to nine months after there has been any effective rain at all).

The war in southern Somalia has had major impacts on livestock marketing in the region. It has meant that cross-border trade with Kenya currently is flourishing and overseas exports have virtually stopped. The growth in border commerce is reflected in the marketing statistics of the main border district of Garissa, Kenya (Table 2). From 1991 to 1995, sales of cattle—the main animal marketed—in Garissa have more than doubled, and have increased by three-fold since 1989. In 1989, the sales of

Table 2: Cattle
Sales in Garissa,
Kenya:
1989-1996

| Year | Number of Sales | Value (Kenya Shillings) |
|----------------------|-----------------|-------------------------|
| 1989 | 24 395 | 51 717 400 |
| 1990 | 32 664 | 84 273 120 |
| 1991 | 33 449 | 99 510 775 |
| (Civil War) | ----- | ----- |
| 1992 | 65 127 | 162 229 648 |
| 1993 | 67 076 | 387 162 670 |
| 1994 | 62 351 | 436 457 000 |
| 1995 | 80 795 | 565 565 000 |
| 1996 (until May '96) | 24 590 | 184 425 000 |

Based on annual reports Ministry of Agriculture and Livestock Development, Garissa

cattle in Garissa were 24,395, while they had increased to 80,795 by 1995. Herders and traders acknowledge that this dramatic increase is a result of the growth in cross-border trade. Recent reports from the area also confirm this trend (United Nations Development Office for Somalia [UNDOS] 1995). The dependence on Somali animals at the market is especially high because Garissa District experienced an approximate 50 percent drop off in aggregate herds during the 1992 drought (Kenya 1994).

POLICY IMPLICATIONS

The findings of the report point to several areas germane to policy. The majority of these highlight the need to maintain the flexibility of pastoral production systems in dry regions.

Managing Strategic Key Resources ("Accessibility" and "Mobility"):

Although the recovery of strategic grazing resources lost during the past century is unrealistic, an effort should be made to identify those remaining key resources where herder access needs to be protected, particularly during dry seasons and droughts.

The Kenya/Somalia borderlands are a particularly "patchy environment" (Scoones 1989), where the prime grazing resources are around seasonally-flooded pans (e.g., the Lag areas of Jira and Dera and the coastal plains), swamps (e.g., the Lorian swamp of northeastern Kenya), and river valleys (e.g., the Tana and Jubba rivers). Access to them and their productivity—which is already threatened in Somalia and Kenya due to civil unrest, dam construction, and irrigation schemes—often determines whether or not herders survive harsh years without massive livestock losses. While it may not be possible to alleviate long-standing rivalries among different groups, conflict resolution can be facilitated by advocating situations of fair access, where one group or use is not heavily favored over another.

Mobile Veterinary Services: The efforts of several NGOs in support of paraveterinarians and veterinary supplies during the past four years has been beneficial and has allowed herders to graze tsetse-infested areas more easily. At present, private traders also are an important source of veterinary supplies, which are imported from neighboring countries. Efforts should be made to continue to support paraveterinary

efforts and, in emergency droughts, donors should think of subsidizing prices and supplies.

Cereal Banks and Emergency Livestock Buying Programs: The sharp rise in grain prices during a prolonged dry season or drought often is a reason why herders are forced to market productive animals at “throw-away” prices. It is also a reason why the terms-of-trade for herders are often so volatile. Community-based cereal banks have been implemented in the Sahel with mixed results, but they still warrant attention, especially if organization and management issues can be effectively addressed.

Some efforts by NGOs in the region to initiate emergency buying programs, so that herders reap some economic benefits before their animals perish or before they are sold at very low prices. In parts of northern Kenya emergency buying campaigns have been used both to improve conditions of herders as well as to supply a source of protein to refugee and famine victims. Private traders are often used and the purchased livestock is slaughtered, dried, and then sold or distributed to refugee camps.

COMMENTS

In summary, the report has shown the kinds of decisions that pastoralists confront during the onset of a drought and the importance of maintaining herder mobility and accessibility to key resources. It has drawn on data that span a nine-year period in order to show how herders make decisions under conditions of drought, disease, and conflict. While it is specific to the ethnic Somali areas of northeastern Kenya and southern Somalia, the model presented is generally applicable to other pastoral areas of the East African Horn. By showing how the timing of decisions is so critical for pastoral enterprises, it points to critical periods of a drought where assistance or NGO/donor action can alleviate hardships. In short, the report reiterates what is commonly accepted by pastoral practitioners: external parties must be willing to rethink orthodox development strategies, in order to support the flexibility and mobility of pastoral systems in virtually every type of program, from veterinary to marketing to extension activities.

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WORKSHOPS



| | |
|---|-----|
| REGIONAL WORKSHOPS: OVERVIEW | 145 |
| EAST AFRICA LIVESTOCK ASSESSMENT | 149 |
| LATIN AMERICA REGIONAL LIVESTOCK ASSESSMENT | 165 |
| CENTRAL ASIA ANIMAL PRODUCT REGIONAL ASSESSMENT | 182 |
| SMALL RUMINANT PRODUCTION: RECOMMENDATIONS FOR SOUTHEAST ASIA | 196 |

REGIONAL LIVESTOCK ASSESSMENT WORKSHOPS

Objective: *To identify, prioritize and describe the researchable problems of animal production in the region that will be used to develop the SR-CRSP program in the region for the next five years.*

OVERVIEW

In October of 1995, the Advisory Panel set forth a process for the grant extension of the Small Ruminant Collaborative Research Support Program (SR-CRSP). The renewal process, which emphasizes bottom-up inputs, places considerable importance on customer input, team building and planning. The process endorsed by the Advisory Panel closely follows reengineering principles and the new vision of AID.

In addition, the Advisory Panel identified three major themes on which the SR-CRSP program should focus in the next five years: nutrition and its implications for child development, livestock impact on the environment, and the role of policy environment to enable the economic development of the livestock sector.

The first step towards the SR-CRSP grant renewal, was the organization of regional workshops designed to identify and prioritize perceived problems and potential areas for research and development. As a forum for client input, the workshops were conceived to allow maximum opportunity for nationals of the region to present their perceptions of the issues and constraints.

The problem models developed by the workshop participants will establish the potential scope of the CRSP's regional activities and form the topical basis for the renewal proposal. Using the specific problems identified at the workshops, the Management Entity of the Small Ruminant CRSP issued Requests for Proposals (RFPs) for assessment teams in June 1996. The Assessment Teams will have nine months to undertake comprehensive studies to identify the major constraints and issues associated with a specific problem. Within a year, each assessment team will prepare and submit a comprehensive proposal for review and possible funding for implementation.

The Advisory Panel recommended the SR-CRSP program concentrate in three regions of the world: East Africa, Central Asia and Latin America. In early 1996, the Management Entity of the SR-CRSP organized and sponsored three workshops in each of those regions. The workshops were held in collaboration with a regional organization active in each region. The SR-CRSP teamed with ASARECA in East Africa, ICARDA and the Uzbek Academy of Sciences in Central Asia and IICA in Latin America.

Workshop participants included representatives of the countries in the region, NGOs, NARs, IARCs, USAID, local universities and the private sector.

The workshops will play a significant role in the design and structure of the SR-CRSP extension. The workshop participants looked at problems of livestock in the region, identified major institutions involved in relevant research and established general guidelines for the Assessment Teams. The workshops were structured to provide each member country the opportunity to fully participate in the identification and prioritization of the problems that will serve as a basis for the future agenda of the SR-CRSP.

CRSP MODEL: STRUCTURE AND FUNCTION

At each workshop Dr. Montague Demment, SR-CRSP Director presented the history of the CRSPs, the advantages to the CRSP model and the SR-CRSP program goals and objectives. Details of his presentation are included in the foreword of this publication.

Advantages of the CRSP Model

Cost Effective. The CRSP model is designed to take advantage of the comparative advantage of the partners to ensure that USAID funds are leveraged to a maximal extent. The backbone of this cost efficiency is the spirit of partnership inherent in the formation of the CRSP. This partnership results in matching funds from both host country and US universities. In the SR-CRSP this funding has amounted to \$50M over the life of the CRSP and

exceeded the USAID contribution over that period. This level of matching and leveraged funds is the highest among the CRSP programs and certainly represents a major efficiency for the Agency. The other benefit of the partnership relationship has been the Principal Investigator (PI) and Resident Scientist relationship. This partnership, structured to provide strong linkages between the PI in the US and the Resident Scientist in the host country, makes obsolete the need for expatriate scientists in country and hence removes major costs of housing, transport, schooling that accompany expatriate positions in host countries.

Collaboration with US Universities. The success of American agriculture is due in large part to the productive partnership created between the Land Grant Universities and the farmer. This system has connected the power of basic science with the food production systems of the nation to produce a secure, cheap and profitable food supply. The US land grant universities also represent a major resource for expertise in the sciences related to agricultural production. For example there are more soil scientists in a single major land grant university than there are in the entire CGIAR system. The opportunity to link with such a rich system of scientific expertise provides NARS with a diversity of potential contacts that they can not achieve within their own countries. These linkages can be particularly productive as the ability to communicate quickly and cheaply become increasingly available.

Internationalization of US Scientists and Host Country Training. The power of the US culture and economy can be a

SR-CRSP STRATEGIC OBJECTIVES

To strengthen the ability of institutions to identify problems and constraints and develop appropriate solutions in production systems in which livestock play a role.

To support decision makers in developing more effective policies and technologies to improve livestock production, marketing, processing, and natural resource conservation and management.

To identify, study, and strengthen communication systems (including but not limited to extension) among livestock producers, businesses, researchers, and consumers.

To enhance the nutritional status of targeted populations through consumption of livestock products.

To increase employment and incomes among livestock producers and associated value-added agribusinesses.

force that isolates and limits the international perspective of its scientists. Because of the ease with which scientists can focus on domestic problems, it is essential to create mechanisms to expose developing US scientists to the international scene. This is especially true in the age of globalization. We need to develop a strong cohort of internationally focused scientists to make the international linkages that are the basis of intellectual and technologies exchange in the emerging markets. The training provided to US students through the CRSP does just this. The CRSP has also been a highly effective training mechanism for host country students.

Long Term Collaborations: The long-term nature of the CRSP programs has built strong ties between the cooperating

institutions and their scientists. The relationships built during the program are a major link that provides stability to institutions and individual scientists that fosters creativity and accomplishment.

COUNTRY PRESENTATIONS

At each regional workshop, country representatives were asked to present a paper on the constraints of livestock production in their respective countries as well as identify potential collaborators. The presentations began with a look at the livestock production systems of the respective countries and the policies governing the use of land in the country. Representatives described the structure and interaction between the institutional components playing a role

in the development of policy, information and extension in the livestock sector. Linkages and reporting responsibilities of the national and regional institutions were also indicated. Data on the number of scientists in relevant fields to livestock was provided for each of the research institutions. Discussion time was allotted following each presentation.

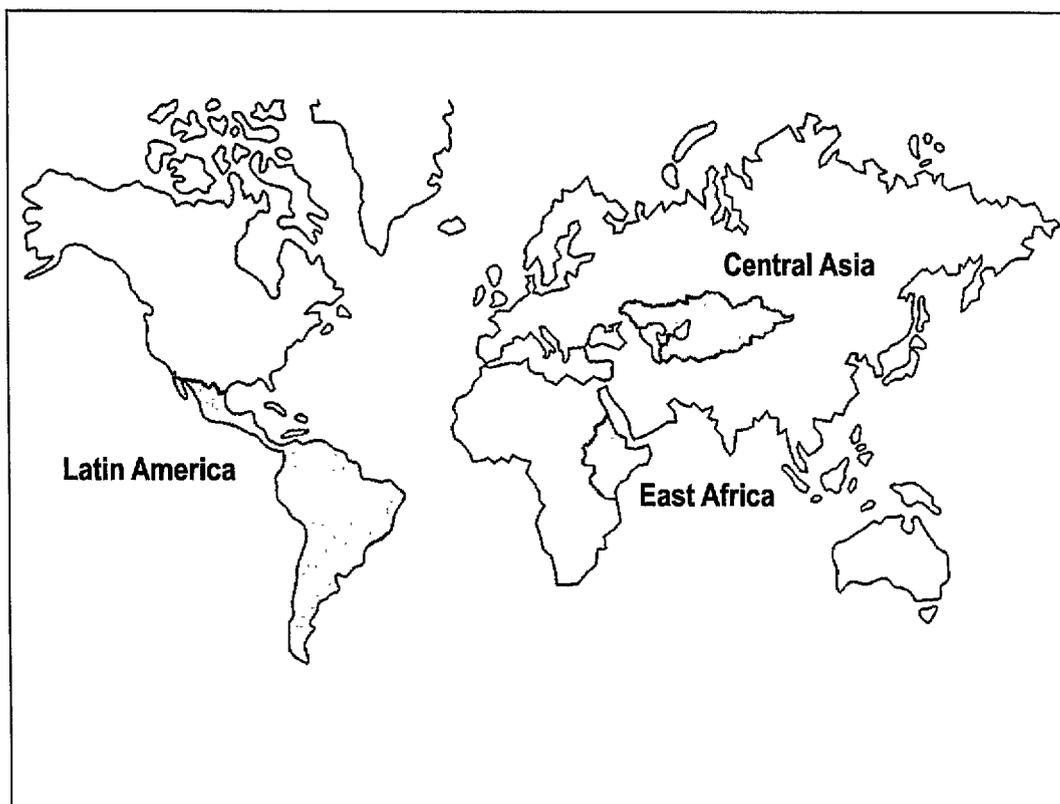
RESOURCE PRESENTATIONS

In addition to the country representatives, resource people were invited to represent the thematic subjects. Presentation topics included Policy, Human Nutrition, Wildlife/Livestock interactions, Livestock/Environment, Livestock Production Systems, Impact of Decollectivisation and NGOs.

PRIORITIES

Thematic working groups were charged with the task of producing a set of prioritized constraints related to livestock production that are the assessment and description of the underlying processes responsible or connected to the identified problem model in their theme. Themes included: Human Nutrition, Economic Growth, Policy, and Livestock/Environment. The groups were further given the responsibility to identify and characterize potential partners for US Land Grant Universities with the capabilities of addressing the problem model. At the conclusion of the workshop, participants ranked the priority topics with the SR-CRSP goals and objectives in mind.

During 1996 Regional Assessment Workshops were held in three regions of the world; Latin America, East Africa and Central Asia.



EAST AFRICA LIVESTOCK ASSESSMENT WORKSHOP
29 JANUARY - 1 FEBRUARY 1996
ENTEBBE, UGANDA

The East African Livestock Assessment Workshop was the first of three workshops to be organized and coordinated by the Small Ruminant CRSP.

INTRODUCTION

In collaboration with the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), the Small Ruminant CRSP sponsored the East African Regional Livestock Assessment Workshop January 29 - February 1, 1996, in Entebbe, Uganda. Seven of the ten ASARECA member countries were represented at the workshop along with participants from NGOs, NARs, IARCs, USAID, local universities and the private sector. Representation was primarily African with a few specialists of non-African nationality.

ASSOCIATION FOR STRENGTHENING AGRICULTURAL RESEARCH IN EASTERN AND CENTRAL AFRICA (ASARECA)

The workshop commenced with opening remarks by Dr. Mrema, Executive Secretary of ASARECA. Dr. Mrema presented the goals and aspirations of ASARECA. He began with a brief history of the formation of the association. ASARECA is one of the four sub-regional organizations for agricultural research in Sub-Saharan Africa. The others are: SACCAR (South Africa), CORAF (West Africa)

and INSAH (Sahelian Zone). ASARECA is governed by a Committee of Directors, comprised of one director of agricultural research from each member country. The Executive Secretary is responsible for executing decisions of the Committee of Directors and assumes administrative oversight of the association.

The Association has the following objectives:

- To update the strategic national Agricultural Research Plans while ensuring that research responds to demands (clients/markets).
- To identify common constraints to agricultural productivity in the region.
- To implement joint regional research programmes.
- To create consolidated funding mechanisms for agricultural research.
- To contribute to meeting the human, physical and financial resource requirements of the regional programmes decided jointly.
- To establish a regional plan for the development and management of human resources.

- To harmonize and improve the management information systems of the member institutions.
- To establish harmonized systems of scientific and technical information and documentation.
- To publish the results of joint research
- To promote the exchange of genetic material.
- To stimulate the researchers to assume real responsibility for the research programmes in which they participate, and for the results.
- To develop more effective and cheaper mechanisms for linking research, extension, producers and markets.
- To disseminate new technologies and knowledge to end-users.

Dr. Mrema concluded with a brief look at the issues requiring consideration when prioritizing and identifying constraints in livestock research. He identified ten issues for consideration:

- Budgetary constraints
- Problem of pastoralists
- Supply of livestock products to urban and other non-livestock keepers
- Reduce transaction costs for trade in livestock products
- Urban farming
- Local production vs. imports
- Policies
- Intensive vs. Extensive systems
- Institutions
- Natural Resources/Conservation Issues

EAST AFRICA LIVESTOCK ASSESSMENT WORKSHOP PARTICIPANTS

| | | |
|--|--|--|
| <p>Augusta Abate KARI, Kenya</p> <p>Isaac Aluba, USAID, Uganda</p> <p>Montague Demment SR-CRSP, USA</p> <p>Cyprian Ebong NAARI, Uganda</p> <p>Alemu Gebrewold IAR, Ethiopia</p> <p>Kamau Githaiga Kenya Wildlife Service, Kenya</p> <p>Mark Infield African Wildlife Foundation Uganda</p> <p>G.H. Kiwuwa Makerere University Uganda</p> | <p>Maynard Lugenja Ministry of Agriculture Tanzania</p> <p>Ernest Manirambona ISABU, Burundi</p> <p>S.M. Mbuza Dept. of Animal Prod. & Marketing Uganda</p> <p>Steve Mihok ICIPE, Kenya</p> <p>G. Mrema ASARECA, Uganda</p> <p>John S. Mugerwa NARO, Uganda</p> <p>Suzanne Murphy University of California USA</p> | <p>Jean Ndikumana ILRI, Kenya</p> <p>Peter K. Ngategize Uganda Coffee Dev. Authority Uganda</p> <p>Moses Onim Lagrotech Consultants Kenya</p> <p>Christie Peacock FARM Africa U.K.</p> <p>Jhon Rasambainarivo MRAD/ FOFIFA Madagascar</p> <p>Patterson Semenye SR-CRSP, Kenya</p> <p>Ralph Von Kaufmann ILRI, Ethiopia</p> |
|--|--|--|

THEMATIC GROUPS

Workgroups in East Africa were formed around the following themes: Livestock/Environment, Human Nutrition and Economic Growth. The stated goals for the thematic workgroups were:

- To produce a set of prioritized constraints (problem models) related to livestock production that are the assessment and description of the underlying processes responsible or connected to the identified problem model in each theme.
- Identify and characterize potential partners for US Land Grant Universities with the capabilities of addressing the problem model.
- Provide information for ASARECA to set their livestock research priorities.

The results of the group discussions are presented below.

PRIORITY TOPICS FOR RESEARCH IN HUMAN NUTRITION

Introduction: A high prevalence (40%) of childhood malnutrition exists in East Africa. Two types of malnutrition have been identified: (1) protein-energy malnutrition (PEM) resulting from inadequate quantities of food; (2) micronutrient malnutrition due to poor quality food (e.g., low intakes of iron, vitamin A, vitamin B12, zinc, and calcium). Children with PEM will usually have micronutrient deficiencies as well, although micronutrient deficiencies may exist without PEM.

Objective: To identify and evaluate practical methods to increase animal products in children's diets to alleviate malnutrition.

Hypothesis: Increasing animal products in children's diets will enhance child health and development.

Activities:

Review of literature and other available knowledge to clearly identify constraints and gaps in information regarding:

- Nutritional status and dietary data
- Policy, economic status, agricultural practices, etc.

Conduct surveys (PRAs, RRAs, etc.) for validation of existing information (if any) and establish the magnitude of the researchable nutrition problems

Characterize the nutritional content of typical diets

Develop the most appropriate intervention protocols:

- Educational
- Household animal production
- Community access to animal products

Implement randomized controlled trials
Measure impact of the selected interventions (e.g., improvements in birth weight, growth, child survival, and cognitive development).

Outputs:

Comprehensive description of the nutritional status of the community.

A summary of the nutritional adequacy of typical diets in the community.

An evaluation of the impact of adding animal products to children's diets.

A handbook describing these methods and their possible application in other communities.

Relevance: The problems are universal in East and Central Africa.

Actors:

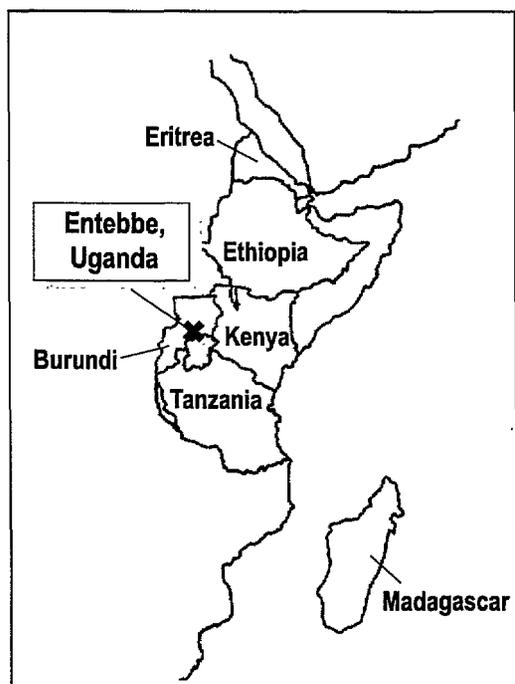
- Land grant universities in the US.
- Agricultural universities in East and Central Africa.
- NARS and Ministries of Health and Agriculture.
- NGOs such as International Center for Research on Women (ICRW), FARM Africa, Save the Children's Fund, Freedom from Hunger, Heifer Project International, CARE, OXFAM, Action Aid, Plan International.
- IARCs (ILRI, IFPRI)
- UNICEF
- Private sector (e.g., US Livestock and Meat Board, Land O' Lakes, meat packers).

Active Projects:

ICRW/FARM Africa dairy goat project in Ethiopia (contact: Charlotte Johnson-Welch at ICRW, Washington, DC).

Note: Consideration should be given to incorporation of human nutrition components into existing livestock research and development projects.

East Africa



PRIORITY TOPICS FOR RESEARCH IN LIVESTOCK PRODUCTION, WILDLIFE INTERACTIONS AND ENVIRONMENTAL CONSERVATION

Introduction: Under this general research area two main areas of interest were examined:

- Crop/livestock production systems
- Livestock/wildlife production systems

Bearing in mind the interests of the Small Ruminant CRSP and the considerable research already carried out on crop/livestock production systems the group concentrated discussions on livestock/wildlife production systems and examined areas of research that would promote increased production whilst enhancing environmental conservation in rangeland. It is felt that though some of the ideas may have relevance to forest areas, their greater significance is for arid and semi-arid rangeland habitats.

Livestock/Wildlife Production Systems

The major topics identified were:

1. Establishing policies that would support a sustainable balance between food production and conservation of the environment.
2. Community based management strategies for protected areas.
3. Management strategies to integrate livestock and wildlife populations to maximize the production of rangeland ecosystems.
4. Problems in pastoralist production systems in response to periodic droughts.

(1) Policies and their importance for incorporating wildlife into the development of sustainable balances between food production and conservation of the environment.

Objective: To establish an appropriate and sustainable balance between food production and environmental conservation.

Research has shown that mixed species systems can result in higher production in both biomass terms and economic terms than single species systems. Current policies in the east African region do not, however, promote such systems and traditional and cultural dispositions and the conservatism common amongst farmers tend to result in concentration on single species production systems, or at best the use of two or three domestic animal varieties. The expectation that the control of livestock diseases (notably by the effective control of tsetse fly) will make large areas of rangeland currently unavailable to livestock and often important wildlife areas available for livestock production also presents the opportunity for the development of mixed livestock/wildlife production systems.

Hypothesis: Creation of a well researched policy environment will permit optimal balances between food production and environmental conservation on land made available by the control of livestock diseases.

Activities: The following areas of research were identified as necessary for validating the above hypothesis:

- Social sciences:

- Society and resource use
- Conflict resolution
- Resource sharing
- Traditional structures
- Forms of social organizations
- Needs and demands of rangeland communities
- Economics of production:
 - Pricing and marketing
 - Cost of production
- Range ecology:
 - Conflicting uses
 - Ecological monitoring
 - Range and wildlife management (protection and use)
 - Stocking rates in mixed species systems
- Ownership:
 - Communal management vs. private management of land in terms of food production and conservation.
 - Ownership of wildlife (private Vs state)
 - Conflicting interests
- Development of wildlife industry:
 - Relationship to tourism
 - Processing of by-products
 - Marketing
- Facilitation:
 - Extension
 - Producer associations
 - Tax environment
 - Conflict resolving current and future conflict between wildlife and other agricultural production systems.

Outputs: Lands likely to be opened up by eradication of diseases will be managed under optimum regimes balancing both environmental conservation and food production.

Relevance: The products of this research will apply to a great proportion of the rangelands in Africa.

Actors: Expertise is available to carry out these activities from; Land grant Universities, ILRI, Government agencies concerned with management of wildlife, and various NGOs. The following agencies are active in this type of research:

- UNEP
- WLTU
- NEMA (Uganda)

(2) Community based management strategies for protected areas.

Objective: To examine empirically the apparent advantages of a community based approach to protected area management in the pursuit of sustainable conservation areas.

The general acceptance of community based conservation as the correct approach to protected area management, largely replacing protectionist approaches, has come about largely in the absence of empirical evidence to demonstrate its facility. Despite the lack of real evidence, most western based conservation organizations, if not all African conservation authorities, now require that projects funded by them include activities to enable communities to participate in and benefit from protected area management. The complex nature of community based approaches to protected area management and the apparent failure of many of the pilot projects implemented around the continent, suggest the importance of a body of data to support the theoretical rationale for involving local communities in protected area management.

Hypothesis: Community based approaches to protected area management are more effective than traditional protectionist approaches.

Activities: The following areas of research were identified as necessary for validating the above hypothesis:

- Environmental monitoring
 - comparing environmental parameters both inside and outside PAs under different management regimes.
- Economic analysis
 - Respective costs of different management regimes, current expenditure and projections.
 - External pressure on protected areas and vice-versa - comparing the pressures exerted on the PAs to allow analysis of the degree of impact of management on the problem (land pressure, poaching pressure, natural resources, population pressure, etc.), and the degree of negative impact caused by the PA on local communities (e.g., crop damage, loss of livestock, loss of traditional resources, etc.)
- Sociological aspects
 - Attitudes of communities to the PA, roles of community structures in management, impact of management initiatives on social structures.
 - Economic impact on the community, comparison between the economic cost of the PA on the community with the value of benefits created under a community based approach.

Outputs: This research will provide data which can be used to better evaluate the benefits of adopting a community based approach to protected area

management. The techniques involved will be viewed realistically, and applied in a practical and appropriate way, rather than as an act of faith or as an act of political correctness.

Relevance: The products of this research will apply to most countries within the region developing various forms of community based conservation initiatives.

Actors: Available expertise to undertake these activities are: International research organizations like ILRI, Land grant Universities, NGOs, and some governmental organizations. Agencies with active research projects related to this topic are:

- AWF
- WWF
- WCI
- IUCN
- FOC
- IFF
- CARE
- KWS
- ANGAP (MADAGASCAR)

(3) Management Of Mixed Livestock/ Wildlife Populations To Maximize Efficiency Of Use Of Rangeland Resources.

Objective: To maximize efficiency in the use of ecosystems by stocking both livestock and wildlife in the rangelands.

Rangeland management theory and wild and domestic animal ecology research suggest that productivity in terms of biomass production will be increased by employing a multi-species production system rather than a single species system. It is suggested that this will

result from the ecological adaptations and niche separation demonstrated by the wide variety of large mammals and reflected to some extent in the different domestic animals. At a simplistic level it is clear that in woodland savannas, a mixture of grazers and browsers will make fuller use of the available natural forage resource than either grazers or browsers alone. Thus, keeping a mixture of browsers and grazers would allow higher stocking rates to be maintained, leading to higher production from a given area. Management of a mixed species production system, however, is more complex, and where this included wildlife, the required technical skills may not exist.

Hypothesis: Animal production can be improved by incorporating wildlife into the production system.

Activities: The following areas of research were identified as necessary for validating the above hypothesis:

- Ecology of domestic and wild herbivores
 - water
 - forage
 - habitat
- Management in drought prone environments
- Economics (natural resources/ production).
- Production technologies
 - harvesting animals
 - processing
 - fencing
 - disease management
 - most appropriate management techniques
- Training
 - extension workers, producers

- Biodiversity - livestock, wildlife and plants
- Habitat modification in relation to production systems
 - production levels
 - cultural perspectives
 - ecological mechanisms
- Use of animals (domestic and wild) as environmental management tools.

Outputs: The output of this research will be the formulation of stocking densities that are optimal for the rangeland ecosystems when stocked with a mixture of wildlife and livestock. This will prevent environmental degradation and allow for the most economic and ecologically efficient use of the land.

Relevance: The products of this research will apply to most parts of African rangelands.

Actors: Expertise available to carry out these activities are NGOs like WCI, WWF, Government agencies and Land grant Universities. It was difficult to identify agencies active in these activities in this region.

(4) Production inefficiencies in pastoralist systems resulting from droughts.

Objective: To research mechanisms that will assist pastoralists to overcome limitations on their livestock production system resulting from inability to de-stock rapidly in response to droughts and re-stock following droughts.

Traditional pastoralist strategies of reducing risk in rangeland in highly variable rainfall areas depended on mobility, exploitation of habitat

variability, distribution of animals over a social network, and large herd sizes. These strategies were highly adaptive and enable higher levels of production from the land than western based ranching models of production. Reduction in mobility and the available land has compromised these strategies in many circumstances. Retention of large herds in particular tends to result in dramatic collapses in livestock populations in response to drought, often with accompanying damage to the environment. Enabling pastoralists to reduce herd size in advance of droughts to avoid die-offs and thus loss of capital, and restock rapidly to exploit available forage resources following droughts should increase the productivity of the rangeland and provide significant social and environmental benefits.

Hypothesis: Mechanisms for connecting pastoralist to financial institutions to increase liquidity of livestock would be effective in enhancing production and environmental protection in arid and semi-arid rangeland system.

Activities: This topic relates closely to the topic presented by the animal production for economic development group to examine the problems of pastoralists' responses to droughts. The rationale presented here could be combined with their rationale.

Crop/Livestock Production Systems

The following topics were examined:

1. Reducing herd sizes through intensification will ameliorate environmental degradation.

2. Testing available technology packages that are efficient, environmentally efficient and economically viable.
3. Development of methodologies for transfer and adoption of technologies
4. Use of marginal lands within high intensity production systems.

(5) Appropriate mechanisms can be developed to connect pastoralist systems to the central national economies in ways that allow livestock capital to be integrated into national and local capital markets providing flexibility to deal with drought and minimize environmental degradation.

(Topic is similar to one identified by the economic development group.)

(6) Marginal lands within high intensity production systems.

Objective: To examine mechanisms for the sustainable use of marginal, ecologically fragile lands existing with high intensity production systems, currently subject to inappropriate and generally environmentally damaging production systems.

Many areas characterized by high population densities and high intensity crop/livestock production systems contain within them areas of marginal production potential, but which often play an important role in the provision of ecological services and are high in biodiversity. Examples would be steep forested or grassland slopes and seasonally inundated valleys or wetlands. Land pressure often forces farmers to exploit these marginal lands in inappropriate ways that are not

sustainable and which may damage the production potential of the entire system, and certainly of the marginal lands. Land-uses for these marginal areas need to be developed which would contribute to the productivity of the farming system but which will be sustainable and support the retention of biodiversity.

Hypothesis: Sustainable management of marginal area resources can increase farming system production in the short term whilst retaining biodiversity.

Activities: The following areas of research were identified as necessary for validating the above hypothesis:

- Characterization of marginal lands within a high intensity production area selected for study.
- Examination of uses of marginal lands and economic analysis of their contribution to the production system.
- Impact of land use on habitat and biodiversity.
- Participatory development of alternative land uses for marginal areas that would increase production and reduce environmental damage.
- Economic and environmental impact analyses of identified alternative land uses.
- Specific examination of potential roles for wildlife within alternative land use systems (e.g. small antelopes for meat production, butterfly pupae production, honey production).

Outputs: Methodologies for examination of potential for marginal lands to contribute towards crop/livestock production systems.

Relevance: Highly relevant to highland areas in the region, especially Ethiopia, and to Uganda's extensive wetlands.

Actors: Potential collaborators would be IUCN (Wetland Program, Uganda), FARM Africa, NARs.

PRIORITY TOPICS FOR RESEARCH IN ANIMAL AGRICULTURE FOR ECONOMIC DEVELOPMENT

Introduction: Though no intellectual restriction was applied, selection of the major topics was done within the ASARECA identified priorities and with an eye to the exploiting the comparative advantages of the CRSP approach to collaborative research. There will be other priority topics, appropriate to other approaches to regional collaboration in agricultural research, that have not been identified in this exercise. This prioritization also assumes a commitment by regional national agricultural research institutions to collaboration with US Land Grant Universities and other institutions which will have to be validated by further consultation. The role of the CRSP in building capacity for achieving the research objectives will be assessed as a component of each selected project.

The major topics that were identified for research in animal agriculture for economic development (not in order of priority) were:

1. Ensuring the food security and development needs of resource poor households.
2. Improving the ability of pastoral people to cope with and recover from drought.

3. Establishing a enabling policy environment.
4. Matching livestock genotypes to ecological and economic environments.
5. Improving input and output markets.
6. Conserving forage and browse plant and livestock biodiversity.
7. Optimizing land use and natural resource conservation by integrating domestic and wild animal species.

(1) Ensuring the food security and development needs of resource poor households

Objective: To use livestock, especially small ruminants to enable resource poor households to cope with stress and enter the monetary economy. The priority target group will most likely be women in households that currently do not have livestock and little opportunity to acquire them as a hedge against poor harvests.

Hypothesis: Livestock are important in maintaining household security in times of stress, especially in resource poor households.

Activities: The following activities have been identified as necessary for validating the above hypothesis:

- identifying appropriate target groups that are typical of a broad cross section of people in East Africa. This will be preceded by establishing criteria for identifying such groups;
- establishing human nutrition profiles partly as criteria for identification and as baselines for assessing progress in achieving food security;
- identifying appropriate interventions;

- developing appropriate means for resource people to access credit e.g., through women peer groups; and
- extension techniques in human nutrition.

Outputs: The output of this research will be viable approaches for improving the welfare and food security of the poorest communities in rural areas and enabling them to enter the market economy.

Relevance: The products of this research will apply to significant numbers of people in all East African countries.

Actors: The following agencies are active in this type of research and development:

- FARM-Africa
- Save the Children Fund
- CARE International
- International Center for Research on Women (with FARM-Africa)
- Ethiopian Health and Nutrition Research Institute
- UNICEF

(2) Improving the ability of pastoral people to cope with and recover from drought

Objective: To improve the chances of livestock people being able to withstand catastrophes and sustain their production systems and welfare under changing ecological, social and economic circumstances.

Hypothesis: By better matching of traditional coping mechanisms with appropriate policy and technical options, pastoral systems will be more

sustainable and better able to accommodate change.

Activities: The following activities have been identified as necessary for validating the above hypothesis:

- identification of central and local government, and traditional authorities which affect the behavior of pastoral systems and elucidation of their roles;
- identification, description and evaluation of pastoral coping mechanisms;
- assessing extent, and consequences, of changing terms of trade between pastoral societies and providers of food grains and other essential goods and services. And studying food sources, quality of market information and state of infrastructure of trade in livestock and foodstuffs;
- identification of available technologies for amelioration of the effect of drought, especially water and feed options;
- analyses of options open for pastoral mobility and likely trends;
- design and implementation of a pastoral famine early warning system for East African countries that will complement the FEWS in place for grain crops. This will inter alia involve the identification of locationally-strategic partners in research, extension and NGO communities and provision of means for them to be trained in famine early warning and enabling them to conduct trials on coping mechanisms suggested by the pastoral communities amongst whom they work; and
- depending on resources, this may be

linked to the design and validation of appropriate herd health procedures to control diseases that exacerbate the deleterious effects of droughts.

Outputs: An early warning system that will constitute a vital component of effective relief to development assistance and which will ameliorate the effect of future drought and disease catastrophes.

Relevance: The products of this research will apply to significant numbers of people in all East African countries, especially those with large pastoral communities.

Actors: The following agencies are active in this type of research and development:

- FARM-Africa's northern Kenya camel production improvement project
- Save the Children Fund
- CARE
- OXFAM
- IGADD
- CARE International
- ILRI associated Livestock research networks; CARNET, SRNET and AFRNET
- World Bank
- USAID
- IDRC
- FAO

(3) *Establishing an enabling policy environment*

Objective: To provide government with the necessary information and analysis of options with which to formulate

policies that will stimulate change and progress in animal agriculture for the benefit of smallholders, pastoralists and consumers of livestock products; milk, meat, fiber, hides, manure and draught power.

Hypothesis: The creation of an optimal policy environment will facilitate change and encourage economic growth.

Activities: The following activities have been identified as necessary for validating the above hypothesis:

- identifying of the agencies and communities involved in developing animal agriculture including state and NGO extension agencies, NARS and farmers' organizations;
- analyzing land tenure and resource use arrangements;
- identifying and logging meta data, i.e., what data exists on the particular topic, where it is, how much there is, its quality, its format and accessibility;
- analyzing the likely effect of different pricing policies for inputs and outputs; and
- studying the marketing arrangements and the role of government through regulation and the actions of parastatal marketing agencies and the degree of competition in the market place.

Outputs: Enabling policy options for consideration by government advisors and decision makers.

Relevance: The products of this research will apply to significant numbers of people in all East African countries.

Actors: The following agencies are active in this type of research and development:

- World Bank
- European Union
- Bilateral donors
- ILRI and IFPRI

(4) Matching livestock genotypes to ecological and economic environments

Objective: To provide the extension services concerned with animal agriculture with appropriate information on which to base advice to farmers on the use of indigenous resources rather than depending on exotic germplasm and foreign technologies that may not be well adapted to their less than ideal marketing and ecological circumstances.

Hypothesis: Matching animal genotypes to prevailing ecological and economic circumstances will maximize human welfare, farm profitability and the sustainability of smallholder farming systems.

Activities: The following activities have been identified as necessary for validating the above hypothesis:

- analysis of feeding and other production factors affected by the ecology and prevailing farming systems. This will inter alia included identification of appropriate crop residue, forage, browse and agro-industrial bi-products available for feeding to livestock. This will include determining the potential for utilization of novel feeds;
- analysis of the strength of demand for livestock products, the marketing systems including the provision of market information, the state of the

infrastructure and central and local government policies and regulations that restrict freedom of trade;

- identification and epidemiology of the important endemic livestock diseases, diagnostic tools and capabilities and efficacy and delivery systems for of disease control measures;
- identification, characterization and assessment of the production potential and productivity traits such as disease and stress tolerance capability of available local and exotic livestock genotypes and their crosses; and
- modeling of key systems to take account of the above factors.

Outputs: Systems of smallholder production that despite less than maximum output are both more profitable and more sustainable than high input systems dependent on exotic germplasm.

Relevance: The products of this research will apply to significant numbers of people in all East African countries.

Actors: The following agencies are active in this type of research and development:

- ITAG
- Heifer Project International
- FARM-Africa
- VETAID
- ILRI, ICIPE, ICRAF

(5) Improving input and output markets

Objective: To provide decision makers with information they need to remove

market imperfections that will reduce the prices of inputs and costs of sales and make animal products available to a wider cross section of urban consumers, especially the more disadvantaged families.

Hypothesis: that, present marketing arrangements constrain adoption of innovations and response to consumer demand; and

that, improvements can be made to processing and delivery systems to make foods of animal origin accessible to the poorer urban consumers.

Activities: The following activities have been identified as necessary for validating the above hypothesis:

- analysis of the demand for animal products;
- assess the need for credit and devise appropriate way of providing credit that will make inputs available in the rural areas. This should include inventory finance for wholesalers and rural retailers as well as for producers;
- the supply and maintenance of animal-drawn implements in rural areas including the capacity of commercial suppliers and local artisans
- assess the seasonal availability of animal feedstuffs;
- analysis of the supply of veterinary drugs and services and the role of government and the private sector in this;
- analysis of alternative processing and delivery systems that will reach the less well off communities with appropriate healthful products; and
- analysis of the effect of alternative pricing and import and export

policies on the supply of inputs for animal agriculture and the demand for locally produced animal products.

Outputs: This research will provide suggestions for improved input and output marketing arrangements that will reduce the risks and increase the returns to investment in animal agriculture.

Relevance: The products of this research will apply to significant numbers of people in all East African countries.

Actors: The following agencies are active in this type of research and development:

- FARM-Africa
- ITAG
- Private sector

(6) Conserving forage and browse plant and livestock biodiversity

Objective: To ensure that the invaluable diversity of domestic livestock breeds and forage varieties are conserved for sustaining and improving future production systems

Hypothesis: that, varieties of forage and fodder plants and breeds of domestic livestock with valuable properties are threatened and that in situ conservation technologies and policies can be devised and implemented

Activities: The following activities have been identified as necessary for validating the above hypothesis:

- characterize and phenotype indigenous forage and browse plants, and plants with medicinal veterinary

uses that may be threatened due to expanding cultivation, overgrazing or other causes;

- characterize and phenotype indigenous livestock breeds that may be threatened by neglect, crossbreeding or other causes;
- determine population abundance and assess the extent and urgency of the threats to vulnerable population;
- identify important production and stress tolerance traits in threatened germplasm;
- determine appropriate conservation programs for selected plants in genebanks and in situ conservation schemes that can elicit community interest and participation; and
- devise and implement appropriate *in-situ* conservation schemes for threatened livestock breeds that can be profitably managed by communities that have traditionally kept the breeds selected for conservation

Outputs: Invaluable plant varieties and livestock breeds preserved for the benefit of future communities world-wide.

Relevance: The products of this research will apply to significant numbers of people in all East African Countries and around the world.

Actors: The following agencies are active in this type of research and development:

- FAO
- ILRI
- ICRAF
- Signatories to the Agenda 21 convention on biodiversity including the USA
- UNEP

(7) Optimizing land use and natural resource conservation by integrating domestic and wild animal species

Objective: To ensure that the opportunity is not lost to conserve biodiversity and improve sustainable use of natural resources through ignorance of the benefits and technology for integrating wildlife into commercial land use systems.

Hypothesis: In certain circumstances wildlife can contribute to the sustainability and profitability of farming systems.

Activities: The following activities have been identified as necessary for validating the above hypothesis:

- conduct a desk study of the grazing and watering behavior of wildlife species with potential for commercial exploitation in mixed land-use systems;
- determine if there are ways of incorporating grazing and watering requirements into the prevailing land tenure and resource use systems where they might have commercial potential;
- determine the technology and husbandry required for rearing wildlife for efficient reproduction and profitably achieving appropriate size and ages for the desired end uses such as slaughter for meat, sport hunting and green hunting;
- determining the institutional constraints such as ownership law and market regulations that may constrain exploitation of wildlife and their products; and
- determine disease factors that may affect livestock species on the farms

and ranches on; which the animals are kept and neighboring properties.

Outputs: Technical and policy recommendations for increasing the opportunities for rural producers to benefit from the humane exploitation of wildlife.

Relevance: The products of this research will apply to significant

numbers of people in all East African countries.

Actors: The following agencies are active in this type of research and development:

- Private enterprise
- African Wildlife Foundation
- FARM-Africa

RANKING BY WORKSHOP PARTICIPANTS

1. *Ensuring the food security and development needs of resource poor households.*
2. *Identify and evaluate practical methods to increase animal products in children's diets.*
3. *Improving the ability of pastoral people to cope with and recover from drought.*
4. *Establishing an enabling policy environment.*
5. *Matching livestock genotypes to ecological and economic environments.*
6. *Improving input and output markets.*
7. *Optimising land use and natural resource conservation by integrating domestic and wild animal species.*
8. *Livestock/Wildlife Production systems.*
9. *Conserving forage and browse plant and livestock biodiversity.*
10. *Crop/Livestock Production systems.*

CENTRAL ASIAN ANIMAL PRODUCTS REGIONAL ASSESSMENT
WORKSHOP
27 FEBRUARY - 1 MARCH 1996
TASHKENT, UZBEKISTAN

INTRODUCTION

In collaboration with the International Center for Agricultural Research in Dry Areas (ICARDA), the Small Ruminant CRSP sponsored the Central Asian Animal Products Regional Assessment (CAAPRA) Workshop February 27 - March 1, 1996, in Tashkent, Uzbekistan. All of the Newly Independent States (NIS) of Central Asia were represented at the workshop along with participants from NGOs, NARs, IARCs, local universities and the private sector. The Uzbek Academy of Agricultural Sciences hosted the workshop in Tashkent.

THEMATIC GROUPS

At the workshop in Central Asia, two workgroups were formed around the following themes: Livestock/ Environment and Policy/ Economic Growth. The stated goals for the thematic workgroups were:

- To produce a set of prioritized constraints (problem models) related to livestock production that are the assessment and description of the underlying processes responsible or connected to the identified problem model in each theme.
- Identify and characterize potential

partners for US Land Grant Universities with the capabilities of addressing the problem model.

The results of the group discussions are presented below. The participants did not rank the problem models.

PRIORITY TOPICS FOR RESEARCH IN LIVESTOCK AND ENVIRONMENT

(1) Development Of Sustainable Rangeland Management Systems Suited To The Changing Economic And Private Environment

Objectives: The arid regions of Central Asia have a wide variety of climatic and rangeland types and effective technologies to preserve these rangelands should be based on sound ecological principals.

During the period of transition to a market economy, pasture management and water supply systems as well as economic and social conditions are changing. This may result in a need to alter the structure of farming systems. Research is therefore urgently needed which takes these factors into account to design alternative farming and pastoral systems.

Activities:

- Studying and evaluation of ecological (climate, soil, plants) conditions in different regions of Central Asia.
- Studying of water availability on the rangelands; a. artesian wells, b. wells for stock water supplies, c. water delivery, d. domestic water.
- Optional regimes of usage and different types of property (private farmers, cooperatives, collective and state farms, farmers associations, etc.)
Moderate use with rangeland rotation system
Intensive use with rangeland rotation system
Transhumant system.
- Solving the problem of determining the optimal balance and intensive and extensive sheep production.

Outputs:

- Advantages of different and appropriate rangelands management system demonstrated.
- A 10% improvement in rangeland and animal production compared to present grazing systems.
- Appropriate range management systems identified.
- Improved quality of pasture forage in terms of botanical composition, including the introduction of forage crops.
- Recommended extensive sheep husbandry practices for different economic and ecological environments.

Actors:

- Kazak Research Institute of Karakul Sheep Breeding
- Uzbek Research Institute of Karakul

Sheep Breeding

- Turkmen Research Institute of Animal Husbandry and Veterinary Studies
- Turkmen Institute of Deserts
- Kirgiz Research Institute of Forage and Pasture
- Tadjik Institute of Animal Husbandry

(2) Strategies To Reduce Desertification And Develop Vegetation Improvement Of Degraded Rangelands

Objectives: Anthropogenic influences may have a marked effect on arid lands and in the new economic environment rangelands and pastures may have lost their self-regulating capacities. The extreme desert conditions of Central Asia demand appropriate methods for effectively using the limited pasture resources without disturbing the ecosystem.

There is a need to design new pasture-based systems that will tolerate more intensive use without degradation under the difficult ecological conditions. Rainfed pastures can provide cheaper feed without the associated risk of secondary salinity. Previous experiments have shown that sown pastures of appropriate species under rainfed conditions can yield several times more than native pastures.

Activities:

- Studies and collection missions to areas of Central Asia, to collect seeds of potentially productive and useful forage species and to evaluate and multiply them for further use in various ecological zones.
- Studies of the capabilities and

adaptation of new forage species, introduction of nurseries and creation of germplasm banks of forage crops.

- Developing technologies for forage crop production in Central Asia.
- Producing higher yielding cultivars of forage crops.
- Developing methods to combat desertification.

Outputs:

- Germplasm collections of forage crop and range species established. (This material will provide the basis to improve forage production in the region and other similar ecosystems of the world.)
- Optimal seeding and cultivation techniques developed for range species.

Actors:

- Kazak Research Institute of Karakul Sheep Breeding
- Uzbek Research Institute of Karakul Sheep Breeding
- Uzbek Institute of Forestry
- Complex Institute of Regional Problems of Samarkand (Branch of Uzbek Academy of Sciences)
- Botany Institute (Uzbek Academy of Sciences)
- Kirgiz Scientific Production Association of Forage, Pastures and Range Improvement
- Turkmen Institute of Deserts
- Turkmen Research Institute of Animal Husbandry and Veterinary Studies

(3) Cattle Production Systems

Objectives: During the transition period to a market economy there are different

forms of farming- state farms, collective farms, joint-stock company farms and small private farming. The production and processing of livestock products, breeding, reproduction and feeding systems which were developed for large state livestock complexes may no longer be appropriate for use on small private farms and emerging systems. Thus, it is important to develop new technologies suitable for these new farming systems.

Activities:

- Conduct surveys to describe and analyze the present production systems and to identify constraints to milk and meat production.
- Describe and analyze the production characteristics of local breeds and develop appropriate breeding programs.
- Adapt the systems of production and processing of meat and milk to the new conditions.
- Evaluate the conditions, technology and potential improvement of animal husbandry (barn, shelter, etc...).
- Evaluate and adapt established methods of feeding to provide a mechanism for optimal feed use and optimal production.
- Assess the impact of farm ownership on farm mechanization.

Outputs:

- Production systems appropriate to the new economic environment.
- Prioritized list of constraints arising from the systems analysis.
- A standardized regional feed rationing system suitable for the new intensive production systems.
- More efficient food production systems.
- Recommendations about farm

ownership policy appropriate to the new economic environment.

- Suitable forage production and utilization systems.

Actors:

- Uzbek Research Institute of Animal Husbandry
- Kazak Research Institute of Animal Husbandry
- Tadjik Research Institute of Animal Husbandry
- Kirgiz Research Institute of Animal Husbandry
- Turkmen Research Institute of Animal Husbandry and Veterinary Studies

(4) Small Ruminant Production Systems

Objectives: Sheep production is one important branch of the livestock industry in the Central Asian countries. Breeding of Karakul sheep is an important agricultural sector, with an annual production of about 300,000 tonnes of milk which is used to produce *brinza* cheese. This sector also produces 3-4 million units of rennet, 800-850 tonnes of fermented products such as yoghurt, and 3-3.5 million Karakul pelts. During the last 5-6 years sheep wool and meat production decreased by 15-25% and the quality of Karakul pelts deteriorated. The changing farming environment requires the development of new diversified systems of small ruminant production.

Activities:

- Make a local, regional and global survey to identify markets for the products of small ruminant production systems.

- Identify and describe the comparative advantages of different production systems and animal breeds (Karakul, etc..) (to enable effective competition in these markets).
- Develop the technology (what technology) to support the above.
- Conduct selection studies to produce Karakul fleeces or pelts of different colours which meet current market demands.
- Generate technologies (management systems?) to increase meat, milk, fat and fleece productivity.
- Conduct studies to enable qualitative and quantitative improvement of raw wool.
- Evaluate, and if necessary increase, fertility and disease resistance of sheep.

Outputs:

- A list of potential markets for small ruminant products.
- A list of the comparative advantages of local products.
- Effective sheep and goat production systems suited to the local ecological conditions and new forms of ownership.
- Recommended allocation of sheep and goats breeds to different new systems.
- Increased quality of Karakul fleeces with regional colour variations adapted to international market conditions.
- Improved technologies for producing (processing?) wool, meat, fat.
- Better fertility and disease resistance in small ruminants.

Actors:

- Uzbek Research Institute of Animal Husbandry
- Uzbek Research Institute of Karakul Sheep Breeding
- Tashkent Agrarian University
- Kazak Research Institute of Sheep Breeding
- Kazak Research Institute of Karakul Sheep Breeding
- Turkmen Agricultural Institute
- Turkmen Research Institute of Animal Husbandry and Veterinary Studies
- Tadjik Research Institute of Animal Husbandry
- Kirgiz Research Institute of Animal Husbandry

(5) Development Of Methods To Characterize And Monitor Rangeland Condition Using Remote Sensing, Gis And Modeling

Objectives: The changing economic environment, growing population pressure and the associated threat of over-grazing and cropping are putting the rangelands of Central Asia under threat. The large areas and diversity of the rangelands in the region creates an opportunity to use remote sensing to characterize and monitor the changes in the local management systems and land use. It is therefore necessary to develop and to use these methodologies for estimating the condition of the rangelands and to predict their productivity using satellite imagery and aerial photography. This will be combined in geographic information system (GIS) that integrate climate, soil, vegetation data and land use from different regions.

Zoning of arid pastures using aerial photography and satellite imagery are the most advanced techniques for determining the productivity and degradation of rangelands. Mapping the productivity of pastures in arid areas is a step towards developing rational systems of management which should decrease the rate of degradation and desertification process.

Activities:

- Collection of climate, soil and vegetation characteristics of representative rangeland types.
- Collection and analysis of representative satellite images covering cropping and rangeland zones of the Central Asian Republics at five years intervals.
- Development and adaptation of deciphering methods for remote sensing information on rangelands.
- Construction of models and algorithms to estimate moisture stress and above ground biomass of range and croplands using remote sensing data and related information collected on representative polygons.
- Development of remote sensing methods to estimate the spread and degree of desertification and soil degradation (including variation of humus content) on rangelands.
- Developing a regional rangeland GIS to integrate soil, vegetation and climate data and to estimate rangeland conditions and the productivity.

Outputs:

- Methods of deciphering remote sensing information on rangelands.
- Models relating pasture biomass and productivity to spectral vegetation

indices and relevant environmental parameters.

- Construction of electronic and hardcopy maps of phytomass productivity and desertification of rangelands.
- Characterization of longterm trends of land use and desertification.

Actors:

- Kazak research Institute of Karakul Breeding
- Turkmen Institute of Deserts
- Institute of Space Exploration (Kazak Academy of Sciences)

(6) Conservation And Evaluation Of Locally Adapted Species Of Animals Of Central Asia

Objectives: Central Asia is the centre of origin of many animal breeds which are well adapted to the local climatic, pastoral and feed conditions. These breeds include the *shviuezebuvidny* cattle population, the *Altauzskaya* and *Bushuevskaya* breeds of cattle, the *Karakulskaya*, *Saradjinskaya*, *Alayskaya*, *Gissarskaya* and other breeds of sheep and the *Arvana* breed of camel. Introduced (exotic) breeds are potentially more productive than these indigenous breeds although clearly less adapted to local conditions. For this reason it is necessary to design new management systems for local breeds and to increase productivity by studying their genetics and feed requirements.

Activities:

- Characterize and evaluate local breeds of farm animals.
- Determine their role in new livestock systems.
- Assess the size and structure of the

local breeds and races and their regional distribution.

- Develop (and test) effective genetic methods to improve the productivity of cattle.
- Study the useful biological specificity of meat breeds (adaptation to native vegetation, forage and disease environment).
- Develop recommendations for the improvement of elite races (populations).

Outputs:

- Better *in situ* conservation of local breeds (races, populations) of farm animals.
- Elite (nucleus) flocks created (which conserve and improve farm animals under various environments for the benefit of private and government farms).
- Better genotypes from nucleus flocks distributed to improve productivity of local flocks.

Actors:

- Uzbek Research Institute of Animal Husbandry
- Uzbek Research Institute of Karakul Sheep Breeding
- Kazak Research Institute of Karakul Sheep Breeding
- Kirgiz Research Institute of Animal Husbandry
- Turkmen Research Institute of Animal Husbandry and Veterinary Studies
- Tadjik Research Institute of Animal Husbandry
- Kazak Research Institute of Animal Husbandry

(7) Emerging Animal Health Problems In The Changing Economic Environment

Objectives: Intensification of livestock production systems requires reliable protection against infectious, invasive(?) and non-infectious diseases and the privatization of state farms is resulting in many small private farms with flocks of 30-100 small ruminants. This is leading to a change in the prevalence of different diseases, particularly a reduction in the number of infectious diseases (*Salmonellosis, Pasteurellosis, Colibacteriosis*) and an increase in some non-infectious diseases such as helminth parasites. It is important to understand the reasons for this change to enable better prediction possible epizootics and better planning of control measures. Furthermore, the need to develop new veterinary services to serve the small private farms is evident due to the increasing importance of this sector.

The domestic production and supply of veterinary medicines made from local materials (microbial preparations, feed additives, macro- and micro-elements) is one of the main challenges facing the livestock industry. Another is the need to study zoonoses (*Brucellosis, Echinococcosis??*) and the development of prophylactic control measures.

Activities:

- Study the epizootiology of infectious, non-infectious and invasive diseases affecting animals kept under new management conditions.
- Study the seasonal prevalence of diseases, including zoonoses, determine the mechanisms which

spread them and the economic losses they cause.

- Study the effectiveness of new and improved veterinary preparations, including those made from local strains of pathogens, raw materials and phyto-preparations.
- Develop effective health control programs and veterinary services suited to the conditions of management on small private farms.

Outputs:

- a better understanding of the epizootiology of diseases of animals kept under new management systems, the seasonal prevalence of different diseases including zoonoses, the factors causing the spread of the diseases, and the economic costs of the disease.
- effective veterinary preparations, including those made from local strains of pathogens, raw materials and phyto-preparations.
- effective health programs and veterinary services appropriate for the new conditions of management on small farms.

Actors:

- Uzbek Research Institute of Veterinary Studies
- Turkmen Research Institute of Animal Husbandry and Veterinary Studies
- Kazak Research Institute of Animal Husbandry and Veterinary Studies
- Tadjik Research Institute of Veterinary Studies
- Kirgiz Research Institute of Veterinary Studies
- Samarkand Agricultural Institute

(8) Processing, Quality Control And Marketing Of Livestock Products

Objectives: It is important to increase sheep production and improve the quality of processing and product conservation in all regions of Central Asia. Privatization of farms is also important. For these reasons the processing of sheep products - meat, wool and karakul pelts - is an important question in the emerging farming systems. It is therefore necessary to carry out research to create new processing and preservation technologies which are adapted to these new farming systems.

Activities:

- Assess technologies for processing and storing of livestock products while taking into consideration the different forms of ownership and regional ecological conditions.
- Define basic parameters for defining ecologically safe and clean livestock products.

Outputs:

- Constraints to the processing and storing livestock products.
- Quality standards for the main livestock products.
- Appropriate technologies for processing of livestock products adapted to new the conditions of ownership and regional specificity.

Actors:

- Uzbek Research Institute of Animal Husbandry
- Uzbek Agrarian University
- Uzbek Research Institute of Karakul Production
- Kazak Research Institute of Karakul

Production

- Kirgiz Research Institute of Animal Husbandry
- Uzbek Research Institute of Veterinary Studies
- Turkmen Research Institute of Animal Husbandry and Veterinary Studies

(9) Intensification And Optimization Of Fodder Crop Production On Irrigated Land

Objectives: Rational use of irrigated lands to produce fodder in the Central Asian Republics has considerable importance. Indeed, with appropriate use of water and soil resources, two-to-three crops can be harvested each year to provide livestock with different kinds of fodders. Research is needed to study ways to produce high yielding and nutritious fodder crops that use suitable management systems and make optimal use of the limited water resources.

Activities:

- Determine the contribution and the optimal proportion of different irrigated crops in the rotations of Central Asia.
- Establish the most effective combination of main, replicate(?) and intermediate irrigated fodder crops which achieve the highest output.
- Determine the different agroecological zones where highly productive and early maturing varieties of irrigated fodder crops can be grown in the main crop rotations, replicates(?) and intermediate planting???

**Outputs:**

- Irrigated fodder crops in rotations which augment productivity and production levels.
- High yielding and early maturing varieties of irrigated fodder crops for the different regions of Central Asia.

Actors:

- Uzbek Research Institute of Animal Husbandry
- Kazak Research Institute of Karakul Production
- Turkmen Institute of Agriculture
- Kirgiz Scientific-Production Association of Forage, Pastures and Range Improvement
- Kirgiz Research Institute of Agriculture
- Kazak Research Institute of Forage and Pastures
- Uzbek Research Institute of Cotton Production
- Agrofirma "ERKIN"

PRIORITY TOPICS FOR RESEARCH IN POLICY AND ECONOMIC DEVELOPMENT

Introduction: Population growth is rapid in the Central Asian republics: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. Compared with a total of 54 M people in 1990, the region will be the home of a projected 92 M by the year 2025 (World Bank, 1993).

Permanent pastures (rangelands) account for the largest share of the land surface in the region, totaling about 260 million hectares (FAO, 1995). This is comparable with the total area of 272 million hectares of steppe land (100 - 400 mm rainfall) in all of West Asia and North Africa. Irrigated farming in Central Asia covers some 9.4 million hectares and is a major source of feed in the form of crop residues and by-products.

Livestock inventory statistics (FAO, 1995) can be aggregated into Livestock Units (LU = 500 kg bovine at maintenance). Small ruminants are prominent in all five republics. The aggregate number of Livestock Units of Central Asia in the early nineties was about 25 million, compared with about 21 million in the late seventies. Increases in the intervening years and recent sharp reductions in livestock inventories since the collapse of the Soviet Union are hidden in this comparison, however.

There are many points where human capital (including policies and institutions) need strengthening in Central Asia: rangeland tenure and private farm-level development need attention; where pastoralists and farmers are insecure tenants, they cannot be expected to take a long-run view of sustaining the natural resources they use. Large economic gains appear feasible also through devolving property rights and decision taking from state bodies to individual farmers or well organized small groups. These questions deserve strategic research support.

Nine research titles on policy and economic development of livestock production in Central Asia are proposed here. The proposals are defined in two main lines.

The first line is evaluation of the current situation and a 'stock-taking' of the emerging dynamics of livestock production in the region: lessons from decollectivization, household livestock management, the institutional environment and the balances of livestock, feed and food resources (past and future).

The second line of proposals are for optimization of future development paths: adapting livestock production to the new economic conditions, recapitalization of livestock farms, restructuring of livestock support services, and provision of social support services to livestock producers.

Emerging Dynamics (positive analysis: 'taking stock')

(1) Decollectivization: What Must Be Learned And Preserved

Objectives:

1. To summarize lessons from experiences in decollectivization of livestock operations in various countries in and beyond central Asia, showing the conditions and consequences of the various options for different farm structures and production systems.
2. To identify the 'public goods' aspects of collective and public livestock organizations that may be lost in privatization; of particular interest is preservation of high quality genetic stock (both animal and plant).

Hypothesis: Radical privatization may cause the loss of irreplaceable genetic material and important public services, as well as causing unnecessary losses and human suffering. Lessons can be learned from a study of various decollectivization processes, and their contexts and consequences, both within and outside the Central Asian Republics. A summary and analysis of these experiences will enable the most important lessons to be taken into account in any new decollectivization.

Activities:

- Review of literature on decollectivization of livestock and land, particularly rangeland;
- Case studies of contrasting examples of decollectivization in the five Central Asian Republics by survey of experiences in privatization of farms and farm services in general, and livestock farms and services in particular. Special attention will be given to organizational aspects, social aspects and preservation of valuable genetic stock and other production factors;
- Cross-case analysis of decollectivization experiences based on key attributes, contexts and consequences, to draw out the most important lessons

Outputs:

- Publication of a report in Russian and English by mid 1998.

Relevance: There is great concern and confusion regarding the privatization process. This study aims to provide information to policy makers, farm leaders and the general public regarding experiences and options in the process of decollectivization.

Actors: The studies will be designed by multidisciplinary teams of livestock scientists, social scientists and pasture/forage specialists, with advice and participation of international scientists.

(2) Studies Of Household-Level Changes In Livestock Management

Objectives:

1. To rapidly obtain information on the changes on private and collective

farms during the transition period.

2. To develop methods for continuous monitoring of livestock development

Hypotheses: The previous farm data collection systems are breaking down, as they depended on state and collective farm reporting. There is great need for solid information on what is happening in the sector, as governments should base their decisions on sound data. Therefore, there is good reason to initiate an immediate program of participative rapid rural appraisals, and use this experience to develop a large-scale farm data collection system.

Activities: Design and carry out a set of participative appraisals. Use the experience and the findings to develop long-term monitoring system. There will be a series of short, informal studies of different types of livestock-owning communities and families. A representative sample will include different ecological zones in each participating country. Standard Participative Rural Appraisal (PRA) techniques will be used, and training on these techniques will be provided to the design and data collection teams. At a later stage these studies will form the basis for designing large-scale statistical surveys, to monitor changes at the household level.

Outputs: Analyses of livestock management practices in different ecological zones. Description and analysis of management strategies currently employed by different kinds of livestock producers.

Relevance: Such data, not currently available, are essential for informed

government planning and design of livestock improvement projects.

Actors: The studies will be designed by multidisciplinary teams of livestock scientists, social scientists and pasture/forage specialists, with advice and participation of international scientists. The field data collection and participative studies will be carried out by junior scientists working together with regional and district specialists. Rural producers will participate in the studies.

(3) Analyses Of The Institutional Environment For Livestock Development

Objectives:

1. To identify the main policy instruments which assist or hinder development in the livestock sector.
2. To understand and strengthen the institutional links between research and policy-making.

Hypothesis: The governments of Central Asia have a number of mechanisms which can be applied to influence the direction of livestock development in the process of transition. Such mechanisms include:

- subsidies on inputs(water, veterinary drugs, fodder, etc).
- tariffs on livestock product exports.
- protection of domestic livestock processing industries.
- trading regulation on livestock products.
- domestic pricing policies on livestock products.
- state and private investment for infrastructure related to the livestock sector.

Activities: An examination of each country's laws and regulation which directly or indirectly effect livestock production and marketing. Comparisons will be drawn with other countries where similar ecological and economic conditions prevail.

Outputs: Recommendations for changes in national laws and policies which promote the livestock sector. Presentation of various options for development of the sector, drawing out economic, social and environmental costs and benefits of each option.

Actors: An international team of policy analysts, with expertise in both intensive and extensive livestock sectors, working together with senior Central Asian scientists in pasture and livestock and with senior economic policy advisors in the national governments.

(4) Feed And Animal Resource Balances In Central Asia: Past, Present And Future, To The Year 2025

Objectives:

1. To provide a picture of past and present balances of livestock inventories and feed resources, including rangelands, crop residues and forage crops, and feed grains and other concentrates.
2. To provide a picture of food production balances, and the role of livestock products in human diets in the region.
3. To project the effects of human population growth to the year 2025 on feed and food demand in the Central Asian republics.

Hypothesis:

Heterogeneous natural resource bases among the five Central Asian republics lead to differentiation in crop/livestock/range systems, differences in food production for the growing human populations. An assessment of these relationships will help in focusing research and development support.

Activities:

- Study the development over time (early '70s, late '80s and early '90s) of country-by-country inventories of feed resources from cropland, rangelands and agro-industrial by-products in Central Asia;
- Study the development of livestock numbers, country-by-country, for the same periods;
- Study the production of all foods and their relationships with livestock production;
- Study the balances of feed, livestock and food for past, present and future periods (to 2025) in light of past and projected human population growths.

Outputs: A report in Russian and English by mid-1998.

Relevance: This study is needed to show livestock production in perspective with the natural resource bases and human populations of the Central Asian republics, enabling objective assessments of the relative importance of the different elements of agricultural production in the planning and focusing of livestock research and development.

Actors: This work would be lead by ICARDA but can only be completed

satisfactorily with the direct participation of experts on the feed and food situations in each of the Central Asian republics.

Optimization (normative analysis: how to go in the future)

(5) Adaptation Of Livestock Production To New Economic Conditions

Objective: To elaborate suitable methods for constrained optimization of individual farm management (size, enterprise mixes, market focus), illustrated with case studies under contrasting conditions; in support of privatization ('firmerization') of livestock production that is more efficient, equitable and environmentally sustainable than centralized production.

Hypothesis: Each particular physical environment, location with respect to markets (for livestock inputs and outputs), and each farm household (labor and capital and risk preference) condition may have a different optimal farm plan; therefore, farmers need a choice of visible options to choose among... not blanket recommendations.

Activities:

- Elaboration and illustration of multiple goal optimization methods, using contrasting case studies of livestock farmers;
- Development and illustration of methods for calculating comparative advantages;
- To identify examples and best principles of farmers' organizations (for input supply, credit, marketing);
- Development and illustration of

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methods for on-farm trials, to test and demonstrate animal health, nutrition, reproductive and financial management by small farmers.

Outputs: Training of NARS staff of Central Asia and joint publications in Russian and English on:

- multiple goal optimization methods, using contrasting case studies of livestock farmers;
- methods for calculating comparative advantages with respect to local, regional and world markets;
- best principles of farmers' organizations (for input supply, credit, marketing);
- methods for on-farm trials, to test and demonstrate animal health, nutrition, reproductive and financial management by small farmers.

Relevance: Guidelines for small private farmers is lacking and very much needed. The research outputs here, will provide part of the basis for developing location-specific extension material for farmers.

Actors: An international team of agricultural economists, with expertise in both intensive and extensive livestock sectors, working together with senior Central Asian scientists in pasture and livestock and with senior economic policy advisors in the national governments.

(6) Recapitalization Of Livestock Farmers

Objectives: To find practical options for the recapitalization of livestock farms, and related services.

Hypothesis: The financing of new small farms with livestock enterprises is a crucial area of need which, if not ameliorated, could retard rural development in Central Asia.

Activities:

- Studies of practical options for provision of credit to small farmers

Outputs: Guidelines for practical steps in recapitalization of livestock farms in Central Asia, published in Russian and English by mid-1998.

Relevance: Credit for long-term financing of capital equipment, facilities and livestock, as well as shorter term credit for purchase of key inputs, is often lacking and is a reason for underemployment of land, labor and management resources for livestock production in Central Asia.

Actors: An international team of agricultural economists, with expertise in both intensive and extensive livestock sectors, working together with senior Central Asian scientists in pasture and livestock and with senior economic policy advisors in the national governments.

(7) Best Practices In The Restructuring Of Livestock-Support Services

Objective: To study various options and develop policy recommendations and best practices for the restructuring of livestock farm support services, including animal health services, input supply, small and large scale processing and marketing of livestock products.

Hypothesis: With decollectivization, a lack of support services to livestock production is hindering development of the sector.

Activities: An appraisal of the 'public good' and market prospects for provision of livestock support services will be carried out in Central Asia. Practical options will be explored and the missing elements for bringing these into operation will be identified.

Outputs: An analysis of practical options for development of economically viable livestock support services, published in Russian and English by mid 1998.

Relevance: Support services provide the bridge between subsistence and market oriented livestock production, lowering transaction costs and increasing efficiency of resource use.

Actors: An international team of agricultural economists, with expertise in both intensive and extensive livestock sectors, working together with senior Central Asian scientists in pasture and livestock and with senior economic policy advisors in the national governments.

(8) Methods To Alleviate The Negative Impacts Of Transition By Provision Of Social Services To Livestock Producers

Objectives: To determine the most cost-effective way of providing essential social services to remote shepherding families in the extensive livestock areas.

Hypothesis: Decollectivization has caused a breakdown in the provision of

both social as well as technical services to families in the livestock sector. Such services include health, sanitation, schooling, water, power, public records and security. These services were provided through the state to large collectives, but as some Central Asian republics move towards privatization, these services are not being maintained. As yet, these services have not been replaced. One result is that families, especially in remote grazing areas, may abandon livestock-keeping, and migrate to town in search of alternative employment. Another result is a decline in animal production. Both results are negative, at least in the short term.

Activities: Review the experiences of other countries in providing cost-effective social services to low-density populations of mobile livestock-keepers. Evaluate whether producers in Central Asia could afford to pay for these services, and at what level of payment. Identify possible sources of social service provision in the private sector, and what would be required for these to be activated (e.g. financial credit and training). Examine the possibility of encouraging producer associations which could receive and international assistance in providing services to their members.

Outputs: Recommendations on how to improve social and to the livestock sector. The roles of the state, regional administration, producer associations and the private sector to be specified. Identification of the needs for credit and personnel to implement the recommendations.

Actors: An international specialist in participative rural development (working with producer associations), an international economist with experience in costing social services, national economists and regional planners from the Central Asian republics, and livestock producers.

(9) Options For Rangeland Tenure Under Decollectivization

Objectives:

1. Review the current laws and practices in each participating Central Asian republic, regarding access rights for livestock and their owners on different types of rangelands.
2. Identify and assess the options for rangeland use as decollectivization proceeds in each country. This will include comparison with other countries.

Hypothesis: Some current systems of livestock husbandry are no longer economically viable with the reduction of state support for fodder. Other systems are also thought to be environmentally damaging causing soil degradation and loss of biodiversity due to overuse of pastures especially those nearer to settlements. As the large-scale collectives are broken up, new patterns of rangeland use are being adopted by newly-privatized livestock owners. Which methods of rangeland use should be encouraged by the state is not at present clear. Further field research and comparative analysis is required.

Activities: Carry out empirical studies of rangeland uses being adopted by different types of livestock producers

undergoing decollectivization. Studies are to be carried out in various agro-ecological and climatic zones. Each use is to be assessed in terms of economic returns, social impacts, sustainability and environmental consequences. New concepts and methods of semi-arid rangeland assessment developed in Europe, Australia, North America and South Africa will be applied in these assessments.

Outputs: Recommendations on the options for rangeland regulation, access and management which can be considered by national and regional administrations, and groups of livestock producers. The recommendations will be accompanied by estimates of costs and benefits for each option.

Actors: International biological and social scientists with an understanding of new models of rangeland ecology, to work together with senior pasture and livestock specialists in Central Asia in designing a set of field studies. These studies to be carried out by junior scientists in participation with regional and district officials, with the participation of livestock producers.

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LATIN AMERICA REGIONAL LIVESTOCK ASSESSMENT WORKSHOP
15 - 18 APRIL 1996
SAN JOSÉ, COSTA RICA

INTRODUCTION

In collaboration with the Inter-American Institute for Cooperation on Agriculture (IICA), the Small Ruminant CRSP sponsored the East African Regional Livestock Assessment Workshop Paril 15 - 18, 1996 in San José, Costa Rica. Nine countries of Latin America were represented at the workshop: Belize, Guatemala, Mexico, Honduras, Costa Rica, Peru, Bolivia, Ecuador, and Trinidad. Participants from NGOs, NARs, IARCs, FAO, local universities and the private sector.

THEMATIC GROUPS

Three workgroups were formed around the following themes: Human Nutrition, Livestock/Environment and Economic Growth. The stated goals for the thematic workgroups were:

- To produce a set of prioritized constraints (problem models) related to livestock production that are the assessment and description of the underlying processes responsible or connected to the identified problem model in each theme.
- Identify and characterize potential partners for US Land Grant Universities with the capabilities of addressing the problem model.

The results of the group discussions are presented below.

**PRIORITY RESEARCH TOPIC ON
ECONOMIC GROWTH/POLICY**

***(1) Livestock Production Systems For
Ecoregions***

Introduction: There continues to be a large population of rural low-resource farmers in all countries of the LAC. These persons have a) little income, b) few employment opportunities, c) have a diet low in protein and nutrients especially those from animal origin and hence are prone to major nutritional deficiencies and generally have problems of food security. Yet there exist low-resource production and marketing systems of animal production of various species which feed well on shrubs and other forest trees under intensive/semi-intensive systems of production which are environmentally friendly.

Objective: To identify, characterize, adapt, test and validate these animal systems and transfer them to these low-resource farmers.

Hypothesis: If low-resource farmers work with these systems, help adapt them and demonstrate them to other farmers, there would be a high adoption rate that will generate employment, increase income, improve nutrition and food security.

Activities:

- Identification of target groups and their agro-socio-economic characterization using a sondeo approach to establish baselines and determine needs, constraints and opportunities.
- Identify, analyse and characterize the named technologies and understand the reasons for their successful performance.
- Adapt, test, validate and transfer such technologies into other interested areas in similar ecoregions and groups of farmers.
- Develop information packages and recommendations and continue to provide technical backstopping.
- Monitor and evaluate farmers' adoption, adaptation and performance under their conditions and their criteria.
- Upgrade capacity of the clients through relevant training.

Outputs:

- Tested, adapted and validated production and marketing livestock systems successfully developed.
- Systems transferred to wider groups of farmers and being utilized by farmers to achieve their objectives and to train other farmers.
- Farmers trained on technology management, adaptation and evaluation.
- Farmers having gainful employment

and cash income, and having animal products in the daily diets of their family.

- Information packages, recommendations and training materials for technology transfer and use by other groups.

Regional relevance: Low-resource farmers constitute a significant population of most LAC countries and face the same problems of food security, employment, income and nutrition.

Actors:

- Land grant universities in USA
- CATIE in Costa Rica
- National and subnational R&D organizations
- Institutes in LAC, e.g. CARDI, CFNI in the Caribbean
- Farmers' Associations in the LAC
- NGOs

Active Projects:

- EDF funded goat project in the Caribbean
- EDF funded feed and feeding systems in the Caribbean
- CATIE goat project

(2) Impact of Macro-Economic and Trade Globalization

Introduction: LAC is endowed with a productive resource base for livestock production superior to that of the other major regions of the developing world. Furthermore, the LAC region provides an expanding market for livestock products which can be attractive for highly productive regions, i.e. Oceania, and also for the livestock commodity

surpluses from the developed countries. Accordingly, it is critical to understand the effects and trends induced by these economic changes in order to direct the structural adjustments to effectively exploit the created opportunities and mitigate the negative impacts of globalized trade.

Objective: To determine the potential short and long term impact and trends of the economic globalization policies and the downsizing of the public sector on the livestock industry, rural development and natural resources under different scenarios.

Hypothesis: According to economic and trade trends during the last 2 decades, present macro-economic and trade liberalization changes will bring about substantial repercussions on livestock product flows within and among countries, the actors involved in livestock production and trade, technology demand, labor employment, input markets, natural resources and the institutional modalities for providing support services (i.e. research and extension), to the livestock industry.

Activities:

- Review previous research results in each country to define the specific objectives and final methodology for the regional analysis.
- Constitute a multi-national and multi-disciplinary team to conduct the proposed research.
- Compare and contrast the predicted impacts with what has been occurring in the region as a whole and specifically within some countries leading in international trade liberalization and others

lagging behind in such process.

- Study the impact trends and implications for other regions of the world which are potential competitors or clients of LAC countries with respect to the major livestock commodities.
- Evaluate in selected countries and in the LAC region as a whole the impact of economic globalization policies, public sector downsizing, privatization of selected livestock-related services.
- Interview key informants involved in the production-to-consumption chain of the major livestock commodities.
- Identify market niches for livestock products, even though of small size, which can be supplied advantageously by LAC countries.
- Construct short and long-term scenarios considering market forces and potential government adjustment policies to determine the expected impact on employment, producer incomes, natural resource use, and production systems with major advantages.

Outputs:

- Analysis of impact and trends associated with the globalization, privatization and public sector downsizing processes on the livestock industry, the participating actors and resource use.
- Empirically supported results and recommendations for public and private sector decision-making in LAC countries, regional fora and regional organizations.

Regional relevance: Intra-regional free trade decisions, the integration of most

LAC countries into the World Trade Organization and the economic and social importance of the livestock industry make it imperative to render the highest priority of this project for all countries of the LAC region and indeed for the rest of the world.

Actors:

- USA Universities, e.g. UC-Davis
- Education and research institutions in LAC
- Multi-national organizations in LAC: IICA, CEPAL and SELA
- Producer organizations, processors, marketers of LAC countries.
- Ministries of Agriculture of LAC.

(3) Livestock Product Market Intelligence and Development

Introduction: Instigated by a) the mounting negative national balance of payments and the weakening value of national currencies and b) economic stabilization and structural adjustment pressures, many LAC countries have taken the “fast track” approach to liberalizing their economy, adopting policies which lead to:

- Greater trade globalization,
- Stimulation of increased private sector participation
- Increased reliance on market forces to drive and regulate economic activity.

In the context of this new environment, a market-led approach must be applied to develop the livestock industry, hence enabling the sector to make notable a contribution to economic growth with equity. Most LAC countries lack an adequate information system and service for domestic and international livestock markets.

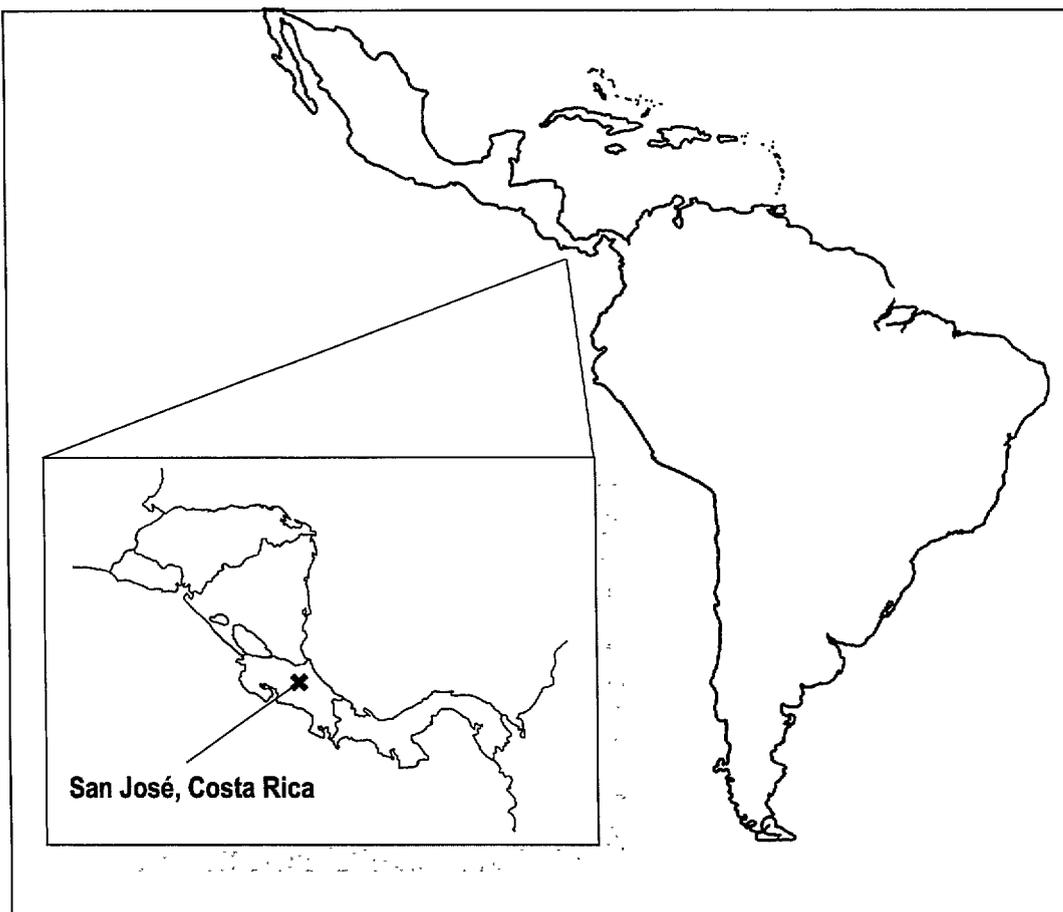
Objective: To provide producers, processors, marketers, policy makers, researchers and developers with timely market intelligence, to promote access to national and international livestock product markets, and to enable/facilitate effective competition in the livestock industry in representative countries of LAC.

Hypothesis: Poor market intelligence and poor delivery of relevant market information on livestock products (including niche ethnic markets) constrain the development and adoption of technological innovations for production and processing, development of appropriate effective marketing policies, and the generation of greater household income and foreign exchange from the livestock industry.

Activities:

- Analysis of quality, pricing, health, stratification and relevant conditions in local, national and international markets for major and promising livestock products.
- Diagnosis of the existing market policies, intelligence, information delivery systems and technical capacity in each country.
- Analysis and implementation of proposed interventions to address identified constraints and priorities in 2 above.
- Design and communication of market information packages to the specific target audiences (producers, processors, researchers, developers, policy makers) through appropriate media.
- Monitoring and evaluation of the utilization and impact of market information on production, research

Latin America



and extension programs and income generation.

- Training of local personnel in market intelligence, information delivery, M&E, etc.

Outputs: This research project will produce:

- Periodic market information bulletins, news releases and training manuals tailored to the targetted groups.
- Improved systems and human capacity for market intelligence, delivery, M&E.
- Increased production, productivity and income for producers, processors and forex from the

livestock industry.

- Tested research methodologies for livestock market intelligence and delivery, etc.
- Publications for national and international audiences.

Regional relevance: Many countries (i.e. Mexico, Trinidad & Tobago, Costa Rica, Honduras and Belize) have established market-led approaches and will benefit directly from the results of this research.

Actors/Collaborators:

- International/Regional: IICA, IFPRI, ILRI, CARDI, CATIE and the Caribbean Export Development Agency.

- Universities: UC-Davis, UNAM, UCR, UWI
- NARs: Ministries of Agric and Livestock, Research and extension departments
- NGOs: Chamber of Commerce, Development-oriented agencies, Extension and credit groups.
- Organizations: Livestock producers organizations, etc.
- Media: radio stations, TV stations, newspapers
- Funding: CRSP, Governments, IDB, IFAD, country-USAID

Active Projects:

- IICA?, IFPRI?, ILRI?, CARDI?, CATIE?
- Mexico
- T&T
- Costa Rica
- Honduras
- Belize: Marketing Intelligence Service (Contact: Mr Jose Castellanos or Dr M. Avila, MAF, Belmopan, Tel: 501-2-22242, Fax 22409)

(4) Empowerment of Producers

Introduction: The vast majority of livestock producers are small farmers with mixed farming systems in which decision making responsibilities on resource allocation, technology adoption, product utilization, and access to technical information are spread out and dynamic among various members of the household and community organizations. Improving their farming and livestock systems requires clear strategies and methods for empowerment and effective participation of the real decision makers in the research and development efforts.

Objective: To determine intra- and inter-household decision making processes and evaluate cost effective methods to empower them in order to increase livestock production and productivity.

Hypothesis: Empowering resource-limited livestock producers, i.e. participation of the real decision makers in livestock research, extension and support services, will lead to higher rates of technological adoption and substantial gains in livestock productivity, hence on enhancing household food security and nutrition, gainful employment and the sustainable development of the livestock industry.

Activities:

- Characterize the principal livestock production systems (e.g. cattle, dairy, pig, small ruminants, homeyard, honey bees systems) to determine the roles, knowledge, perspectives, priorities and decision making power of household members.
- Determination of the labor requirements and contribution and access, distribution of benefits from livestock production enterprises and activities, and social indicators, according to intra- and inter-household gender and age classes.
- Development and/or adaptation of appropriate participatory methods to involve the relevant household decision makers and beneficiaries in strategic activities, e.g.: selection and evaluation of technological innovations (e.g. agroforestry, dual purpose cattle, household value adding activities), setting priorities for research and extension, and livestock system management (i.e. resource allocation, choice of

technologies, product utilization and marketing strategies).

- Training of change agents, service support agents and researchers in participatory methods to empower producers.
- Monitoring and evaluation of impacts of participatory approaches on technology adoption, livestock production, household nutrition, labor productivity, and natural resource conservation.

Outputs: This research project will produce:

- Improved human capacity for participatory research and development in the public and private sectors.
- Increased livestock technology adoption and production, household income, employment and quality of natural resources.
- Tested research methodologies and training manuals on participatory approaches and methods for resource limited households.
- Publications for national and international audiences.

Relevance: Many countries (i.e. Mexico, Trinidad & Tobago, Costa Rica, Honduras and Belize) will benefit directly from the results of this research.

Actors:

- International/Regional: CIAT, CARDI, CATIE.
- Universities: UC-Davis, UACH, UADY, UWI
- NARs: Ministries of Agric and Livestock, Research and extension departments, Comision Nacional Caprina de Costa Rica.
- NGOs: Development-oriented

agencies, Extension and credit groups.

- Organizations: Livestock producers organizations, etc.

Active Projects:

- Asociacion Costarricense Creadores de Cabras, (Contact person: Ing. Alejandra Jimenez Salas, Apartado 141-2250, San Jose Costa Rica, Tel: 506-279-6314 Fax: 506-279-6519.
- Belize Enterprise for Sustained Technology (BEST), (Contact: Ms Bridgitte Cullerton, Director, Belmopan, Tel) Belmopan, Tel: 501-2-22242, Fax 22409)
- Sheep and Goat Project, EDF Funded, Jamaica and Guyana (Dr S Parasram, Director of Research, CARDI, Trinidad and Tobago.

PRIORITY RESEARCH TOPICS ON LIVESTOCK/ENVIRONMENT

(1) Improvement Of Small Scale Agro-Processing Of Livestock Products

Introduction: Rural poverty has been associated with over exploitation and degradation of natural resources. Income generation at the farm level is often limited by inappropriate timing of sales and poor quality presentation of primary livestock products; encouragement of on-farm and village level processing operations could generate a significant increase in farm revenues.

Actual agroindustrial processing has concentrated in large scale units located at urban and peri-urban areas, often times associated with high risk of pollution and wide spread squalor among the labor force.

Objectives: To increase farm revenue while improving product quality and insuring better employment opportunities at the small farm level.

To reduce natural resource degradation through increased farm revenue and offer alternative decentralized small rural processing that would reduce the negative environmental impact of modern agroindustries in large cities.

Hypothesis: Increased farm income obtained through processing of primary livestock products will improve the living standard of small farmers through added value to their produce, creation of employment opportunities and increased hygiene and quality levels offered to consumers; while reducing risks of over exploitation of natural resources. Better rural employment opportunities will reduce social degradation caused by emigration to cities.

Numerous decentralized processing units of small size will reduce large or significant pollution caused by agroindustries in large cities.

Activities:

- Determination of products to be processed and their end-products.
- Identification and preliminary assessment of processing technologies and marketing schemes.
- Research and validation of new processing technologies such as cheese making, toffee (cajeta), sausages, dry-salted meat, shearing and fleece classification, dehairing, spinning and weaving, raw-hide tanning, leather handicrafts, etc.
- Training of producers, processors

and family members.

- Marketing research.
- People's organization.
- Supply contracts between consumers and producers (input-output).

Outputs:

- Appropriate, environmentally friendly processing technologies applicable at the small farm/village level, being used.
- Marketing schemes in place.
- Trained families and professionals.
- Increased farm revenues and higher/better nutritional intake.
- Increased job opportunities and reduced rural emigration.
- Utilization of processing by-products at village and on-farm level.
- Improved quality and sanitary standards of livestock products offered to consumers.
- Training material and technical reports.
- Reduced city pollution levels caused by large agroindustries.

Relevance: Particularly important for small farmers located in distant areas (difficult access) throughout the LAC Region.

Actors:

- INCAP, EARTH, ECAG, ZAMORANO, CITA (ucr)
- CIPAV, IMCA, DSEC
- FAO, IICA

(2) Adjusting Improved Technologies To Resource-Poor Farmers

Introduction: Many efforts have been made to develop improved technologies, which in many cases have resulted in interventions with proven capacity to increase productivity of production

systems. Unfortunately, resource-poor farmers, due to specific constraints, have not been able to access the benefits of these technologies. Nevertheless, these technologies have the potential to assist these farmers if adequate adjustments are made.

Objective: To identify available improved technologies and adjust them to the circumstances of resource-poor farmers.

Hypothesis: Improved technologies capable of improving productivity that are available, but which require adjustment and validation under the specific conditions of resource-poor farmers.

Activities:

- Definition of pertinent indicators related to productivity, sustainability, equity and empowerment.
- Identification (inventory) and preliminary assessment of available technologies.
- Definition of validation method.
- Confirmation of preliminary assessment with farmer's participation.
- Implementation at farm level. Monitoring and evaluation.
- Analysis and definition of technology transfer (TT) approach.
- Implementation of TT. Monitoring and evaluation.

Outputs:

- A validated TT methodology
- Validated technologies
- Trained farmers and professionals
- Sets of indicators
- Support system for T.T. in place
- Training material and technical reports

Relevance: Particularly on the Pacific Slopes of Mexico and the Central America Isthmus, the Andean Highlands, the flooded savannas of the Orinoco and Amazon Basin and the Caribbean Islands.

Actors:

- INIFAP, ICTA, BELIZE, ZAMORANO, DICTA, MAG-Nic, EARTH, ECAG, UCR, IDIAP, ICA, INIA, LA MOLINA, IVITA, IBTA
- CIPAV, IMCA, DESEC
- IICA, CATIE, CIAT, ILRI, ICRAF, FAO, CARDI

(3) Evaluation, protection and equitable rational use of wildlife in livestock production systems.

Introduction: A lack of knowledge exists among rural ranchers on how to carry out sustainable harvests of wildlife. There is also a lack of knowledge concerning the positive and negative interactions between livestock and wildlife. The rural community, many times, fails to perceive economic benefits from wildlife because of this lack of knowledge, and many wildlife species fail to receive protection from the rural community because of this lack of economic value.

Objective: To identify and determine the degree of ecological and economical compatibility between wildlife and livestock and to design potential methods that permit the rational management and/or sustainable harvest of wildlife in association with livestock, by the rural community.

Hypothesis: A rational management/use of wildlife will contribute to the

conservation of these species and their habitats, since the rural community will receive a direct economic benefit from such species.

Activities:

- Literature review and other sources of information to identify actual cases and other new potential uses and/or interactions.
- Characterize actual relations (positive and negative) between wildlife and livestock.
- Evaluate the success and effectiveness of actual projects in the region.
- Evaluate environmental-, social- and economic impact of actual projects in the region.
- Design new models of rational use of wildlife associated with livestock.
- Propose research to fill existing voids in information.
- Training of extensionists and ranchers
- Implementation of models in selected sites.
- Periodic evaluation and monitoring.

Outputs:

- An analytical description of actual systems and their capacity to improve life conditions of the rural community.
- The proposition of rational and economic management systems for wildlife in livestock operations.
- Research results publications.
- Political recommendations for improved management and conservation of wildlife.

Relevance: Central America, Caribbean Basin, Ecuador, Peru, Chile, Bolivia, Argentina

Actors:

- Land grant universities-USA
- Agricultural and natural resource universities of the Caribbean Basin and Andean region (PRMVS-UNA, Costa Rica, CATIE, EARTH, La Molina, Peru, Cordoba, Argentina, etc.
- Ministries of Agriculture, Environment, Natural Resources, CONACS, RAMSAR, USFWS
- ONG's, DESCO, CEDEP, Nature Conservancy, WWF
- Small Producers and Peasant Communities of the Andean region, community organizations or associations,
- Private sector: (e.g. Textile Industry of Japan, Italy, Peru, England, Andean Mining Companies, Alpaca International Association)
- FAD (International Fund for Agricultural Development), InterAmerican Foundation,

Active Projects:

- Soil Conservation and water management project (IFAD)
- Vicuna Management and Conservation Project
- Cattle projects of MINAE-UNA-Ramsar-FAO, Costa Rica
- Duck egg production-harvest, El Jocotal, El Salvador

(4) Adjusting livestock production systems to environmental potentials and limitations

Introduction: Traditional livestock production is based on practices that in appearance are detrimental to the environment (e.g. deforestation, overgrazing and grazing on slopes) if management is not controlled. This has

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been reflected in poor and insufficient technical and financial support as well as in poor levels of productivity. In contrast it is also known that livestock production, relative to intensive agriculture, is more stable in particular under extreme environmental conditions. The social and economic role of livestock over all Latin American

countries, the rate utilization of natural resources and the needs of a growing demand of animal products, requires new approaches and new technologies leading to sustainable production and resource management to achieve improvements not only in family income and farmer's well being but also in environmental stability.

Objective: To develop and adjust livestock production technologies in order to achieve sustainable and rational use of natural resources and the environment.

Hypothesis: Livestock can be productive and compatible with rational use and management of natural resources and the environment.

Activities:

- Assessment and development of alternatives to alleviate seasonal effects on livestock production, due to variations in quality and quantity of available forage resources.
- Assessment of indigenous livestock and forage genetic resources.
- Adjustment and development of agroforestry (silvopastoral) technologies as a means for rational and sustainable use of natural resources and the environment.
- Development of appropriate animal production technologies for fragile slope areas and tropical savannas.
- Organization and management of livestock production activities (health, reproduction, nutrition, grazing and infrastructure) in accordance to requirements of new developed technological approaches.
- Monitoring of the impact on water, soil and vegetation caused by livestock production practices.

Outputs:

- Sustainable alternatives of livestock production to improve productivity and family income on the basis of a rational use and management of natural resources and the environment.

- Increased knowledge, awareness and policy recommendations on the interaction of livestock and environment.

Relevance: Improvement of farmer's income and well being on the basis of rational utilization of in- place available resources.

Actors:

- Small and medium-scale farmers
- Private enterprises
- Foundations and NGO's
- National and international research centers (CATIE, EARTH, Universidad Nacional de Costa Rica, CIAT/Bolivia, Universidad Cochabamba/Bolivia, RERUMEN, IBTA/Bolivia y Universidad Central del Ecuador, INIAP/Ecuador, Universidad Catolica/Ecuador)

PRIORITY TOPIC FOR HUMAN
NUTRITION

Animal Source Products: A Key Issue For Child Growth And Cognitive Development.

Objective: To introduce or increase intake of animal source products into poor rural household diets, it especially of young children and women, in a sustainable way compatible with natural resources, the socio-economic realities and cultural values.

Hypothesis: Low intake of animal source products result in a poor quality diet (low micronutrients content), which in turn, affects reproductive outcome and physical growth, and mental development of children.

Issues:

- The activities will be related to the following three main issues:
- How to increase or introduce animal sources.
- How to ensure a steady household supply over time of the animal source products through proper preservation and processing.
- How to ensure household consumption of animal source products for dietary improvement, without excluding market opportunities.

Activities:

- To increase or introduce animal sources.
 - a) Ethnographic studies in a regional basis:
 - Availability
 - Management
 - Utilization
 - Consumption
 - Acceptability of potential animal source foods
 - b) Baseline studies (in planned intervention area and control area):
 - Household socio-economic status
 - Nutritional value of typical diet
 - Nutritional status of community
 - c) Qualitative evaluation of the promising animal sources, alone and in combination with non animal foods (nutrient content analyses)
- To ensure a steady household supply over time of animal source products through proper preservation and processing.
 - Ethnographic studies (current and past practices) on food preservation and processing.
 - Improvement of current methods and/or development and introduction of new methods.

- Post-processing nutrient content evaluation.
 - To ensure household consumption of animal source products for dietary improvement without excluding market opportunities.
 - Education/information through formal and informal activities about value of animal source foods.
 - Development of mechanisms to overcome negative attitudes and beliefs toward diet improvement with animal sources.
 - Participatory "hands on" household preparation, recipe design and test consumption of improved or new dishes.
 - Periodic follow up of acceptability and continuation of dietary improvement.
 - Controlled study of impact (outcome evaluation). In both, control and study areas:
 - Independent variables
 - Diet pattern and food consumption and nutrient intake for macro and micro nutrients of family member
 - Dependant variables
 - Growth (anthropometry) and nutritional status of family members (children, women)
 - Cognitive function, motor and mental for infants and preschoolers, cognitive function and school performance in school children.
 - Household evaluation (baseline vs. post intervention)
 - Micro-environment analysis
 - Household food intake
- (all of above will be carried out on two occasions at least three months apart)

Intervening variables

- socio-economic status
- illness
- genetic/familial factors
- micro-environment, etc

Household evaluation (baseline vrs. post intervention)

- micro-economic analysis
- household food intake

Relevance: Mexico - Central America, Andean Region

Actors:

- Central America and Mexico Region
Instituto Mexicano de Nutricion. (Mexico)
Instituto de Nutricion para Centro America y Panama (INCAP).

Guatemala.

University of California
ICAITI, Guatemala (meat and milk production)

- Andean Region
Instituto de Investigacion Nutricional (Lima, Peru)
Universidad Central, o Catolica, o San Francisco de Quito (Quito, Ecuador)
Univresidad Nacional de Cochabamba (Bolivia)
University of California
Cornell University
- Carribean Region
Carribean Food and Nutrition Institute
University of the West Indies
- NGO's
- Women's Groups

RANKING BY WORKSHOP PARTICIPANTS

1. *Livestock Production Systems for Ecosystems.*
2. *Adjusting Livestock Production Systems to Environmental Potential and Limitations.*
3. *Animal Source Products Key to Child Development.*
4. *Improvement of Small Scale Agro-Processing of Livestock Products.*
5. *Adjusting Improved Technologies to Resource Product Farmers.*
6. *Impact of Macro-Economic and Trade Policy.*
7. *Empowerment of Producers*
8. *Livestock Product Market Intelligence.*
9. *Evaluation, Protection and Equitable Rational Use of Wildlife in Livestock Production Systems.*

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SMALL RUMINANT PRODUCTION:
RECOMMENDATIONS FOR SOUTHEAST ASIA
12 - 15 MAY 1996
PARAPUT, NORTH SUMATRA, INDONESIA

INTRODUCTION

This international workshop jointly sponsored by the Small Ruminant Collaborative Research Support Program (SR-CRSP) and the Agency for Agricultural Research and Development of Indonesia (AARD) was held in Parapat, North Sumatra from 12 - 15 May 1996. Scientists and extension personnel from Indonesia, Malaysia, the Philippines, Kenya, Australia and the United States participated in the workshop. The overall workshop objectives were to:

1. Develop practical recommendations and strategies for small ruminant (SR) production in low and high input systems, and
2. Develop future research priorities to achieve the needed growth in SR production.

The workshop was organized into five general topics which included:

1. Feeds and nutritional strategies for SR production.
2. Breeding system strategies for SR production.
3. Health management strategies for SR production.
4. Economic potential and analysis of

SR production systems.

5. Technology transfer strategies for SR production.

In addition, special working group discussions were conducted to develop material to be used for easy extension of the improved technologies developed for SR production.

The following overview by Kevin Pond, Texas Tech University, highlights and summarizes the papers presented and discussions held at the workshop. The published proceedings can be obtained by contacting the Management Entity of the Small Ruminant CRSP.

FEEDS AND NUTRITIONAL STRATEGIES FOR SR PRODUCTION

The workshop was opened by Tatang Ibrahim, who presented the paper entitled **Forage Production for Low and High Input Systems in Southeast Asia**. He identified three general ecosystems in which small ruminant production occurs: plantation tree crop, food-crop production and open ground. Research at Sungai Putih, North Sumatra, Indonesia has concentrated on

developing forages that will fit with SR production associated with tree-crop plantations; however, recommendations for Southeast Asia have been developed with information from other areas and other production systems.

The following six grasses, five herbaceous legumes and four tree and shrub legumes are recommended for use in Southeast Asia.

Adapted grasses

For use in plantation tree-cropping: *Brachiaria brizantha* CIAT 6780; *Brachiaria Decembers* cv *Basilisk*; and *Brachiaria humidicola* cv Tully. For use in cut and carry systems: *Andropogon gayanus* cv Kent; *Paspalum atratum*; and *Panicum maximum* cv CIAT 6299.

Adapted herbaceous legumes

For use in plantation tree-cropping: *Arachis pintoi*; and *Arachis glabrata*. For use in open ground or grassland ecosystems: *Stylosanthes guianensis* CIAT 184; *Stylosanthes hamata* cv Verano; and *Centrosema pubescens* CIAT 15160.

Adapted tree and shrub legumes

Tree and shrub legumes that fit into all systems include *Leucaena* spp., *Gliricidia sepium*, *Calliandra calothyrsus* and *Desmanthus virgatus*.

To have successful new forage integration, one must have good establishment. Areas critical for proper establishment include proper soil preparation, must have good seed quality, must protect young plants from

animals and weeds and must plant in proper conditions.

As new forages are developed and tested, it is critical to have the farmer involved in the development. This will help avoid problems associated with poor adoption rates of improved forages.

Forage Tree Legumes for Ruminant Production in Southeast Asia, with Special Reference to the *Leucaena* Genus was presented by Ben Mullen. He indicated that tree legumes fit into SR production systems because of their high nutritive quality and because farmers are able and willing to grow them. Although tree legumes vary in nutrient quality and adaptability, generally they contain high amounts of nitrogen, many required minerals (Ca, P, Mg and trace minerals) and because of tannin content may aid in nutrient bypass. The fiber content is lower than most agro-industrial by-product feeds and the smallholder has accepted tree legumes as part of the nutrition of their animals.

Tree legumes should be viewed as a supplementary feed. Biggest response in terms of increased daily gain has been seen with legumes added at 30 to 50% of the total diet. The secondary compounds can cause problems at higher levels of supplementation and feeding of 100% tree legume should be avoided.

The secondary compounds include condensed tannins (CT) that can reduce palatability and can complex with proteins. The levels of CT in tree legumes is variable from 0 to 15%. Some tree legume species such as *gliricidia* have CT of 2% but 90% of the CT is bound and, therefore, creates little

nutritional problem. Another secondary compound found in leucaena is mimosine. Mimosine is a nonprotein amino acid that can be toxic to SR. However, most SR will have the rumen microbes that can detoxify mimosine. Inoculation of rumen fluid from an animal that has the microbes to animals that do not is recommended if leucaena is to be fed at high levels. Leucaena can be supplemented at 5 to 10% to all SR with no problems associated with mimosine.

There are some agronomic limitations that need to be overcome for successful use of three legumes in all environments. For best production most tree legumes cannot tolerate cool temperatures (below 17°C), some are not very tolerant of acid soils or soils of low fertility. In times of extended drought, tree legumes will survive but may lose a significant portion of their leaves, therefore, reducing the available feed resource. In the case of leucaena, a small insect psyllid caused extensive damage to tree stands. Psyllid resistant lines are now available.

Tree legumes fit into every system of SR production and should be used as effective high quality supplements.

Supplementation Strategies for Small Ruminants in High and Low Input Production Systems was presented by Andi Djajanegara. The significance of the population of SR in the region and the contribution of SR, to supply meat and security, needs to be understood. The population of SR in Asia rose from 620 million in 1988 to 685 million in 1992. In Indonesia there are currently 11.8 million goats and 6.5 million sheep. The annual rate of increase in population of

SR is 1%/year worldwide but 2.4%/year in Asia and 3.2%/year and 1.2%/year in Indonesia for goats and sheep, respectively. However, it must also be understood that most smallholder farmers own SR as insurance and for their potential in accumulating capital rather than for maximizing income. Supplementation strategies are much different for low input as compared to high input systems.

A shared nutritional problem is associated with knowing the nutritional requirements of SR in Southeast Asia. The nutrient requirement guidelines developed in temperate climates by the National Research Council (NRC) and the Agriculture Research Council (ARC) are for larger, faster growing animals than present in Southeast Asia. Feed for SR is usually lower quality but reproductive potential (nonseasonal breeding, high litter size, etc.) is high in Southeast Asia SR compared to temperate SR. Nutrient requirements of protein and energy for growth have been compiled for SR based on Indonesia diets but requirements for gestation and lactation of Southeast Asia SR are lacking verification.

The production systems for SR in Southeast Asia are smallholder oriented cut and carry (some grazing) based on native grasses, integrated tree cropping systems where animals graze under tree crops and high input systems based on by-product feeding and supplementation. Each system has unique needs nutritionally. The basic principal in each system is to balance the nutrients in the diet to meet the desired level of production. For low input systems this may involve ensuring

sufficient forage dry matter intake with possible supplementation of additional protein (often with tree legumes), energy (often with rice bran) and mineral supplementation for calcium, phosphorus and sodium. Nutrient demands are highest in all systems for SR at the end of gestation and during lactation.

There are many feed resources for SR including by-products from field and plantation crops (cassava leaves and peelings to cotton seed), from tree crops, from fruit processing and from agro-industrial industries. Special forages and/or tree legumes can also be planted specifically for use by SR. High input systems will utilize more of the above feed resources to increase productivity of the SR population with an increased economical return.

BREEDING SYSTEM STRATEGIES FOR SR PRODUCTION

Breeding Strategies for Low Input Systems was presented by Eric Bradford. A clear distinction needs to be made between optimum and maximum genetic performance. Optimizing genetic performance may not be at maximum levels. The level of desired performance may be different for different systems so it is important to match genetic improvement to desired performance. The goal for genetic improvement should be to match genetic potential to economically feasible levels of feeding and management.

There are three basic tools for genetic improvement: the use of different breed resources, the use of selection with indigenous breeds and use of major

genes. The use of different breed resources can result in large and rapid change. Selection also will allow for change but at a slower rate. The use of major genes is limited because only a few are known and there may be deleterious secondary effects. If breed introduction is the chosen tool, then it is imperative to select from breeds that were developed in similar environments and evaluation should be over the full life cycle.

In any selection program accurate records need to be maintained on individuals. At a minimum, records of lambing dates, parentage and weaning weights should be maintained as, from these, other information can be calculated. Selection criteria will be different for various objectives but, in general, males should be selected for post weaning growth and females selected based on productivity (weight of lamb weaned/ewe).

The government can play a very important role in developing genetic resources and making technology available to the farmer. The government should have a professionally staffed breeding farm that selects for appropriate traits. The farm should sell breeding stock to farmers and provide information on production and provide other technical services.

Breeding Strategies for High Input Small Ruminant Systems was presented by M. Khusahry. The objective of increasing the number of sheep integrated into tree-crop production systems in Malaysia involved finding not only the genetic resources that performed in terms of average daily gain but also

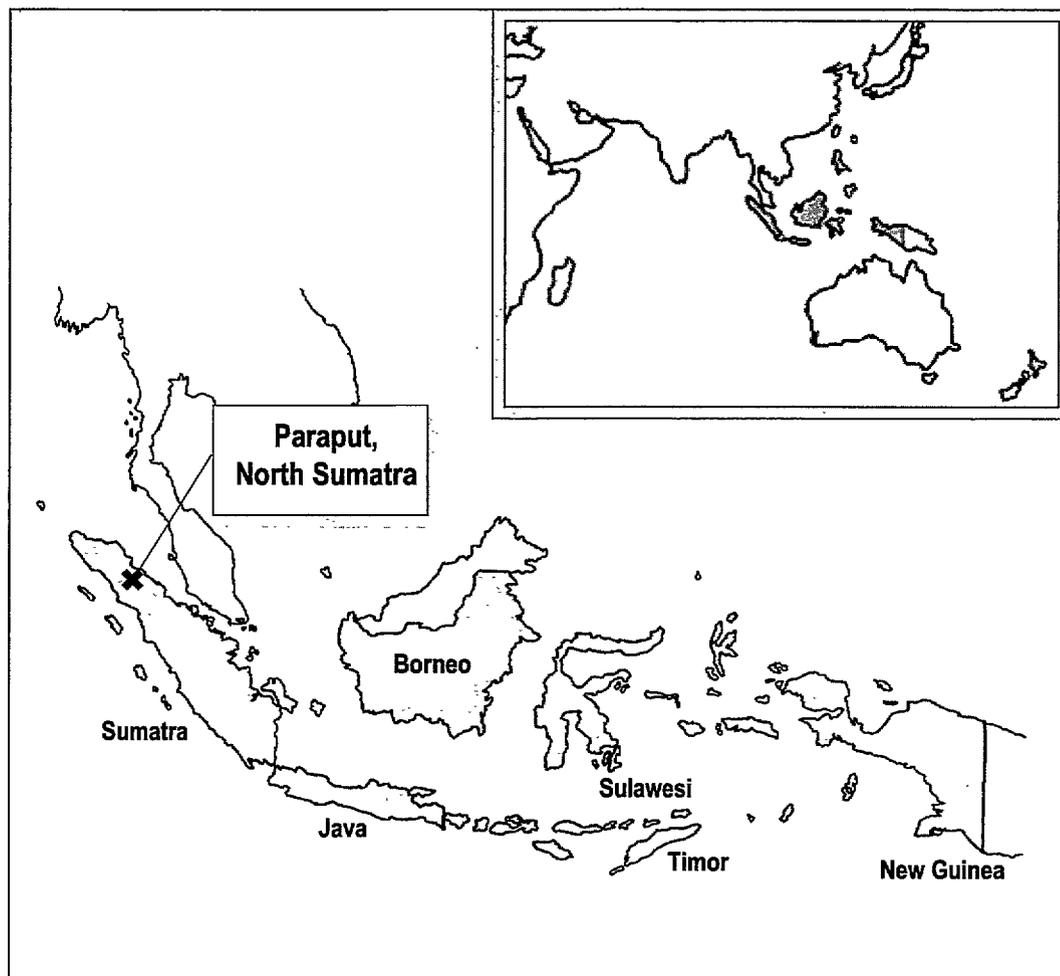
that had appropriate fertility and reproduction. With the exception of the Dorset x Malin, wool and wool crosses failed to adapt to the environment and produce at desired levels.

The current approach is to use hair sheep introductions that were developed in similar environments. The St. Croix, and more recently the Bali-Bali, have been introduced and are now being evaluated as pure- and cross-breeds. The St. Croix and Bali-Bali crossed with Malin and with Malin x Dorset look very promising.

For needed seedstock production, it is suggested that rams be evaluated and produced from a flock of at least 500

ewes. For replacement ewes, another flock of 5,000 to 10,000 ewes should be utilized with selection to include short lambing intervals.

The major constraint to the current system is that of limited forage available to meet the needs of very large flocks. Alternatives for tree crop integration should include changing tree planting patterns to allow for more high-light areas for forage production and utilizing alternative or by-product feeds. For example, some work has focused on chopping the fronds from oil palms for use as feed. The combination of supplying improved germplasm with proper feed resources is critical.



Indonesia

HEALTH MANAGEMENT STRATEGIES FOR SR PRODUCTION

Health and Disease Problems of Small Ruminants and Management Aspects to Minimize Such Problems was presented by Alan Wilson. Techniques are currently available to control the most common diseases of small ruminants. Often it is a question of having the proper delivery system for technology and supplies, and certainly there needs to be a positive economic return for intervention. The important diseases of SR in Southeast Asia include internal parasites (especially *Haemonchus*) liver fluke, pancreatic fluke (only in sheep in some areas), sarcoptic mange (goats only) and screw worm infestations of both sheep and goats. Other diseases that are not important to SR but affect other species, include malignant catarrhal fever (MCF), which affects Bali cattle thereby restricting sheep production to areas without Bali cattle, orbivirus and foot and mouth disease.

Health and management problems usually involve a complex series of factors. The entire system needs to be understood before intervention is appropriate. It is best to utilize a farmers first approach, understand the entire production system and realize the climatic factors involved. It is also a must to conduct a cost/benefit analysis before intervention. Management remains the most important factor involved in proper disease control!

Parasite Control for Small Ruminant Production was presented by Beriajaya. He indicated that the tropical environment is ideal for parasite survival

year round and is, therefore, a continuous challenge. Although there are a variety of parasites, helminths clearly have the largest effect on SR production and survival. There are many ways to help control parasites. These include chemical treatment, which can be very effective but usually expensive and must be used in conjunction with other management procedures (as pasture rotation), improved nutrition, new biological (fungi) control, breeding for resistance and improved management.

The management system utilized by the farmer also has an effect on ability to control parasites. In a cut and carry system, introduction of parasites to the animal can be limited if forage that is not contaminated with larva is provided to the SR. Animals on an improved nutritional level are also able to tolerate internal parasites with less outward effects. The repeated use of anthelmintics on grazing animals or on animals that are immediately re-exposed to new larva is not a very effective measure to reduce parasite burden because it is very short lived.

The best way to reduce parasite burden is to strategically use anthelmintics in conjunction with pasture rotation or feeding of clean forage. A combination of management techniques is the best approach.

ECONOMIC POTENTIAL AND ANALYSIS OF SR PRODUCTION SYSTEMS

Economic Potential of Small Ruminant Agribusiness in Southeast Asia was presented by Henk C. Knipscheer. Asia has half of the world's

SR with China and India accounting for half the SR in Asia. Indonesia, the Philippines, Thailand and Malaysia are also large players in the region trying to meet their own needs along with exporting to Singapore and/or Malaysia.

The demand for SR was presented for each country by using estimates of population increases, income change per capita and income elasticity. There is a very large demand for SR in Southeast Asia. To meet this demand will require use of available resources. The major advantage of SR is that they can utilize forages and by-product feeds that do not compete with humans. By evaluating the land area resources of the region, looking at permanent pasture, forest land and other land, and assigning forage production values for each type of land, an estimate of the feed resource was calculated. If one assumes that a SR will consume 3% of body weight, the potential number of SR can be estimated. Indonesia and Malaysia can greatly increase the population of SR to utilize this vast forage resource.

The recent technologies developed for SR will also play an important role in increasing production. Some of these technologies include: use of adapted, improved sheep (hair sheep crosses); use of supplemental feeds (by-products); use of new, improved forages; use of mineral and molasses blocks; proper use of anthelmintics and general improvement in management.

Several lessons have been learned evaluating the SR-CRSP programs. To improve profitability a systems approach is needed and new technologies need to be assessed at the farmer level. For

application of technology, an input delivery system needs to be in place that preferably involves the private sector. It works best if the farmers can be organized for development of new markets, new services and information.

The production of SR in Southeast Asia has a huge potential. The demand is high for the traditional market, a developing export market and for high quality meat for local markets. Such development should involve partnerships with the private sector and organization of farmers. The scientist may have a slightly different role in the successful transfer of technology to the farmer.

The Economic Analysis of Small Ruminant Production for Low and High Input Systems was presented by Tjeppy Soedjana. He indicated that it should be recognized that 95% of the SR population is owned by smallholders with low input systems. In many cases the major reason of ownership is for security, savings and the distribution of risk, whereas, high input systems utilize intensive external inputs.

Low input systems usually are of low productivity, make use of family labor and make use of existing resources. In many cases, new technology forces smallholders to increase inputs and, thereby, increase output.

High input systems have profit as the major objective and demand return on investment. High input systems are usually larger, requiring larger and improved facilities and are more capital intensive. In many cases such high input systems are joint ventures.

There is a place for both systems. Research and extension emphasis should be placed on improving production and production efficiency rather than just increasing the population of SR.

TECHNOLOGY TRANSFER STRATEGIES FOR SR PRODUCTION

The Development of the Kenya Dual Purpose Goat (KDPG) and the Extension of Related Technologies in Kenya was presented by Joseph Kogi. Kenya has a SR population of 11 million goats and 9 million sheep. The objective of the Dual Purpose Goat (DPG) program in Kenya was to develop a stable composite breed of goat that is adaptable and productive in a smallholder production environment. The genetic makeup of the DPG is a four breed composite, 25% each of the East African, Galla, Toggenburg and Anglo-Nubian breeds. The East African and Galla are adapted breeds while the Toggenburg and Anglo-Nubian are of more temperate development. The combination has resulted in a goat capable of milk and meat production.

Current production targets are 25 kg yearling weight, 2.09 kg/d milk production, 120 days in lactation and 13 kg kid weaning weight. During the selection program breed resistance to Haemonchus has been monitored. Various techniques, including genetic markers for resistance, have been utilized which should increase the accuracy of prediction.

The program has been a joint collaborative effort among institutions and disciplines including animal

breeding and genetics, nutrition and management, animal health and socioeconomics. An on-farm research program and demonstration farms have been part of the program.

To expand the numbers of DPG and get animals to the farmers, a multiplication unit is being developed. A nucleus herd will be kept (by the government) that will provide does to multipliers who in turn will provide animals to commercial producers. Plans are to develop a DPG breed association.

The program has been successful in developing a desired animal that requires low investment, limited land area and yet provides nutrition and income for the family from the use and sale of milk and meat.

The Approaches in Technology Promotion and Transfer for Small Ruminants in the Philippines was presented by Pat Faylon. The use of SR in the Philippines was limited by high neonatal mortality. Systems of utilizing SR in conjunction with coconut production were also needed. The objective of the research and development and technology transfer program were to reduce neonatal mortality to less than 10%.

Research and development concentrated on improving management practices, improving genetics (selection) and improved uses of anthelmintics. Grazing systems, strategic supplementation, use of molasses blocks, tree legumes, improved performance of indigenous breeds and use of chemical and traditional deworming techniques were all evaluated and developed.

The technology was then transferred to farmers utilizing a variety of approaches. Training seminars were conducted, home visits included and technology packages developed in the form of comics, primers and audio visuals. Other communications were accomplished via radio, TV and print press. The best approach was a combination of seminars and hands-on training. Field trips were also effective because "to see is to believe."

The programs have been successful but the interagency, interdisciplinary research and development was challenging.

The Development of Small Ruminant Industry in Malaysia: Experiences in the Transfer of Technology was presented by Abdul Malik Johan. The population of SR in Malaysia is relatively low and production is insufficient to meet demand and, therefore, there is high importation. In the early 1980s, there was a general economic downturn and tree crop plantations desired economic diversification and a more environmentally friendly method of weed control. This led to increased interest in sheep integration into tree crop plantations.

At that time, technology was available in the form of field demonstrations and on farm trials. The need was to integrate research already done and get it transferred to practice. The approach was to utilize farmer groups and government agencies. Slight adjustments were needed in the technology after which it was given to farmer groups. From the government side, at that time, there was

a concerted effort to promote livestock systems.

Malaysia was in the fortunate position to have basic experience and research in the integration of SR into tree crops and the extension to the farmer was successful. Improvements continue to be made in general management and selection.

Persistence of Technology Introduced by Small Ruminant Collaborative Research Support Program Outreach Projects was presented by Roger Merkel. To test developed technology, the SR-CRSP in Indonesia has been involved in on-farm research in Java called the Outreach Pilot Project (OPP), and in two areas of North Sumatra, the Outreach Research Project (ORP) located in Sungai Putih and the Outreach Project Membang Muda (OPMM) located at Membang Muda. Each program was a little different, but generally selected farmers were given a barn subsidy, tree legumes for planting and 4 to 6 ewes (usually bred) and a ram. The farmers received extension advice and on-farm research was conducted at the farmer level.

Developed technology extended to the farmers included barn divisions and design, legume trees, mineral blocks, molasses blocks, strategic concentrate feeding, crossbred animals, deworming practices, record keeping and need for ram rotation to prevent inbreeding.

A review of the farmers three years after the OPP in Java and review of ORP and OPMM farmers indicate the following: adequate forage/grazing is generally provided; legume trees are used as

supplements; minerals are used, if available; concentrates are not fed; crossbreeds are preferred; rams are rotated only if facilitated; anthelmintics are given but no records are kept.

The implications are that we may need to rethink technology in terms of what is needed and also that an effective extension agent is critical in adopting technology and maintaining desired practices.

It is very important to remember what technology should accomplish:

- must be needed by the farmer
- must have financial return
- must have quick, visible success
- fit the farming system
- should address the most limiting factor to production
- should be easy to teach and learn
- must be culturally acceptable
- simple
- labor intensive vs. capital intensive

WORKING GROUPS - REVISION OF EXTENSION BOOK

Each discipline group reviewed and revised the extension tech pack that was released by the SR-CRSP in 1988 and developed for Java. A loose, three-ring notebook format was discussed whereby basic information on SR production could be included and specific information for integration into rubber plantations, oil palm plantations, coconut plantations, cut and carry systems, etc. could be added as appropriate. Groups will work on revisions with overall coordination being done by Roger Merkel.

PROJECT EXPENDITURES

| | |
|---|-----|
| EXPENDITURES BY PROGRAM | 209 |
| APPROVED PROGRAM BUDGETS | 211 |
| SUMMARY OF HOST COUNTRY CONTRIBUTIONS | 213 |
| MATCHING CONTRIBUTIONS FROM U.S. INSTITUTIONS | 215 |

**SMALL RUMINANT CRSP
USAID GRANT NO. DAN-1328-G-00-0046-00
EXPENDITURES BY PROGRAM**

| Institutions | Disciplines | Year 12 90/91 | Year 13 91/92 | Year 14 92/93 | Year 15 93/94 | Year 16 94/95 | YEAR 17 95/96 | Total |
|-------------------------|-----------------|------------------|------------------|------------------|------------------|------------------|------------------|-----------------|
| Univ. of Ca., Davis | Genetics | \$331,324.81 | \$321,288.16 | \$253,754.00 | \$178,367.45 | \$49,738.66 | \$18,257.07 | \$1,152,730.15 |
| Univ. of Ca., Davis | Agric. Econ | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$18,411.18 | \$18,411.18 |
| Colorado State | Animal Hlth | \$179,497.99 | \$195,474.36 | \$137,000.00 | \$0.00 | \$0.00 | \$0.00 | \$511,972.35 |
| Univ. of Missouri | Sociology | \$201,575.76 | \$353,614.61 | \$345,687.42 | \$217,925.32 | \$132,324.00 | \$179,530.00 | \$1,430,657.11 |
| Montana St Univ | Breeding | \$110,568.80 | \$105,196.99 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$215,765.79 |
| N. Carolina St Univ | Nutrition | \$383,672.90 | \$337,642.00 | \$303,258.17 | \$305,833.06 | \$104,548.00 | \$0.00 | \$1,434,954.13 |
| Texas A&M Univ. | Breeding | \$141,524.58 | \$194,460.00 | \$165,750.00 | \$150,321.83 | \$79,135.00 | \$166,525.00 | \$897,716.41 |
| Texas Tech. Univ. | Range-Nutr | \$84,122.34 | \$191,010.28 | \$168,446.05 | \$132,179.41 | \$0.00 | \$0.00 | \$575,758.08 |
| Utah State Univ. | Range-Eco | \$91,342.42 | \$133,195.00 | \$142,270.00 | \$165,870.00 | \$100,327.93 | \$39,000.00 | \$672,005.35 |
| Wash St Univ. | Health | \$160,000.00 | \$175,000.00 | \$146,000.00 | \$197,061.34 | \$204,073.64 | \$193,974.87 | \$1,076,109.85 |
| Winrock Int'l. | Dairy Mgmt. | \$233,000.00 | \$186,690.00 | \$126,318.17 | \$78,290.76 | \$42,014.00 | \$226,887.19 | \$893,200.12 |
| Winrock Int'l. | Economics | \$212,325.07 | \$246,906.00 | \$187,000.00 | \$173,095.25 | \$128,125.00 | \$115,979.19 | \$1,063,430.51 |
| Univ. of Wisc | Networkg | \$0.00 | \$0.00 | \$28,779.79 | \$13,829.53 | \$0.00 | \$0.00 | \$42,609.32 |
| Univ. of Kent | Anthro | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$23,659.34 | \$23,659.34 |
| | Subtotal | \$2,128,954.67 | \$2,440,477.40 | \$2,004,263.60 | \$1,612,773.95 | \$840,286.23 | \$982,223.84 | \$10,008,979.69 |
| HOST COUNTRIES * | | | | | | | | |
| Indonesia | | \$0.00 | \$0.00 | \$7,099.00 | \$0.00 | \$81,464.25 | \$0.00 | \$88,563.25 |
| Kenya | | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 |
| Morocco | | \$14,609.18 | \$10,756.76 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$25,365.94 |
| Bolivia | | \$42,656.96 | \$147,330.90 | \$46,241.74 | \$34,656.64 | \$93,290.74 | \$15,192.28 | \$379,369.26 |
| | Subtotal | \$57,266.14 | \$158,087.66 | \$53,340.74 | \$34,656.64 | \$174,754.99 | \$15,192.28 | \$493,298.45 |
| Management Entity ** | | \$439,035.03 | \$498,501.98 | \$658,193.61 | \$422,137.36 | \$297,538.46 | \$512,194.45 | \$2,827,600.89 |
| Small Grants | | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$38,423.91 | \$38,423.91 |
| | Subtotal | \$439,035.03 | \$498,501.98 | \$658,193.61 | \$422,137.36 | \$297,538.46 | \$550,618.36 | \$2,866,024.80 |
| | TOTAL | \$2,625,255.84 | \$3,097,067.04 | \$2,715,797.95 | \$2,069,567.95 | \$1,312,579.68 | \$1,548,034.48 | \$13,368,302.94 |

* Most Host Country Expenses are reflected in the expenditures for the participating U.S. institutions.

** Expenditure for ME includes expenses for EEP, Board Meetings, Technical Committee and other meetings.

SMALL RUMINANT CRSP
USAID GRANT NO. DAN-1328-G-00-0046-00
APPROVED PROGRAM BUDGETS

| Institutions | Disciplines | Year 12 | Year 13 | Year 14 | Year 15 | Year 16 | Year 17 | Total |
|---------------------------------|-----------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|------------------------|
| | | 90/91 | 91/92 | 92/93 | 93/94 | 94/95 | 95/96 | |
| Univ. of Calif., Davis | Genetics | \$281,246.00 | \$233,000.00 | \$185,000.00 | \$223,167.00 | \$49,876.00 | \$50,000.00 | \$1,022,289.00 |
| Univ. of Calif., Davis | Agric. Econ. | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$18,661.00 | \$18,661.00 |
| Colorado State | Animal Health | \$201,570.00 | \$175,000.00 | \$137,000.00 | \$0.00 | \$0.00 | \$0.00 | \$513,570.00 |
| Univ. of Missouri | Sociology | \$313,500.00 | \$202,442.00 | \$210,000.00 | \$266,780.00 | \$132,324.00 | \$179,530.00 | \$1,304,576.00 |
| Montana State Univ. | Breeding | \$113,025.00 | \$106,412.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$219,437.00 |
| N. Carolina State Univ. | Nutrition | \$295,000.00 | \$227,000.00 | \$195,000.00 | \$352,100.00 | \$104,548.00 | \$60,000.00 | \$1,233,648.00 |
| Texas A&M Univ. | Breeding | \$210,659.00 | \$140,000.00 | \$129,000.00 | \$167,000.00 | \$79,135.00 | \$166,525.00 | \$892,319.00 |
| Texas Tech. Univ. | Range-Nutritio | \$180,000.00 | \$115,000.00 | \$118,000.00 | \$170,000.00 | \$0.00 | \$0.00 | \$583,000.00 |
| Utah State Univ. | Range-Ecology | \$120,000.00 | \$115,000.00 | \$115,000.00 | \$165,870.00 | \$114,804.00 | \$39,000.00 | \$669,674.00 |
| Washington State Univ. | Health | \$160,000.00 | \$175,000.00 | \$146,000.00 | \$304,327.00 | \$204,435.00 | \$196,000.00 | \$1,185,762.00 |
| Winrock Int'l. | Dairy Mgmt. | \$200,000.00 | \$150,000.00 | \$107,000.00 | \$82,500.00 | \$42,014.00 | \$138,000.00 | \$719,514.00 |
| Winrock Int'l. | Economics | \$255,000.00 | \$202,558.00 | \$177,000.00 | \$205,000.00 | \$128,125.00 | \$228,600.00 | \$1,196,283.00 |
| Univ. of Wisconsin | Networking | \$0.00 | \$0.00 | \$40,000.00 | \$55,000.00 | \$0.00 | \$0.00 | \$95,000.00 |
| Univ. of Kentucky | Anthropology | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$23,669.00 | \$23,669.00 |
| | Subtotal | \$2,330,000.00 | \$1,841,412.00 | \$1,559,000.00 | \$1,991,744.00 | \$855,261.00 | \$1,099,985.00 | \$9,677,402.00 |
| Management Entity* | | \$600,000.00 | \$610,000.00 | \$610,000.00 | \$524,275.00 | \$311,813.00 | \$600,294.00 | \$3,256,382.00 |
| Program Enhancement Funds | | \$0.00 | \$43,588.00 | \$40,000.00 | \$15,000.00 | \$71,479.41 | \$56,021.00 | \$226,088.41 |
| Host Countries | | \$310,000.00 | \$305,000.00 | \$206,500.00 | \$41,620.00 | \$106,293.00 | \$15,273.00 | \$984,686.00 |
| Linkages | | \$65,000.00 | \$0.00 | \$70,000.00 | \$0.00 | \$0.00 | \$0.00 | \$135,000.00 |
| Impact Assessment | | \$0.00 | \$0.00 | \$0.00 | \$3,133.00 | \$0.00 | \$0.00 | \$3,133.00 |
| Networks | | \$0.00 | \$0.00 | \$14,700.00 | \$0.00 | \$0.00 | \$0.00 | \$14,700.00 |
| Funds for Student Training | | \$0.00 | \$0.00 | \$0.00 | \$20,000.00 | \$874.00 | \$0.00 | \$20,874.00 |
| New Site/Activity/Grant Renewal | | \$0.00 | \$0.00 | \$459,800.00 | \$19,000.00 | \$75,000.00 | \$266,389.00 | \$820,189.00 |
| | Subtotal | \$975,000.00 | \$958,588.00 | \$1,401,000.00 | \$623,028.00 | \$565,459.41 | \$937,977.00 | \$5,461,052.41 |
| Small Grants | | | | | | \$12,540.00 | \$40,160.00 | \$52,700.00 |
| Publications | | | | | | \$6,089.00 | \$8,770.00 | \$14,859.00 |
| | Subtotal | | | | | \$18,629.00 | \$48,930.00 | \$67,559.00 |
| | TOTAL | \$3,305,000.00 | \$2,800,000.00 | \$2,960,000.00 | \$2,614,772.00 | \$1,439,349.41 | \$2,086,892.00 | \$15,206,013.41 |

* Allocation for ME includes funding for External Evaluation Panel, Board Meetings, Technical Committee, and other meetings.

SMALL RUMINANT CRSP
USAID GRANT No. DAN-1328-G-00-0046-00
SUMMARY OF HOST COUNTRY CONTRIBUTIONS

| Host Country | Year 12 90/91 | Year 13 91/92 | Year 14 92/93 | Year 15 93/94 | Year 16 94/95 | Year 17 95/96 | Total |
|------------------|------------------|------------------|------------------|------------------|------------------|------------------|-----------------|
| Bolivia | \$809.00 | \$164,787.00 | \$81,230.00 | \$117,013.48 | \$125,764.12 | \$0.00 | \$489,603.60 |
| Indonesia | \$1,428,400.00 | \$3,691,400.00 | \$4,692,840.00 | \$5,004,400.00 | \$4,999,800.00 | \$5,013,800.00 | \$24,830,640.00 |
| Kenya | \$218,771.00 | \$216,284.00 | \$127,919.00 | \$56,489.00 | \$254,718.00 | \$280,995.00 | \$1,155,176.00 |
| Morocco | \$1,044,000.00 | \$826,000.00 | \$811,000.00 | \$0.00 | \$0.00 | \$0.00 | \$2,681,000.00 |
| Peru | \$6,845.00 | \$6,500.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$13,345.00 |
| TOTAL | \$2,698,825.00 | \$4,904,971.00 | \$5,712,989.00 | \$5,177,902.48 | \$5,380,282.12 | \$5,294,795.00 | \$29,169,764.60 |
| Non-CRSP Support | \$46,615.00 | \$120,962.00 | \$166,259.00 | \$340,472.00 | \$84,301.00 | \$0.00 | \$758,609.00 |
| TOTAL | \$2,745,440.00 | \$5,025,933.00 | \$5,879,248.00 | \$5,518,374.48 | \$5,464,583.12 | \$5,294,795.00 | \$29,928,373.60 |

SMALL RUMINANT CRSP
 USAID GRANT No. DAN-1328-G-00-0046-00
 MATCHING CONTRIBUTIONS FROM U.S. INSTITUTIONS

| Institution | Disciplines | Year 12 90/91 | Year 13 91/92 | Year 14 92/93 | Year 15 93/94 | Year 16 94/95 | Year 17 95/96 | Total |
|-----------------------|-----------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|-----------------------|
| Univ. of Calif, Davis | Genetics | \$118,292.08 | \$122,877.02 | \$103,056.00 | \$92,682.00 | \$36,282.00 | \$18,951.36 | \$492,140.46 |
| Univ. of Calif, Davis | Agric. Econ. | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 |
| Colorado State | Animal Health | \$53,333.04 | \$87,499.62 | \$41,861.38 | \$0.00 | \$0.00 | \$0.00 | \$182,694.04 |
| Univ. of Missouri | Sociology | \$66,184.42 | \$81,894.67 | \$121,900.45 | \$91,115.58 | \$33,601.39 | \$51,541.90 | \$446,238.41 |
| Montana State Univ | Breeding | \$60,734.04 | \$52,668.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$113,402.04 |
| No Carolina St Univ | Nutrition | \$64,731.14 | \$55,975.10 | \$53,631.00 | \$55,192.79 | \$20,331.83 | \$0.00 | \$249,861.86 |
| Texas A&M Univ | Breeding | \$46,289.63 | \$53,757.88 | \$63,822.49 | \$63,704.89 | \$25,303.42 | \$46,172.71 | \$299,051.02 |
| Texas Tech. Univ | Range-Nutrition | \$51,422.63 | \$68,212.94 | \$49,900.38 | \$45,924.26 | \$0.00 | \$0.00 | \$215,460.21 |
| Utah State Univ | Range Ecology | \$46,379.09 | \$84,756.83 | \$52,639.90 | \$54,737.10 | \$73,152.99 | \$9,750.00 | \$321,415.91 |
| Wash St Univ | Health | \$53,333.00 | \$81,373.76 | \$48,180.00 | \$120,470.61 | \$85,296.23 | \$117,106.12 | \$505,759.72 |
| Winrock Int'l. | Economics | \$75,406.90 | \$83,273.79 | \$102,045.27 | \$92,258.89 | \$71,268.24 | \$65,491.23 | \$489,744.32 |
| Winrock Int'l. | Dairy Mgmt. | \$68,022.61 | \$56,749.01 | \$26,262.35 | \$47,138.48 | \$26,750.68 | \$33,149.03 | \$258,072.16 |
| Univ of Wisc | Networking | \$0.00 | \$0.00 | \$0.00 | \$11,795.61 | \$0.00 | \$0.00 | \$11,795.61 |
| Univ of Kent | Anthropology | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$4,715.00 | \$4,715.00 |
| | TOTAL | \$704,128.58 | \$829,038.62 | \$663,299.22 | \$675,020.21 | \$371,986.78 | \$346,877.35 | \$3,590,350.76 |

Previous Page Blank

GLOSSARY

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| AARD | Agency for International Research and Development, Indonesia |
| ACIAR | Australian Centre for International Agricultural Research |
| ADG | Average daily gain |
| AFRNET | African Feed Resources Network |
| AGRIS | International Information System for the Agricultural Sciences and Technology, FAO |
| AID | Agency for International Development, Washington D.C., USA |
| AIGACAA | Asociacion Integral de Ganadevos en Camelidos de los Andes Altos |
| ARC | Agriculture Research Council |
| ASARECA | Association for Strengthening Agricultural Research in Eastern and Central Africa |
| ATI | Appropriate Technology International |
| B | Barbados Blackbelly Sheep |
| BC | Barbados x Sumatra Sheep |
| BIFAD | Board for International Food and Agriculture Development |
| BPP | National Rubber Research Institute, Indonesia |
| BPT | Balai Penelitian Ternak, Bogor, Indonesia (Animal Husbandry Research Institute) |
| BW | Body weight |
| CAP | Common Agricultural Policy |
| CARDI | Caribbean Agricultural Research and Development Institute |
| CATIE | Centro Agronomico Tropical de Investigacion y Ensenaza |
| CBE | Commercial Bank of Ethiopia |
| CBPP | Contagious Bovine Pleuropneumonia |

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| CCPP | Contagious Caprine Pleuropneumonia |
| CGIAR | Consultative Group on International Agricultural Research |
| CIAT | Centro Internacional de Agricultura Tropical |
| CORAF | Conference de la Recherche Agronomique des Responsable Africains et Francais |
| CP | Crude protein |
| CPV | Capripox virus |
| CRIAS | Coordinating Research Institute for Animal Science, Indonesia |
| CRSP | Collaborative Research Support Program |
| CSIRO | Commonwealth Scientific and Industrial Research Organization |
| CSU | Colorado State University |
| CT | condensed tannins |
| d | day |
| DM | Dry Matter |
| DPG | Dual Purpose Goat |
| EEC | European Economic Community |
| EEP | External Evaluation Panel |
| ELISA | Enzyme linked immunosorbent assays |
| EPG | Eggs per Gram |
| EU | European Union |
| FAO | Food and Agriculture Organization, United Nations |
| FD | Full-day |
| FEWS | Famine Early Warning System |
| FMD | Foot and Mouth Disease |
| GIS | Geographic Information System |
| GPS | Global Positioning Systems |
| GTZ | Deutsche Gesellschaft für Technische Zusammenarbeit (German Agency for Technical Cooperation) |
| h | hour |

| | |
|----------------|--|
| H | St. Croix Sheep |
| HC | St. Croix x Sumatra Sheep |
| ha | Hectare |
| HEM | Hemicellulose |
| HPI | Heifer Project International |
| IARC | International Agricultural Research Center |
| IBTA | Instituto Boliviano de Tecnologia Agropecuaria |
| ICA | Instituto Colombiano Agropecuaria, Colombia |
| ICARDA | International Centre for Agricultural Research in the Dry Areas |
| ICIPE | International Centre of Insect Physiology and Ecology |
| ICRAF | International Centre for Research on Agroforestry |
| ICRISAT | International Crops Research Institute for the Semiarid Tropics |
| ICRW | International Center for Research on Women |
| IDIAP | Agricultural Research Institute of Panama |
| IDRC | International Development Research Centre (Canada) |
| IEMUT | French Tropical Veterinary Institute |
| IFAD | International Fund for Agricultural Development |
| IFPRI | International Food Policy Research Institute |
| IICA | Interamerican Institute for Cooperation in Agriculture |
| ILRAD | International Laboratory for Research on Animal Diseases |
| ILRI | International Livestock Research Institute |
| INCAP | Instituto de Nutricion para Centro America y Panama |
| INIA | Instituto Nacional de Investigacion Agrarias |
| IP2TP | Installation for Research and Assessment of Agricultural Technology |
| IPB | Bogor Agricultural University |
| JESS | Jubba Environmental and Socioeconomic Studies |
| KARI | Kenya Agricultural Research Institute |
| KDPG | Kenya Dual Purpose Goat |

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|-----------------|---|
| KEVEVAPI | Kenya Veterinarian Vaccine Production Institute |
| kg | kilogram |
| KNP | Katavi National Park |
| Ksh | Kenya Shilling |
| KWS | Kenya Wildlife Service |
| LAC | Latin American Countries |
| LDC | Lesser Developed Country |
| LU | Livestock Units |
| M | Composite Population Sheep: 25% St. Croix, 25% Barbados Blackbelly, 50% Sumatran Sheep |
| MALDM | Ministry of Agriculture, Livestock Development and Marketing |
| MCF | Malignant Catarrhal Fever |
| ME | Management Entity |
| MIAC | MidAmerica International Agricultural Consortium |
| MOU | Memorandum of Understanding |
| MUCIA | Midwest Universities Consortium for International Agriculture |
| NAARI | Namulaonge Agricultural and Animal Production Research Institute |
| NARO | National Agricultural Research Organization |
| NARS | National Agricultural Research System |
| NCSU | North Carolina State University |
| NDF | Neutral detergent fiber |
| NDVI | Normalized Difference Vegetation Indices |
| NES | Nucleus Estate Smallholder |
| NFTA | Nitrogen Fixing Tree Association |
| NGO | Non-Governmental Organization |
| NIH | National Institute for Health |
| NIS | Newly Independent States |
| NRC | National Research Council |

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|----------------|--|
| NSDV | Nairobi Sheep Disease Virus |
| NSF | National Science Foundation |
| ODI | Overseas Development Institute |
| OMD | Organic Matter Digestibility |
| OMI | Organic Matter Intake |
| OPC | Ovine pulmonary carcinoma |
| OPMM | Outreach Research Project at Membang Muda |
| OPP | Outreach Pilot Project |
| OPS | Outreach Project for the Sosa |
| ORP | Outreach Research Project |
| OvLV | Ovine lentivirus |
| PA | Participatory Appraisal |
| PAC | Program Advisory Committee |
| PCV | Packed Cell Volume |
| PEM | Protein-Energy Malnutrition |
| PI | Principal Investigator |
| PL480 | Public Law No. 480 |
| PRA | Participatory Rural Appraisals |
| PVO | Public Volunteer Organization |
| RAINAT | Research and Assessment Installation for Agricultural Technology |
| RERUMEN | Latin American Network of the Small Ruminant CRSP |
| RFA | Request for Assistance |
| RFP | Request for Proposals |
| RGR | Rukwa Game Reserve |
| RIAP | Research Institute for Animal Production, Bogor, Indonesia |
| RISPAL | Latin American Network for Animal Production Systems Research, IDRC |
| RS | Resident Scientist |
| RVFV | Rift Valley Fever Virus |

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|----------------|---|
| S | Sumatra Sheep |
| SACCAR | Southern African Centre for Cooperation in Agricultural Research |
| SBPT | Balai Penelitian Ternak, Sei Putih, Indonesia (Animal Husbandry Research Institute) |
| SR-CRSP | Small Ruminant Collaborative Research Support Program |
| SRNET | Pan-African Small Ruminant Research Network |
| SRUPNA | Small Ruminant Production Systems Network for Asia |
| TANAPA | Tanzania National Parks |
| TAMU | Texas A&M University |
| TDN | Total digestible nutrients |
| Techpac | Technology Package |
| TT | Technology Transfer |
| UCD | University of California, Davis |
| UCR | University of Costa Rica |
| UMC | University of Missouri-Columbia |
| UNDOS | United Nations Development Office for Somalia |
| UNDP | United Nations Development Program |
| UNICEF | United Nations Children's Fund |
| USAID | United States Agency for International Development |
| USAMRID | United States Army Medical Research Inst. of Infectious Disease |
| USDA | United States Department of Agriculture |
| USU | Utah State University |
| UWI | University of West Indies |
| WSU | Washington State University |
| WI | Winrock International Institute for Agricultural Development |
| WILD | Women in Livestock Development |
| WTO | World Trade Organization |
| WWF | World Wildlife Fund |

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