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A STRATEGIC PLAN FOR THE SMALL RUMINANT CRSP

for

1990-2000

- TO BE USED AS BASIS FOR 5-YEAR EXTENSION PLANS

Prepared for the SR-CRSP Management Entity

by

SR-CRSP STRATEGIC PLANNING TASK FORCE

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A STRATEGIC PLAN FOR THE SECOND DECADE OF THE SMALL RUMINANT CRSP

Prepared for the Management Entity of
the Small Ruminant Collaborative Research Support Program

by

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Executive Summary

The "Strategic Plan for the Second Decade of the Small Ruminant CRSP" presents an agenda for research in the 1990's. This strategic plan builds on the Small Ruminant Collaborative Research Support Program (SR-CRSP) which was established in 1978 as a means for helping to increase the utility of small ruminants to human populations in many of the less developed regions of the world. This action recognized the role of small ruminants in improving rural incomes, employment, and nutrition and in providing food and fiber for urban populations.

The past ten years of research, training, and institution-building serve as a foundation for the second decade of the SR-CRSP. Faced with the need to plan for the future, the SR-CRSP Board of Directors and Administrative Council which represent all of the participating institutions directed that a strategic plan be developed. This process was initiated with a Strategic Planning Conference in January 1988 at North Carolina State University. A small task force, composed of representatives from the Technical Committee and the Management Entity summarized suggestions and recommendations from the conference and prepared an initial draft of a strategic plan. This plan was submitted to the members of the Technical Committee, Board of Directors, the Administrative Council, the External Evaluation Panel and the USAID project officer for review and inputs. The strategic plan presented here offers a plan which is considered to be feasible, which produces measurable outputs, which maintains the collaborative spirit which characterizes the Program, and which builds on a decade of experience.

Numbers of small ruminants have increased steadily during the last decade. There are now approximately 1,146,000,000 sheep and 492,000,000 goats in the world of which 53 percent and 94 percent respectively are in developing countries. Despite these increases, by 1990 FAO projects a shortfall of sheep and goat meat of approximately 600,000 MT, equivalent to the production from 30-40 million animals.

Funding over a ten-year period, 1979-89, included $38,123,031 from USAID and matching funds from participating institutions in an amount of equivalent to approximately 33 percent of the funds provided by USAID, well above the 25 percent matching requirement. It is a joint effort between USAID, nine universities, one non-profit institution, and governmental agencies in Indonesia, Kenya, Morocco, and Peru. The University of California, Davis is the Management Entity.

SR-CRSP activities in research, education, and institution building have made major contributions to the advancement of sheep and goat production in developing countries. Improved breeds, breeding systems, grazing systems, dual-purpose goat production systems, feeding systems, and vaccines have been developed. Over 1700 research publications have been produced. Substantial

contributions have been made in the training of small ruminant specialists to design and implement research programs. Approximately 253 research scientists have been or will be awarded graduate degrees and 63 have been awarded B.S. degrees. Institutional programs of host countries and of collaborating U.S. institutions have been strengthened and a working network has been established between U.S. and host country institutions.

With this experience and knowledge has come an increased ability to identify and evaluate production constraints and to focus on those which are the most serious and for which a technical solution appears possible. The research agenda proposed in this strategy plan represents the practical priorities of producers and the research capabilities of collaborating research institutions. In each instance the research proposed represents an extension and/or result of previous research findings and activities. Development of institutions/programs that can be sustained and the training of specialists to implement these programs are integral elements of the proposed research program.

Four major program research components were chosen. They are:

1) Development of hair sheep production systems in the tropics. Hair sheep are widely distributed in the tropics and are important sources of income and food for smallholders. The primary rationale for this research component is the high potential for increasing the productivity of hair sheep. Whereas hair sheep constitute about 10 percent of the world's sheep population, little research has been conducted on them. A secondary reason for this component is that many research results can be easily extended throughout the tropics. Research already conducted and/or underway in Brazil, Kenya, and Indonesia constitutes an important base for future research.

The goal of this component is to develop and adapt hair sheep production systems that will improve the economic and nutritional status of smallholders and provide food for urban populations in the humid and sub-humid tropics. Principal research objectives are to:

- Develop a productive strain/s of hair sheep under farm conditions that have optimum genetic potential for reproduction, lactation, and growth; improved adaptation to humid and sub-humid tropical areas; and improved genetic resistance to internal parasites.

- Develop feed production and preservation systems which permit hair sheep to achieve economical levels of production

- Develop year-round nutritional and management strategies that match available feed resources with the production requirements for sheep

- Develop improved disease prevention systems

- Expand basic knowledge on the adaptive physiology of hair sheep

This research would be conducted in site/s in the humid/sub-humid tropics which have a national research capability and interest in hair sheep production, which have a representative production environment, which present opportunities for effective on-farm evaluation of production systems, and which have national personnel interested in the project and in pursuing advanced training. This program would contribute to the development of the research capabilities of national agricultural research systems and the training of staff to develop, transfer, and test appropriate technologies.

2) Development of sustainable small ruminant production in agro-pastoral systems in arid and semi-arid regions. This component was selected primarily because most of the world's small ruminants are produced in these climatic zones. A second reason is that much experience and knowledge has already been gained in SR-CRSP programs in Brazil, Kenya, Morocco and Peru in natural resource management and small ruminant production. A third reason is that other development agencies are not engaged in significant research efforts toward the constructive use of small ruminants in these areas. This is aggravated by conflicts over the utilization of fragile semi-arid and arid lands, i.e. livestock versus cropland agriculture, domesticated livestock versus wildlife, and extensive versus intensive livestock production.

The goal of this component is to develop, test, and implement comprehensive strategic interventions for the development of grazing and livestock management systems in semi-arid and arid areas which will optimize offtake consistent with sustainable ruminant livestock production and will contribute to the equitable economic and social well-being of all participants. Research objectives are:

- Develop and implement a methodology to describe and document the relationships between small ruminant production systems and their social and ecological environments. Research would focus on production, marketing, and policy.

- Synthesize the technical data to develop strategies to guide interventions for sustainable small ruminant production systems. This process will include the testing and validation of production technology packages and of marketing strategies and policy interventions.

- Implement, evaluate, and monitor comprehensive management plans for sustaining small ruminant production in semi-arid and arid regions.

This program proposes two major efforts: research and human resource/institutional development. This component is expected to result in comprehensive management plans and the identification of policy interventions needed for small ruminant production systems that are efficient and that conserve the natural resource base. Trained people will work with host governments and USAID missions to implement integrated natural resource and small ruminant production programs.

3) Focused single discipline research. The rationale for this component is that targeted disciplinary research can help and is often required to alleviate critical ecological, biological, and socioeconomic constraints and to exploit potentials for improving sheep and goat production. An initial effort would be to develop multivalent vaccines for small ruminants. This is prompted by the poor acceptance of a univalent vaccine for contagious caprine pleuropneumonia that was developed by the SR-CRSP in Kenya. Even though this vaccine was effective, commercial production of the vaccine is not attractive because of low profit potential. However multivalent vaccines may be more acceptable because they can be used to treat several diseases simultaneously and thus would be more cost efficient.

The goal of this component is to develop multivalent, virus vectored vaccines which will protect against the major pathogens of sheep and goats. A multivalent virus vectored vaccine can be developed in the SR-CRSP because basic technology is available and some SR-CRSP scientists are now conducting such research. Once developed, this technology could be applied elsewhere.

The principal objectives of this project would be:

- To develop an attenuated pox virus vector for sheep and goats that has no infectious potential for humans.

- To develop an effective and economical multivalent, virus vectored vaccine against the major pathogens of goats.

- To develop an effective and economical multivalent, virus vectored vaccine against the major pathogens of sheep.

- To provide support for the completion of approximately 3 Ph.D. and 5 Master's degrees.

4) Continued research and support activities: This component makes provision for the continuation of selected research projects and the establishment of support activities that are essential to the accomplishment of SR-CRSP objectives.

Research. Several important research projects will either not

be completed during the first phase of the SR-CRSP or will need follow-on support to sustain activities that are vital to the SR-CRSP. Examples of research projects which appear promising and will likely require continued support are:

o Development of dual-purpose goats. Research with Kenyan farmers clearly shows that dual-purpose goats have the potential for making a significant contribution to the nutritional and economic welfare of small rural households. This genetic base, however, is still narrow and the gene pool must be carefully managed. Continuous evaluation of the performance of dual-purpose goats will be needed for several more years.

o Development of production systems for sheep under rubber trees. While the high potential for small ruminant production in conjunction with tree crops is generally recognized, there is nonetheless need to conduct research to determine the long-term impacts of grazing under trees, to screen grasses and legumes for shade tolerance, and to develop systems to minimize labor requirements in managing and protecting grazing flocks.

o Development of the genetics of the prolificacy of sheep. Research on prolificacy is now being conducted in anticipation of further commercialization and intensification of small ruminant production. Prolific strains/breeds of sheep have been identified and characterized. Provision needs to be made to continue this research and to evaluate this germ plasm in intensive farming systems.

Support Activities. The SR-CRSP needs to develop innovative methods for applying its knowledge and experience to new situations where it has not worked previously. Examples of needed activities are:

o Collaborative research agreements with other institutions are needed whereby the development agency would provide funds for SR-CRSP personnel to perform specific work for them. USAID buy-ins and Basic Ordering Agreements might be effectively used to incorporate and/or expand small ruminant components in USAID funded projects.

o Continued support of host country collaborators should be provided to fund selected research activities and to stimulate continued professional development of host country scientists.

o Training at the graduate level should be continued, as well as problem specific, short-term training.

o The small ruminant science network has fostered information exchange and collaborative efforts between institutions and personnel involved in small ruminant programs in the U.S. and overseas. This network should continue to be nurtured and provision should be made for stop-gap technical backstopping and financial support when critically needed.

Budget Projection

It is estimated that the projected ten year program 1990-99 would require $31,591,000 of USAID funds. Estimated amounts for each component are:

Hair sheep production systems	$ 9,030,000
Development of sustainable small ruminant production in agro-pastoral systems	5,508,000
Focused single discipline research-animal health	4,902,000
Continued research activities	2,633,000
Continued support activities	3,976,000
Administration	5,542,000
TOTAL;	$31,591,000

Collaborating U.S. institutions would provide matching funds in accordance with established USAID/BIFAD requirements and guidelines. Host country collaborators would provide institutional and staff support for in-country activities

Preface

The past ten years of research, training and institution-building serve as a prologue for the second decade of the Small Ruminant Collaborative Research Support Program (SR-CRSP). Faced with the opportunity and the challenge to look critically at the future, the SR-CRSP Board of Directors and the Administrative Council, which represent all of the participating institutions, directed that a Strategic Planning Conference be held in early 1988 to plan the next decade of the Small Ruminant Program.

The conference was held at North Carolina State University. It was attended by over fifty participants who represented all of the U.S. and host country institutions, the Management Entity, and the U.S. Agency for International Development (USAID). In addition, four guest scientists presented state of the art papers on nutrition, genetics and animal breeding, diseases, and the socioeconomic aspects of small ruminant production.

A small task force, composed of representatives from the Board of Directors, the Technical Committee, the Administrative Council, and the Management Entity, synthesized the suggestions and recommendations from the conference and drafted a plan which presents an agenda for research in the 1990s.

This plan was presented to a number of the representatives of the various bodies, as well as to the External Evaluation Panel and the USAID Project Officer. These individuals provided suggestions for improving the plan's goals, scope, and structure. What follows is our best effort at producing a plan which is feasible, which produces measurable outputs, which maintains the collaborative spirit which characterizes the Program, and which profits from a decade of experience.

FOUNDATIONS FOR THE SECOND DECADE

THE IMPORTANCE OF SMALL RUMINANTS

The Small Ruminant Collaborative Research Support Program (SR-CRSP) was established a decade ago to increase the utility of small ruminants to human populations in many of the less developed regions of the world. This action recognized the role of small ruminants in enhancing income, providing cash flow, increasing employment opportunities and reducing risk, in addition to their importance as providers of meat, milk, hides, fiber and fertilizer to a large percentage of the world's population, especially the rural poor. Now, ten years later, small ruminants continue to play a crucial role in the global fight against hunger and poverty; indeed, their importance has increased in the intervening years!

The world sheep population increased from 1,094,000,000 animals in 1980 to about 1,146,000,000 in 1986 according to the Food and Agriculture Organization (FAO); about 53 percent of these animals were found in developing countries. During the same period, the number of goats increased from 465,000,000 to 492,000,000 animals; about 94 percent of them were located in developing countries.

In 1986, sheep worldwide produced 6,200,000 MT of meat and 8,600,000 MT of milk while goats yielded 2,100,000 MT of meat and 7,800,000 MT of milk. About 44 percent of the world's mutton and 57 percent of its sheep's milk was produced in developing countries. About 90% of the world's goat meat and 70% of goat milk were produced in these countries.

These figures show that in one year small ruminants produced a total of 8,300,000 MT of meat and 16,400,000 MT of milk. More importantly, they provided about 4,600,000 MT of meat and 10,600,000 MT of milk to the inhabitants of the

developing countries. In aggregate these signify an immense, valuable and critical contribution because they provide animal protein to human populations which have very limited access to this important nutrient. Nevertheless, FAO estimates that by 1990, the world demand for meat will exceed production by approximately 600,000 MT, equivalent to the production from 30 to 40 million sheep and goats. The urgency with which we must act is obvious.

However, the importance of small ruminants does not reside principally in their large numbers. These animals have other characteristics which make them extremely beneficial to producers, especially to the poor smallholders who constitute the great majority of the producers in developing countries. Chief among these characteristics is their ability to survive on noncompetitive feed resources. Small ruminants have a high rate of productivity based on the utilization of low quality fibrous feeds which have few alternative uses.

In addition, small ruminant production is often an integral component of agro-pastoral production systems with the livestock intrinsically linked to the crop production activities. Often, they represent the primary source of capital inputs for crop production and thus serve to subsidize indeed, stabilize the crop sector. Many producers use their animals as a reserve cash source, relying on them for cash or barter value when needed.

The close integration between small ruminant and crop production in many parts of the world requires that any efforts at preserving natural resource bases or at developing sustainable agricultural systems must consider the important roles played by small ruminants. In many parts of the developing world, the implementation of sustainable crop production systems cannot succeed unless they are integrated with sustainable small ruminant production systems.

In addition to providing fertilizer for the crops, these animals also represent a desirable alternative to tillage as a means of producing food from marginal areas. Properly managed, they can contribute to the preservation of desirable types of vegetation as a strategy for reducing soil erosion and fire hazards. They also provide edible products for humans which contain high quality nutrients in concentrated form; these serve to complement the nutrients obtained from crop production.

THE SMALL RUMINANT CRSP

The SR-CRSP was initiated in 1978 with support from a Title XII grant of $38,123,031 over a ten year period and with participating institutions providing a matching equivalent of 33 percent of the funds provided by the U.S. Agency for International Development (USAID). It developed as a joint effort between the USAID, Winrock International, nine U.S. universities, and governmental agencies in five host countries. The program is administered as a grant to the University of California, Davis, which, acting as a management entity, maintains fiscal accountability and provides subgrants to U.S. participating institutions. Funding is obligated through April, 1989 and authorized through September, 1990 -- the completion date for the first phase of the SR-CRSP.

The program developed its research and training agendas, and selected overseas worksites and collaborators in Brazil, Indonesia, Kenya, Morocco, and Peru. The longest sustained country program, in Indonesia, has been in place for nine years. The life span of the program has permitted its training and research activities to generate outstanding progress and momentum to enable and equip host country scientists to conduct research with local funding.

The SR-CRSP has always kept in focus the collaborative nature of its work with host country scientists, supporting the priorities they have identified, and emphasizing its mandated role as a research program. In this regard, the U.S. participating institutions have tried to do what universities do best, namely conduct research and train researchers. The goals have been to make host country research programs self-sustaining and to help people to help themselves; to that end, much of the SR-CRSP's work has been conducted on small farms, and in places where new ideas can be tested, adapted, altered, and implemented to benefit those small producers of the world who depend on sheep, goats, and camelids for their well-being or survival.

A DECADE OF RESEARCH

The SR-CRSP has been conducting research for almost eight years. In each of the five host countries, the program has concurrently supported numerous different research efforts. These projects have ranged from highly focused disciplinary attempts to solve specific problems to broadly-based team oriented, interdisciplinary field studies. Much of the work involved cooperative efforts among the various disciplines.

Equally important has been the collaborative emphasis between SR-CRSP researchers and host country scientists. In each research project, the planning, implementation and evaluation of the research has been a joint effort. Much of the success of the SR-CRSP can be directly attributed to the participation of the host country scientists, including many trained by the program.

Numerous projects have required long term (5-10 years) research agendas before yielding results; indeed, some projects are only now beginning to provide answers. Many other projects have provided scientific data which have become

the basis for ensuing research. Other projects have required shorter durations and have already provided information of direct practical utility to the producer.

Research Results

Among the results which have proven to have immediate practical applicability are:

° The discovery that the Moroccan D'Man breed of sheep transmits its high prolificacy additively to first cross and backcross progeny. This makes it possible to use local genetic resources to increase prolificacy in Moroccan sheep to different degrees, in accordance with the requirements of different management and feeding systems.

It is estimated that if 10 percent of Morocco's 10,000,000 ewes are replaced with D'Man crosses, this would generate US$ 5,000,000 in additional gross annual income to their producers.

° The identification of the comparative and interactive grazing behavior of sheep, alpacas and llamas on Peruvian highland ranges. Results show that alpacas have the most opportunistic feeding strategy and that they compete directly with llamas and sheep when range conditions vary; llamas and sheep can be grazed together while alpacas should be managed alone. Moreover, research proved that when used properly, cultivated forages could boost animal production by 15-20%.

° The exciting development of a new vaccine against contagious caprine pleuropneumonia (CCPP) in Kenya. This is an epidemic disease which affects at least 48,000,000 goats in Africa and Asia and which, if untreated, has a mortality rate greater than 80 percent. The vaccine is safe, easily stored, economical to produce and highly efficacious.

If this vaccine was widely used by Kenyan producers, it would prevent an average of 82 annual local outbreaks involving an estimated 300,000 goats.

° The identification and control of caprine arthritis encephalitis viral infection in Kenya, Peru, and other parts of the world. It was determined that viral transmission occurs through colostrum and milk, and methods were developed to prevent its spread. These control methods are very important for the U.S., where about 80 percent of dairy goats are affected. The control of this disease represents a US$ 20,000,000 savings for goat producers worldwide.

° Research in Kenya also developed a composite breed dual-purpose goat for milk and meat production in higher potential farming areas. This was done by combining two locally adapted meat breeds and two imported dairy breeds into a single stock.

The introduction of the dual-purpose goats and of improved forage production practices has resulted in a 66 percent increase in food yield. The goats generate an average of US$ 52 additional income per hectare.

° In Morocco, the project collaborated in the identification of nutritional myopathy among sheep, a condition previously unrecognized in this region. It was determined that this condition is caused by a dietary deficiency in selenium. Methods for correcting the deficiency previously developed in the U.S. were tested and found completely effective in Morocco.

° Research in Indonesia revealed that unsupplemented tropical grasses impose severe restrictions on the growth and reproduction of Javanese Thin Tail sheep and that the growth of Kacang goats is similarly affected. It was found that these constraints could be solved by a supplementation of a complete mineral mixture plus a low fiber feed, and that such a supplement could be provided at low cost by village farmers.

The adoption of improved practices for the utilization of green legume foliage has led to increases in weight gain of 120 percent and to increases in feed efficiency of eighty percent.

° In Brazil, researchers established that forage production in the semi-arid forest regions can be enhanced through vegetal manipulation. It was found that thinning the tree canopy cover resulted in significantly more forage biomass produced beneath the trees. It was furthermore determined that a partial clearing of the canopy was just as effective as complete clearing.

Increases of up to 800 percent in herbaceous vegetation were obtained by totally clearing the tree canopy. Grass production was especially improved by this practice, increasing its proportion of the total herbaceous plant yield from 1.7 percent to 10 percent.

° Research in Peru discovered that the dominant proportion of the livestock produced by highland peasant communities is raised in agro-pastoral communities and not almost exclusively by pastoral communities, as had been previously thought. This finding will change the course of agricultural development strategies in the poorest Andean countries.

Furthermore, the research established that livestock in highland Peruvian agropastoral communities are valued most for the dung that they provide - which is used as fertilizer - rather than for their meat, fiber or cash value.

Research Publications. Many of the program's substantive results have been reported in technical reports, journal articles, books, abstracts, and verbal presentations; a substantial number of these publications have been translated into the principal language of the host country. During the past nine years about 1,735 publications and 175 presentations were prepared. Publications were of the following types:

Books and chapters in books	81
Refereed journal articles published or in press	290
Journal articles submitted for review	92
Technical reports, bulletins and proceedings	709
Abstracts of papers presented at meetings	564

In addition to these publications, by September 1990, the SR-CRSP will have published for each host country a report of research-based technologies which have been evaluated for social, economic and technical feasibility. These publications, in the form of `technical packages' which summarize current management recommendations, will be distributed to the local extension personnel, who will disseminate the useful information to sheep, goat, and camelid producers.

This process of transmitting knowledge gained through research and validated under practical conditions, in the form of practical technological packages, represents the type of output envisioned by the project planners at the beginning of the SR-CRSP.

Programmatic Lessons

In the course of planning, implementing and evaluating their research during these last nine years, SR-CRSP researchers have gained extensive knowledge and insight regarding the execution of collaborative, multidisciplinary small ruminant research at an international level. Their collective experience represents a valuable accumulation of knowledge that will be essential for preparing the next decade of research.

Among the most important programmatic lessons learned are:

° This type of research requires much time. It requires seven or eight years to generate knowledge and to validate it -- through on-farm testing, demonstrations, or repeated observations -- before technical packages can be produced with any degree of confidence; sometimes, it takes even longer.

There are several factors which extend the time required for this research. Progress of small ruminant research in developing countries is slow and deliberate because the production cycle of the animals is three years or more. Demonstration research designs, especially on-farm trials, take even more time than highly controlled experimental designs because they often require yearly repetitions to compensate for the greater site variability. To be sure the pace of research is slower in host countries because resources are often limited and the infrastructure is sometimes deficient. These, and other factors, lengthen the time required to conduct animal research and obtain reliable results.

A distinct advantage of the CRSP concept is that it provides the opportunity to continue research long enough to obtain meaningful results. Perhaps more importantly, it involves scientists that have the experience at the onset of a project to estimate realistically how long research will take to achieve the project goals under different conditions.

° The solution of small ruminant production constraints mandates an understanding of the total production system within which the animals are being produced. The problems must be understood as the producer understands them, and must be resolved in ways that are acceptable to him/her.

This lesson has underscored the program's commitment to interdisciplinary and multidisciplinary research. To recognize and understand the constraints and developing appropriate solutions requires agronomists, ecologists and social scientists as well as animal scientists.

° The host country scientists and administrators must share a commitment to the research goals and this commitment can only be developed if they are involved in the planning design and implementation of the projects. The

development of detailed research plans should proceed only with the participation of the host country collaborators.

° Complex, interdisciplinary projects require continuity in their scientific and administrative staffs. Frequent turnover of key personnel hinders the accumulation of experience and knowledge about target systems which is essential for the appropriate sequencing and analysis of research trials.

A DECADE OF TRAINING

One of the most successful activities of the SR-CRSP has been the training of small ruminant researchers. A significant portion of the project's resources were devoted to providing scientific and technical training to largely host country personnel and to some extent, U.S. students. This training ranged from simple technical non-degree instruction to advanced graduate degree programs. These trainees represent a valuable scientific resource now in place to continue and to expand the scope of international small ruminant research.

Degree Training

Starting in 1979, the SR-CRSP has made available both financial and technical support to provide university training to approximately 300 researchers. As shown in the following table, approximately 80 percent of these students obtained advanced university degrees. Slightly over half of them were trained at U.S. institutions, mostly at the SR-CRSP participating universities.

SR-CRSP SUPPORTED DEGREE TRAINING 1976-1987

	Training Site		
	U.S.		Host Country
	International Students	U.S. Students	
B.S.	1	0	62
M.S.*	50	32	61
Ph.D.	56	27	11
	107	59	134

* An additional 16 students were in training at the time of the survey.

U.S. students represented about 20 percent of the total number of researchers receiving university training. The remainder came from twenty-eight different countries. Approximately 20 percent of all the students were females, most of them host country nationals.

The value of the degree training program goes beyond the number of students trained. A large number of the students from the SR-CRSP host countries conducted their thesis research in their own countries, thus contributing significantly to the knowledge about local small ruminant production. Many participants with MS and PhD degrees are currently serving as co-principal investigators of the SR-CRSP. Still others hold key positions in their research institutions.

Non-degree Training

Simultaneously, the SR-CRSP also implemented a program of technical training. This program ranged from informal training sessions to formal workshops lasting several days. In the past eight years, the project supported

or sponsored 23 training sessions, attended by a total of approximately 1,000 host country participants.

Participants at these sessions have included farmers, technicians, extension workers, project personnel and host government administrators. Some of these sessions were so successful that they now have become annual events.

RATIONALE FOR FUTURE RESEARCH

The usefulness of small ruminants is so vast and so varied that no single research program can hope to solve all the problems which face those who produce them. However, there is some substantive agreement between producers and researchers regarding which problems are most important. The SR-CRSP has focused on these high priority problems since its inception. In some cases, it has found appropriate solutions, while in others it is still trying to develop them.

The probability of success with continued research is enhanced by the significant increase in the numbers of experienced small ruminant researchers. SR-CRSP researchers now have almost ten years of interdisciplinary research experience in the field and a far wider scientific base than when the program was initiated. The body of knowledge about small ruminants and their production is increased greatly; many knowledge gaps are filled and much basic research is completed. Increasingly, SR-CRSP research efforts will be directed toward solving the remaining major problems still faced by producers.

With this increase in experience and knowledge has come an increased ability to identify and evaluate the many production constraints, and to focus on those which are the most serious and for which a technical solution appears possible. This is a difficult exercise. It requires concentrating the research efforts on specific areas, utilizing different programmatic approaches, and simultaneously pursuing different research strategies.

The research agenda proposed here is the outcome of the application of several practical criteria evaluated in the light of the program's experience and knowledge. It is an agenda which reflects the practical priorities of the producers rather than the scientific interest of the researchers. In each case,

the research represents an extension or result of previous research findings and activities. Thus, much of the basic research has already been initiated and some has been completed.

For these reasons, four major program research components were chosen according to different criteria. In each case, the selection was based on an overriding practical consideration. This approach has resulted in a combination of research components which are aimed at solving a wide range of the most important issues facing small ruminant producers.

The **first** research component is directed towards the **development of hair sheep** in the humid and sub-humid tropics. Here, the primary rationale for the research component is the very high potential for increasing productivity of this stock. Hair sheep constitute about ten percent of the world's sheep population yet very little research has been done on them; based on the evidence gained in the SR-CRSP, there is a great potential for their improvement. A secondary rationale for this component is that research results can be easily extended to other sites in the tropics. Improved hair sheep breeds could be introduced in many tropical regions where small ruminant production is already socially and culturally acceptable. They can provide additional income for farmers by complementing their cropping practices.

The SR-CRSP has a preliminary evaluation of hair sheep in Brazil and Kenya. It has also introduced them in Indonesia, where their performance is now being evaluated. The work in these sites constitutes the basis for the future research. The program has gained substantial experience in developing a dual-purpose goat production system in Kenya; the methodology established in this effort will be directly applicable to hair sheep development.

The **second** research component is oriented towards **developing sustainable small ruminant production in agro-pastoral systems** in arid and semi-arid regions. The key to the development of sustainable agricultural systems in these regions depends on the implementation of suitable management strategies for the livestock sector of the food economy.

This component was selected primarily because most of the world's small ruminants are produced in these climatic zones. Improvements developed under this component can be directly applicable to production systems in many parts of the world.

A second reason for focusing SR-CRSP efforts toward arid and semi-arid zones is that much experience and knowledge has been gained in Brazil, Kenya, Morocco and Peru regarding natural resource management and small ruminant production. Research in these countries has shown that protection and improvement of the natural resources are compatible with small ruminant production.

A third reason for directing SR-CRSP efforts towards arid and semi-arid zones is that there are no other development agencies engaged in significant research efforts towards alleviating the constraints to small ruminant production in these areas.

With the knowledge base among SR-CRSP participating institutions and with the experience gained during the past decade, the SR-CRSP Program is in a strong position to direct its research efforts toward enhancing the sustainability of small ruminant production within the existing natural resource base in arid and semi-arid zones.

The **third** research component is more narrowly focused. It represents a concerted interdisciplinary effort to **develop multivalent vaccines** for small

ruminants. The primary justification for this activity is that it will provide small ruminant producers with low cost multivalent vaccines which can be used to treat several of the most important infectious diseases which affect small ruminants. A second justification is that the project expects to obtain results in a relatively short log frame.

This component was developed as a consequence of lessons learned during SR-CRSP research in Kenya. The project developed a univalent vaccine which was not commercially successful because of the cost of manufacture. The Kenyan government speculated that univalent vaccines were often too expensive for treating small ruminants. Multivalent vaccines will be more acceptable because they can be used to treat several diseases simultaneously and thus are far more cost efficient.

The **fourth** program component includes the **continuation of selected current research projects and the establishment of support activities.** Currently, there are several research projects which by their nature will not be completed by the end of the first phase of the SR-CRSP. The projects selected for continuation will be determined within a year when the progress of unfinished projects can be assessed and their practical potential can be evaluated.

It has been the experience of the SR-CRSP that merely conducting international research is not sufficient to improve small ruminant production on a global scale. The information generated through research must be effectively communicated to small ruminant researchers and producers everywhere. Furthermore, the researchers and producers must be able to use this data. In order to ensure the dissemination and utilization of the information developed by the program, several support activities have been planned for the second phase of the program.

COMPONENT 1:

HAIR SHEEP PRODUCTION SYSTEMS RESEARCH

PROBLEM STATEMENT

Small ruminants fit well the needs of limited-resource farm families in the humid and sub-humid tropical developing regions of the world, such as sub-Saharan Africa and portions of Asia and Latin America. Their small size, low feed requirements, short generation interval, and high reproduction rates contribute to high returns on relatively low investments. There exists a high potential for increasing the number of sheep in the humid and sub-humid tropics by improving efficiency in the use of available feed resources.

Meeting increased demands for animal protein by expanding the small ruminant population and by increasing its efficiency appear promising because their production can be highly compatible with cropping activities. There is also a high potential for integrating small ruminant production with tree crops, such as rubber trees and oil palms. Small ruminants can be included as a livestock component in the agro-forestry systems which are now expanding in many tropical regions.

However, not all small ruminants are equally productive in tropical environments. The familiar wooled sheep breeds of the temperate zones fare poorly when exposed to the heat, humidity, diseases, and parasites of the lowland tropics. In contrast, hair sheep, which have evolved under tropical conditions, survive reasonably well; they have the potential for good productivity under tropical environmental constraints.

SR-CRSP research experience in all worksites suggests that it is highly probable that by improving feed supplies, health care practices, management

techniques, and genetic potential, the productivity of hair sheep can be increased and made more cost-effective.

GOAL AND OBJECTIVES

Goal

To develop and adapt hair sheep production systems to the needs of smallholders in the humid and sub-humid tropics, utilizing the local vegetation as the principal feed resource.

Objectives

1. Develop a productive strain of hair sheep with superior genetic potential for resistance or tolerance to internal parasites, which is well adapted to the climate and feed resources of the humid and sub-humid tropics and to the management systems of both smallholders and plantation tree crop owners.
2. Develop feed production and preservation systems which permit hair sheep to achieve economically favorable levels of reproduction and growth.
3. Develop nutritional and management strategies to match the feed resources that are available throughout the year with the production requirements for sheep (e.g., year-round breeding, growing lambs, replacement females, lactating ewes).
4. Develop disease prevention systems (e.g., management and vaccination programs) which result in good health maintenance at low cost.
5. Develop basic knowledge of the adaptive physiology of hair sheep to the humid and sub-humid tropics in order to facilitate the diffusion of the production technology to different situations and regions.

6. Establish an on-farm research program to develop nutrition, health, and management technologies that are technically and economically acceptable to small-scale producers in the humid and sub-humid tropics.

GENERAL APPROACH

The proposed research program for achieving these goals would:

- Develop a productive hair sheep genotype better adapted to the humid and sub-humid tropics than the strains currently available in most countries.
- Develop research capabilities within national agricultural research and extension systems (NARES) to develop, transfer, and test appropriate technologies.

SR-CRSP scientists could provide limited but consistent financial and technical support to assure the successful implementation of the research effort. The SR-CRSP could also provide training in U.S. institutions as well as other types of support for the professional development of the NARES research staff.

Research results will be shared among the participating NARES, thus effectively establishing an international hair sheep research network. The benefits of such a network would be substantial. However, to be effective, the network would require good leadership and sufficient funding to support periodic communication and collaboration among its members.

- Provide consultants from SR-CRSP projects on a short or long-term basis, either by single or periodic visits. This type of assistance is likely to be more useful in the design and evaluation of projects and for resolving problems during their implementation.

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TECHNICAL APPROACH

A. Feed Resource Component

1. Forage Productivity. Cutting frequency experiments comparing the forage productivity of fast-growing tropical grasses and leguminous tree shrubs (e.g., sesbania, leucaena). Measurement of cumulative digestible dry matter and digestible crude protein yields.

2. Feed Preservation. Determining means of preventing feed shortages during the dry season through feed banks, alley cropping, intercropping forage with food crops, or hedgerow cut-and-carry forages. Seasonal surpluses conserved by deferred grazing, hay baling, or silage-making can be fed during periods of feed shortage.

3. Community Nurseries. Many farmers do not have ready access to adapted grasses such as Napier and fast-growing tree legumes such as sesbania, gliricidia, and leucaena. In collaboration with extension agencies, the project will establish community nurseries for the propagation and distribution of seedlings. Farmers will be instructed how to produce forage from the seedlings.

4. Dual-purpose Food/Forage Crops. Sweet potato, maize, sorghum, and other major staple food crops in the humid and sub-humid tropics can be major sources of forage. Cooperative trials will compare the grain and forage characteristics of these varieties and hybrids.

5. Nutrient Values. On-farm and off-farm feed sources will be tested for palatability and percentage of refusals in feeding trials. In-vitro nutrient analyses will also be performed.

6. Lamb Rearing. The production potential of sheep is often limited by the milk yield of ewes. Research will investigate the possibilities

of early weaning and the use of low-cost milk "replacers," such as sweet potato vines.

B. Genetic Research Component

A minimum of two, and preferably three or four, types of hair sheep will be chosen for evaluation. They will be chosen from among the following sources:

- Local types, if available.
- Caribbean and vicinity strains, e.g., Barbados Blackbelly, Virgin Islands, Pelibuey, "West African", Santa Ynez.
- West African sources, e.g., Djallonké.
- Asian subcontinent strains, if any high potential types can be identified.

Strains not available in the country where the project is located will be imported as frozen embryos in sufficient numbers to produce at least 30 ewes per strain. The introduction of frozen embryos should cost no more, and probably less, than that of live animals. Utilizing frozen embryos has the important advantage of significantly reducing the risk of introducing new diseases. It also permits direct comparisons between the introduced animals and the native stock in the first generation, without complications of environmental carryover or maternal effects.

Each stock should be expanded as rapidly as possible to a population of 70 to 80 breeding ewes at an appropriate research station. Sufficient performance data can be obtained during this expansion phase (2 to 3 years) to determine if any of the strains is clearly superior or inferior to the others. Markedly inferior stocks will be culled. The remainder will be crossed, to create a composite population in which selection for defined performance goals can be carried out.

If one of the strains is clearly superior, it will be carried as a pure strain in parallel with the composite population. If there are two to four strains of similar performance, the major effort will be devoted to the selection of an improved strain from the composite base. The predominant local type, whether wool or hair sheep, will also be kept and selected with the same goals.

Selection objectives include:

1. High twinning rate.
2. Frequent parturition.
3. High growth rate among the offspring of highly productive ewes.
4. Resistance to Haemonchosis.
5. Absence of wool.

Each experimental group could be sub-divided and exposed to different management regimes, feeding levels, and other similar variables, if warranted. This would provide an assessment of genotype-environment interaction and would therefore permit the development of more widely applicable information.

Animals of different ages and physiological states from the different experimental sub-groups could be sampled and used in more intensive studies, such as assessments of adaptation to heat stress, resistance and tolerance to parasites, and responses to very high levels of nutrition or to specific nutrient deficiencies. In addition to helping characterize the stocks, the results of such studies should assist in developing improved selection criteria for the selection phase of the project.

If any of the stocks involved show evidence of segregation of major genes, for example prolificacy genes such as the Booroola gene; and if DNA probes are developed for such genes, molecular genetics techniques could be utilized in the

research. This could be done by obtaining tissue samples from the animals for DNA extraction, and doing much of the work collaboratively with a local laboratory, if feasible, or in collaboration with laboratories in the U.S. or elsewhere.

Schedule for Genetic Component:

Year 1. Identify site, prepare facilities, select stocks to be evaluated, and assemble a flock of local sheep. If one of the existing CRSP sites is chosen for the work, major parts of the first year's activities might be already done, and the program could be speeded up.

Year 2. Import embryos, transfer them to local recipient ewes, and produce new stocks.

Years 3 to 5. Expand and evaluate each of the stocks, including detailed physiological evaluations.

Years 4 to 6. Make crosses to produce composite stock.

Years 5 to 10. Practice selection, conduct genetic/environmental interaction studies, and develop integrated management programs for hair sheep in tropical ecosystems.

C. Health Research Component

From the experiences gained in SR-CRSP animal health research in Kenya, Brazil and Peru, a strategy evolved which can now be applied in the hair sheep project. This strategy consists of applying the existing knowledge on the diseases present and focusing the research effort on only those disease problems that represent a production constraint and which have no readily available and feasible solution.

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Specific aims include:

1. To identify the sheep disease problems of major economic importance in the targeted regions; much of this information probably already exists in published form. To supplement the existing information, it will be necessary to monitor the program's animals in order to identify the causes of morbidity and mortality. It is best if this is done in collaboration with host country veterinarians and government diagnostic laboratories, in order to utilize existing facilities and resources.
2. To implement existing disease control procedures for the diseases identified through the implementation of the first project aim. Disease-control programs will be selected on the basis of a comparative cost/benefit analysis of the various possible interventions and on their suitability to local production systems.
3. To develop effective control procedures for diseases currently lacking such procedures. Infectious diseases that are presently uncontrolled and which represent important production constraints would be targeted by a vaccine research project (see Component 3).
4. To collaborate on research to identify and breed animals resistant or resilient to Haemonchus contortus. Haemonchus is a major problem in the tropics and thus developing animals less susceptible to this condition is highly desirable. There is evidence that genetic control of Haemonchus in sheep is now possible.

   The strategy will be to evaluate Haemonchus resistance and resilience in rams selected for desirable production traits. This procedure could add genetic control to the other control methods used against this disease.

If sheep can be found which are resistant to Haemonchosis, they can be exploited to find molecular markers for the resistant trait. Such markers can be identified with DNA probes used to look for restriction fragment length polymorphisms and with monoclonal antibodies to major histocompatibility and related antigens. This area could easily develop into a focused research project.

D. Socio-Economic Component

Before current tropical sheep production systems are altered and improved, or new ones are introduced, it will be necessary to analyze current livestock and crop production practices. This analysis will help to identify the major constraints to production as well as the most promising strategies for improvement.

This will require an interdisciplinary effort to characterize the present systems, identify the areas of intervention, implement on-farm testing and evaluation programs, and monitor changes in the production systems. This will be an on-going process in which the social and biological scientists will collaborate on a continuing basis.

In addition, studies will be conducted on the economic feasibility of the technologies and management practices being developed for use by small farmers.

TIME FRAME

Research will be implemented in three stages:

1990 to 1992. Diagnostic study of current farm production systems. On-station research on health, management, and nutrition of hair sheep, and on feed production and preservation. Assembly of different strains of hair sheep and initial development of breeding program.

1993 to 1995. Monitoring of sheep performance under farm conditions. Scientist-managed on-farm research on agronomy and sheep nutrition and management. On-station research on sheep genetic evaluation, nutrition, health, reproduction, and agronomy.

1996 to 2000. Technical, economic, and socioeconomic evaluation of new hair sheep production systems under farmer management. The farming systems approach will be utilized to assure acceptability by local farmers.

RESEARCH OUTPUTS

- Development of a strain of sheep tested under farm conditions with:
  - -- Optimum genetic potential for reproduction, lactation, and growth.
  - -- Improved adaptation to the humid and sub-humid tropical heat.
  - -- Improved genetic resistance to internal parasites.
- On-farm verification of a forage production and feeding system suitable for smallholders producing the improved sheep in tropical environments.
- Development of farm-validated management strategies for optimizing productivity of the feed resource and sheep production system.
- Accumulation of detailed knowledge of the impact of sheep rearing, in different agroecological systems of the humid and sub-humid tropics, on total food production and on crop productivity and sustainability.
- Obtaining new knowledge of the physiology of adaptation of sheep to high ambient temperatures and other tropical environmental stresses.
- Development of cost effective disease control programs.
- Characterizations of hair sheep production systems and methodological approaches for generating them.

- Training of approximately 10 Ph.D. and 10 MS degrees in the disciplines represented in this project.

PROJECT LOCATION

In addition to the general criteria for the selection of sites during the next phase of the SR-CRSP (Appendix 1), the project must be located in sites which:

- Have a national research capability and interest in hair sheep production and in interdisciplinary farming systems research and extension.
- Have a production environment which will provide sufficient exposure to heat, humidity and the nutritional and health stresses in which hair sheep must be evaluated.
- Present opportunities for effective on-farm evaluation of production systems.
- Have national personnel interested in the project and in pursuing advanced training.

BUDGET PROJECTION

See Appendix 2, Schedule A.

COMPONENT 2:

SUSTAINABLE SMALL RUMINANT PRODUCTION IN SEMI-ARID AND ARID REGIONS

PROBLEM STATEMENT

Over fifty percent of the world's sheep, goats, llamas and alpacas, are produced in arid or semi-arid regions. The comparative advantages of these areas are for animal or for integrated crop/animal production systems.

The rate of degradation of natural resources in these regions is escalating. These areas are characterized by low agricultural productivity, limited feed and water availability, seasonal shortages of forage and water, and periodic droughts. These are precisely the types of environmental constraints under which properly managed small ruminant production can provide the greatest relative benefits.

The sustainability of the natural resources is directly affected by the uncontrolled rate of its exploitation. Livestock production is an important enterprise in these areas, but uncontrolled access has led to overgrazing, denuding of rangelands, and conversion of pastures from productive perennial range grasses to inferior annual grasses and weeds. These negatively impinge on ecosystem stability.

Human population pressures have resulted in the cutting of trees for fuel wood, thus increasing wind and water erosion of the soil. Demand for staple foods and low livestock productivity have resulted in an expansion of croplands in semi-arid, marginally arable regions.

There are several conflicts over the utilization of fragile semi-arid and arid lands. The most important of these conflicts are between:

- Livestock versus cropland agriculture activities.

- Domesticated livestock versus wildlife use of land.
- Extensive versus intensive livestock production.

Without resolution of these conflicts, it will be impossible to develop sustainable agro-pastoral production systems in semi-arid and arid regions. The long-term consequences of current practices are: depletion of resources, adverse climatic changes, and the increasing loss of economic viability of the land.

Attempts to improve animal production in dry regions have largely failed outside of North America and Australia. Sometimes a lack of governmental interest or support for livestock development have undermined efforts to improve livestock production. Government policy has not been able to resolve conflicts between rural and urban interests and between the competing demands of agricultural and industrial national development. Development plans for the management of semi-arid and arid regions have focused on increasing their productivity rather than their sustainability.

Even where policy has sought to support development, progress has been frustrated. Resource managers and policy makers have few means to make plans and design programs to sustain and promote small ruminant production. They have limited information for establishing grazing management systems and for evaluating alternative uses of arid and semi-arid lands.

GOAL AND OBJECTIVES

The goal of this component is to develop, test and implement comprehensive and cohesive strategic interventions for the development of grazing in semi-arid and arid areas which will result in:

- Optimal offtake consistent with sustainable ruminant livestock production.

° The preservation of economic and social well-being for all participants on an equitable basis.

Three objectives will be undertaken to achieve these goals:

1. Develop and implement a methodology to describe and document the relationships between small ruminant production systems and their social and ecological environments. This objective has two research areas:
    - ° Production.
    - ° Marketing and policy.
2. Synthesize the technical data to develop strategies to guide interventions for sustainable small ruminant production systems. The result will be the testing and validation of:
    - ° Production technology packages.
    - ° Marketing strategies and policy alternatives.
3. Implement, evaluate, and monitor comprehensive management plans for sustaining small ruminant production in semi-arid and arid regions.

PROCEDURE

The SR-CRSP proposes two major efforts: research and manpower/institutional development. An emphasis on the development of human and institutional resources is crucial for the achievement of this component's objectives. It is vital that manpower/institutional development be linked to the research so that the personnel trained by the project can use the research results to assist policy implementation. Both efforts will consist of three phases for action which correspond to the three objectives listed above.

Phase One

Phase One will consist of two different types of research. One type will focus on small ruminant production and on the socio-ecological setting in which the production takes place. The other type will examine the marketing/policy environment which affects small ruminant production.

Production Research Effort. The research to be carried out will include collecting baseline diagnostic data on the agro-pastoral production system in semi-arid and arid regions. Biological scientists will take an inventory of land, soil, forage and animals to understand their relationships. The researchers will examine the interactions among the ecological, plant, animal and management effects. The animal and plant scientists will characterize the cropping systems and their relationship to animal production. Social scientists will investigate the relationships between household structures and agro-pastoral production practices.

Research will be both short and long-term in nature, with some ecological and animal research taking longer to complete than social science research. Remote sensing techniques will assist in rapidly understanding the seasonal and spatial utilization patterns of the grazing lands.

Marketing and Policy Research. Sustainability of the natural resource base will depend on the capability of the social and economic systems to adapt to required management changes. A market analysis will be conducted that will investigate the role of markets for agricultural and livestock inputs and outputs. The focus will be on the marketing system for small ruminants and their by-products. Understanding the interregional and international markets for sheep and goats is important to design marketing strategies that will be tailored to producing technological packages for small-scale producers.

Sustainability of the natural resource base will require appropriate involvement of government agencies and local communities in the management of the grazing lands. Social scientists will identify agencies and policies which impact on livestock in semi-arid and arid regions and determine what data are required by the agencies for enacting new policies. Scientists will examine local level decision-making processes to understand the functioning of current grazing management practices and land tenure systems. Because experience shows that local management of resources is more effective than management at the national level, an effort will be made to investigate ways to strengthen the role of local and regional agencies.

Manpower and Institutional Development. The first phase of this effort will be to assess the manpower needs of the recipient country for conducting research on the production and marketing of livestock, as well as on the policies which affect grazing lands. Suitable candidates in academic institutions and key government agencies will be identified for advanced training.

The academic training for biological scientists will be in range management, natural resource conservation, ecology, animal science and agronomy. An estimated total of six Ph.D. and ten Master level biological scientists will be trained in these areas.

Social scientists will be trained to assist in the social and economic aspects of policy implementation for resource management. They will be trained in sociology, resource economics and marketing economics. An anticipated total of two Ph.D. and six Master level social scientists will be trained.

Phase One Outputs. The outputs from this phase support the stated objectives of the project.

1. Development of a research site in the host country.

2. Ecological use inventory of the target area. Characterization of the interrelationships between the ecology and small ruminants.

3. Description of the small ruminant marketing system in the target area with an understanding of its linkages to the regional and national economy.
4. Description of national and local policies that impact on the production of small ruminants and on grazing land utilization.
5. Identification of students and start of degree training.

Phase Two

Production Research Effort. There will be two efforts: the continuation of the long-term field research and a synthesis of the data from the diagnostic studies. The long-term research will be in the areas of forage and grazing land management, ecology and animal management. Interim findings from the research will be used to guide critical on-farm and grazing land experiments.

The major effort of this stage will be to implement the experimental manipulation of environmental variables based on the preliminary results of the field data from Phase One. Possible environmental changes would result from stocking rates, vegetal manipulation techniques, rotation patterns, wildlife competition, etc. Production manipulations could include adjustments in controlled breeding, nutrition regimes, disease prevention practices, and the practices of integrated crop/small ruminant production.

Marketing and Policy Research. The major thrust in this phase will be to synthesize the social and economic data from Phase One and to analyze its implication for production, marketing and policy strategies. Simple analytical tools will be used to evaluate the implication of marketing and policy interventions designed to alleviate constraints which impede integrated resource management. Analysis of national and local policies, such as the imposition of

grazing fees, will be conducted to estimate their social and economic impact on the target population.

Manpower and Institutional Development. The academic training should begin early enough so that students can return to their countries to undertake their theses research during this phase of the project. The students will be involved in the testing of on-farm production technologies, in conducting grazing research, and in policy analysis.

During this phase of the project, the SR-CRSP researchers will help to build up the institutional capability of the agencies that are responsible for grazing land management. Researchers will conduct training programs in the public administration of grazing lands. Where grazing land issues affect neighboring countries, an effort will be made to have regional seminars to address these issues.

Phase Two Outputs. Research outputs from this phase will include tangible results that can be used for the implementation of effective policies. They will include:

1. Experimental results of on-farm trials.
2. Experimental results of grazing management practices.
3. Description of socioeconomic impacts on small ruminant production from experimental changes.
4. Experimental results of marketing and policy interventions.
5. Completed theses relevant to the objectives of the project.

Phase Three

The last phase of the project will generate a comprehensive management plan for sustained small ruminant production and recommendations for the implementation of the plan.

Production Research Effort. In this phase, the production technologies which have been tested on-farm and in the grazing lands will be fine-tuned. The results of the long-term research on grazing lands will be completed and technical packages will be developed and tested.

Marketing and Policy Research. An integrated natural resource policy plan for the target area will be refined in coordination with the host government agencies. Monitoring of the implementation of the plan will be conducted through research evaluations. Marketing and management policies will be validated to insure the desired impacts.

Manpower and Institutional Development. In this stage, the personnel trained by the project will work with the government and the USAID mission to implement the integrated natural resource policy plan. Their objective is to enable the agencies to enact the recommendations developed by the policy research.

Phase Three Outputs.

Two outputs are expected at the end of the third phase of research:

1. Validation of the technical packages.
2. A comprehensive plan of policy interventions for the preservation of the natural resource base and the development of sustainable small ruminant production.

TIME FRAME

The time frame for the different efforts of this component are:

1990-1993 (Phase One)

Research Activities -- Diagnostic survey of small ruminant production systems. Market and policy analyses.

Manpower/Institutional Development -- Identification of relevant agencies and of their manpower needs. Selection of candidates for training to be completed in approximately a year.

1993-1996 (Phase Two)

Research Activities -- Synthesis of data. Implementation of on-farm and grazing land studies. Analysis of marketing and policy interventions and of their impact on production.

Manpower/Institutional Development -- Training of students for advanced degrees. Course work completed early so that students can return to finish theses data collection during Phase Two.

1996-1999 (Phase Three)

Research Activities -- Validation and development of technical packages. Monitoring of the implementation of the recommended policy strategies.

Manpower/Institutional Development -- Academic training completed. Technical support and counsel to agencies and research institutions for the implementation of project recommendations.

PROJECT LOCATIONS

In addition to the general criteria for the selection of sites during the next phase of the SR-CRSP (Appendix 1), this component must be located in a site in which the national government is committed to developing and implementing policies which are based on the research results.

BUDGET PROJECTION

See Appendix 2, Schedule B.

COMPONENT 3:

FOCUSED SINGLE DISCIPLINE RESEARCH - ANIMAL HEALTH

PROBLEM STATEMENT

Surveys of mortality and morbidity rates at SR-CRSP work sites show that infectious diseases continue to be an important constraint to sheep and goat production. This finding is confirmed by other published surveys.

The limited economic value of individual sheep and goats, combined with the low income of the majority of small ruminant producers, limit the health care that these animals receive. For instance, frequent drug treatment of sheep and goats with available anthelmintics will prevent problems with internal parasites such as Haemonchus. However, large numbers of sheep and goat owners either cannot afford these drugs or do not have reliable access to them.

Current vaccines for goat diseases such as Brucella melitensis, are univalent, are usually produced locally, are variable in quality, and poorly distributed. If a minimum of five univalent vaccines are needed to control the major sheep or goat diseases, it is unlikely that they will be all available and affordable to the smallholders who produce the great majority of the world's small ruminants.

The SR-CRSP experience provides a cogent example of the problems inherent in the production and distribution of vaccines to sheep and goat producers. SR-CRSP and Kenyan research scientists developed a vaccine for contagious caprine pleuropneumonia. The vaccine is safe because of inactivation, easily stored because of lyophilization, efficacious because of the quality and duration of the immune response against challenge, and relatively easy and economical to produce.

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However, there has been no interest in the commercial production of the vaccine because its profit potential is too limited. Thus its production and distribution must be entrusted to public agencies, which typically have limited resources and many other priorities.

This, and similar experiences, lead to the conclusion that while infectious diseases are a severe constraint to small ruminant production, the development of univalent vaccines against them is not likely to be an effective strategy. The drugs and univalent vaccines which are used to control cattle diseases are not suitable approaches for sheep and goats because in most instances the value of individual small ruminants does not justify the cost of these interventions.

GOAL

To develop multivalent, virus vectored vaccines which will protect against the major pathogens of sheep and goats.

GENERAL APPROACH

Recombinant vaccinia virus vectors have been made that will induce immunity against multiple infectious diseases (Perkus et al. 1985) and there is no practical limitation on the amount of foreign DNA that can be inserted into the vaccinia virus genome (Mackett and Smith 1986).

The research to develop a multivalent virus vectored vaccine can be done by a program such as SR-CRSP because it has scientists already working with recombinant vaccinia viruses and isolating relevant genes from sheep and goat pathogens. After its initial development, the technology can be applied anywhere. The recombinant vaccine can be stored in a central location and reintroduced, if its use is interrupted.

Simultaneously, a market study can be conducted by SR-CRSP socioeconomists to determine current systems for the supply and distribution of animal health products. This will permit the development of a cost/benefit analysis of the proposed vaccines.

The technology needed to produce a virus vaccine exists in most countries. The same technology can be used to produce a recombinant vaccine, once the vaccine is constructed and tested. Since the production of a recombinant vaccine would be relatively inexpensive, its manufacture and distribution should interest the private sector because small ruminant producers should be willing and able to buy a single inexpensive vaccine which can solve several major infectious disease problems.

Currently, SR-CRSP scientists are defining the genes necessary for insertion into a virus vector that would induce protective immunity against CCPP and heartwater of goats and sheep, as well as pulmonary adenomatosis, progressive pneumonia, and bluetongue in sheep.

Suitable genes from caprine arthritis-encephalitis virus, pathogenic *E. coli*, *Clostridium perfringens*, foot rot-causing organisms, and *Haemonchus* are also being identified by the SR-CRSP. Other genes will be obtained as they become available, allowing the project to capitalize also on the efforts of other research programs.

An important spin-off of such vaccine-related research is the identification of genes and proteins that can be used in rapid diagnostic work and in health surveys of small ruminant flocks.

The vaccinia virus, however, is not currently a suitable vaccine vector for sheep and goats because of its potential to infect humans, especially those with immunosuppression caused by the human immunodeficiency virus. Research is in

progress to genetically alter the vaccinia virus to remove its pathogenic potential for humans, including those with immunosuppression.

A central objective of future SR-CRSP research is to develop and evaluate new vectors which present no threat to humans. Until a new or altered vaccinia vector is available, heterologous genes can be inserted into vaccinia and the recombinant viruses can be tested for immunizing potential under containment testing conditions.

OBJECTIVES

1. To develop an attenuated pox virus vector for sheep and goats that has no infectious potential for humans.
2. To insert the genes coding for proteins inducing protective immune responses to CCPP and heartwater into a pox virus vector.
3. To test the ability of the multivalent virus vectored vaccine to immunize goats and sheep against CCPP and heartwater.

   Recent SR-CRSP results show that CCPP also infects sheep; heartwater is a sheep and goat disease. The goal of the current SR-CRSP health project is to identify these genes. This will probably be done by 1990, in time for the project proposed. Having these genes will allow their insertion into the vaccinia virus and an early test of the vaccine. Success, even under contained conditions, would spur research to identify suitable genes for other diseases and to find an acceptable virus vector.

4. To insert the genes coding for proteins inducing protective immune responses to progressive pneumonia and bluetongue viruses into a pox virus vector.

   These genes are being identified by SR-CRSP scientists and should be available for initial evaluation by 1990.

5. To test the ability of the multivalent virus vectored vaccine to immunize sheep against progressive pneumonia and bluetongue viruses.

6. To complete the development of a multivalent virus vectored vaccine for goats by inserting genes coding for protective proteins of Brucella melitensis and other major pathogens.

   Genes for some of the diseases discussed in the previous section might be available sometime between 1991 and 1993. It is anticipated that SR-CRSP funding will be necessary for research on Brucella melitensis and Brucella ovis.

7. To complete the development of a multivalent virus vectored vaccine for sheep by inserting genes coding for protective proteins of Brucella ovis and other major pathogens.

8. Market study of input supply and distribution of animal health products.

9. Cost/benefit analysis of vaccines.

RESEARCH OUTPUTS

1. A multivalent, virus vectored vaccine against the major pathogens of goats.
2. A multivalent, virus vectored vaccine against the major pathogens of sheep.
3. Approximately 3 Ph.D. and 5 Masters degrees earned.

BUDGET PROJECTION

See Appendix 2, Schedule C.

COMPONENT 4:

CONTINUED RESEARCH AND SUPPORT ACTIVITIES

1. CONTINUATION OF CURRENT RESEARCH PROJECTS

The beginning of the second phase of the SR-CRSP coincides with the continuation of some of its research projects. While some projects can be continued under host country support, others require continued SR-CRSP funding. Among these are some projects which appear promising and which do not require additional basic research. Examples of such research projects are:

Development of Dual-Purpose Goats

Research with Kenyan farmers clearly shows that dual-purpose goats (DPG) have the potential for making a significant contribution to the nutritional and economic welfare of small rural households. Their milk-producing potential is the most important factor influencing their adoption by small farmers. DPGs can become a reliable source of high quality protein for farmers and can help reduce costly milk purchases.

The present herd of DPGs shows great promise. The genetic basis, however, is still narrow and the gene pool has to be managed with great care and supervision for several more years. During this period continuous evaluation of the performance of DPGs is highly warranted. Partial support for continuing this project might come from non-CRSP sources. The USAID mission in Kenya has expressed interest in sustaining the program for up to five years, but to secure such support, complementary SR-CRSP resources will be required.

Development of Production Systems for Sheep Under Rubber Trees

In Malaysia and Indonesia, the high potential for small ruminant production in conjunction with plantation crops has been well documented. Present research

activities are focused on the management of animals and forages under trees of various ages. Important research areas are:

- The long-term impact of grazing and of manure on tree growth and primary crop productivity.
- The screening of grasses for shade tolerance.
- The minimization of labor requirements in managing grazing flocks while maintaining their security.

Studies on the Genetics of Prolificacy in Sheep

The intensification of small livestock management systems has provided many smallholders with an opportunity to specialize in livestock and to derive a major part of their income from it. This is especially true for chickens and pigs. The productivity of such systems is limited primarily by the productive potential of the livestock.

Sheep and goat management systems are becoming increasingly intensive. By focusing on cut-and-carry systems for small ruminants, the SR-CRSP correctly anticipated emerging animal husbandry constraints in heavily populated areas of the Third World.

Research on prolificacy is now being conducted in anticipation of the further commercialization and intensification of small ruminant production. Prolific strains/breeds of sheep have been identified and characterized; this genetic pool will soon be ready for evaluation on these "farms of the future."

2. COLLABORATIVE RESEARCH AGREEMENTS

The SR-CRSP also needs to develop innovative methods for applying its knowledge and experience to new situations and in countries where it has not worked previously. It could do this by entering into collaborative or

consultative agreements with other institutions whereby the research partners would fund SR-CRSP personnel who would perform specific work for them.

One manner of doing this is to incorporate small ruminant components into USAID mission-funded projects. The INTSORMIL CRSP has used this approach quite successfully. It pays the salary and associated costs of a resident scientist and the USAID project pays for all of the local support. Under this arrangement, the CRSP scientist becomes part of a larger USAID project team, engaged in collaborative interdisciplinary research with other U.S. scientists as well as host country scientists.

The SR-CRSP might implement a similar model. First, it can locate proposed or already initiated USAID mission-funded projects which can benefit from a small ruminant component. Second, it can identify the institutional resources it can contribute. Third, it can point out to the project administrators the advantages of SR-CRSP participation in their projects and encourage the allocation of funds for its participation.

While a number of different strategies might be proposed to implement the cost sharing, the strategy of the SR-CRSP paying the salary of its scientist and the USAID project paying the local support costs, might be an acceptable arrangement. This would allow the SR-CRSP disciplinary components to operate in several countries within the framework of multidisciplinary collaborative ventures, at a very modest cost.

Another similar arrangement is to provide institutional support to USAID missions through the new Basic Ordering Agreements (BOA) now being instituted by USAID. A BOA is presently being available for the SR-CRSP. Under such an agreement, the SR-CRSP will provide research and field support services upon

request from individual missions, funding to be delivered by the requesting mission.

All of these arrangements allow USAID to call upon the entire resource base of the SR-CRSP to support particular overseas activities. Consultants outside the particular discipline represented in the country could easily be made available, and the entire framework of knowledge which has been accumulated from various production systems over the past ten years can be brought to bear on specific problems.

3. CONTINUATION OF SUPPORT FOR HOST COUNTRY COLLABORATORS

One of the important accomplishments of the SR-CRSP during the past decade was the development of extensive linkages between U.S. and host country scientists. This was accomplished both through the establishment of collaborative research projects as well as by the development of strong professional ties between U.S.-based academic advisors and their former students. Significant human and financial investments were made to create a pool of experienced host country researchers. The second phase of the SR-CRSP must capitalize on the promise and experience of these researchers.

Host country scientists operate in research environments which often lack sufficient resources to adequately support small ruminant research. This poses great difficulties, especially for the young, newly-trained researchers, who often must work in relative isolation from their colleagues while attempting to initiate and maintain research programs on small ruminants. It is difficult for these scientists to continue their professional development and research interests under such conditions.

It would be both prudent and fruitful to fund some of the research activities of these SR-CRSP collaborators and thus build upon the existing strong professional resources. While some of their research interests might be somewhat different from those of the SR-CRSP, their results are useful both to their country and to the scientific discipline.

Projects funded under a linkage component would seek to support current research which has already produced some results and which maximizes scientific contacts between researchers. Highest priority would be given to projects which are successful, whose premature termination would cause a loss of important results, and where a small investment of resources would allow the successful completion of the project.

A second, but also important objective of such funding is to stimulate the continued professional development of the host country scientists who have been involved with the SR-CRSP. Without some continued professional stimulation and support, the human resources developed by the SR-CRSP in the various host countries might become underutilized or misapplied.

Activities funded might range from host scientists spending sabbatical leaves in the U.S. to collaborative research projects in the host countries. Any activity which requires limited funding and which strengthens already established linkages, would be considered.

4. TRAINING

Development of human resources by degree training in the U.S. and elsewhere has been one of the most successful components of the SR-CRSP. It has resulted in significant contributions to the host countries as well as to U.S. institutions.

Three major reasons for including a well-funded training component in the second decade of the SR-CRSP are:

- Students benefit by having SR-CRSP researchers participate both administratively and technically in the supervision of their academic progress.
- The majority of the students have an opportunity to conduct their thesis research in their own country.
- Academic relationships between SR-CRSP researchers and students evolve into collaborative research relationships after the students' training. This provides them with an important source of technical support and advice while they begin to develop and conduct their own research programs.

5. THE SMALL RUMINANT SCIENCE NETWORK

SR-CRSP researchers as well as host country scientists have periodically had opportunities to meet colleagues from other countries during conferences and workshops, some of them co-sponsored by the SR-CRSP. Many of these contacts have occurred in a haphazard manner, without a systematic focus or long-term strategic purpose; there has been little follow-up to many of these activities.

Consequently, sheep and goat scientists in different countries are unable to keep abreast of technical developments. They do not benefit from the SR-CRSP activities, nor are they able to communicate their own experiences to colleagues from other countries.

One strategy for increasing scientific exchanges between small ruminant researchers in other countries and for enhancing their opportunities for research is to develop a Small Ruminant Science Network (SRSN). Networking has

proven to be an effective means for overcoming the professional isolation of researchers in different countries.

Such a global network can be based upon existing smaller networks or upon any other regional associations of small ruminant researchers. If feasible, the network can be developed in collaboration with other organizations having similar interests.

Network Objectives

The SRSN would have two major objectives:

1. To encourage small ruminant scientists to conduct research which seeks to solve sheep and goat production problems found in developing countries.
2. To develop regional networks of small ruminant scientists which can serve to stimulate interaction and provide peer review of research and teaching activities between researchers in the same region.

The regional networks should also serve to translate local research findings into relevant teaching materials and into inputs for agricultural policy decisions.

Each regional network should provide a forum for identifying the regional constraints to small ruminant production, for developing appropriate methodological strategies to conduct relevant research, for suggesting techniques to interpret research results, for disseminating new research findings, and for suggesting agricultural policies that promote livestock development.

BUDGET PROJECTION

See Appendix 2, Schedules D, E, F and G.

Training costs are integrated into the budget projections of components 1, 2 and 3 (Appendix 2, Schedules A, B and C).

APPENDIX 1

CRITERIA FOR RESEARCH SITE SELECTION

Based on the last decade of overseas research experience, it is suggested that future sites be selected in accordance with these criteria:

1. The site must have small ruminants.
2. The country must maintain friendly relations with the U.S. and must have a supportive USAID mission.
3. The site must have local institutions which are capable of providing scientific counterparts in most of the disciplines involved in the program and which have the potential for providing students for training.
4. The site must require only limited investment for its development.
5. The host country must be prepared to invest in the program.
6. The host country must agree to permit research by U.S. students.
7. The host country must agree to the presence of an expatriate site coordinator.
8. The site must have the potential of generating technology of regional applicability.

APPENDIX 2

Schedule A: Hair Sheep Production Systems Research

(All Amounts Expressed in Thousands)

Category	Phase I 1990/93	Phase II 1993/96	Phase III 1996/99	TOTAL
Scientists & Support Staff	$1,275	$1,339	$1,406	$4,020
Research Costs:				
Supplies & Expense	$321	$337	$354	$1,012
Equipment	$110	$115	$121	$346
Travel	$137	$143	$150	$430
Training	$266	$279	$293	$838
Site Development	$300	$0	$0	$300
Subtotal	$2,409	$2,213	$2,324	$6,946
Indirect Costs	$723	$664	$697	$2,084
TOTAL	$3,132	$2,877	$3,021	$9,030

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FN: TFSCHEDA

Schedule B: Sustainable Small Ruminant Production in Arid and Semi-Arid Regions

(All Amounts Expressed in Thousands)

Category	Phase I 1990/93	Phase II 1993/96	Phase III 1996/99	TOTAL
Scientists & Support Staff	$700	$735	$772	$2,207
Research Costs:				
Supplies & Expense	$205	$211	$222	$638
Equipment	$35	$37	$39	$111
Travel	$45	$47	$49	$141
Training	$266	$280	$294	$840
Site Development	$300	$0	$0	$300
Subtotal	$1,551	$1,310	$1,376	$4,237
Indirect Cost	$465	$393	$413	$1,271
TOTAL	$2,016	$1,703	$1,789	$5,508

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FN:TFSCHEDB

Schedule C: Focused Single Discipline Research - Animal Health

(All Amounts Expressed in Thousands)

Category	Phase I 1990/93	Phase II 1993/96	Phase III 1996/99	TOTAL
Scientists & Support Staff	$616	$638	$656	$1,910
Research Costs:				
Supplies & Expense	$486	$504	$518	$1,508
Equipment	$16	$17	$17	$50
Travel	$32	$34	$35	$101
Training	$65	$67	$69	$201
Site Development	$0	$0	$0	$0
Subtotal	$1,215	$1,260	$1,295	$3,770
Indirect Cost	$365	$378	$389	$1,132
TOTAL	$1,580	$1,638	$1,684	$4,902

Prepared: 9/26/88 jws
FN:TFSCHEDC

Schedules D, E, F and G

(Amounts Expressed in Thousands)

	Phase I 1990/93	Phase II 1993/96	Phase III 1996/99	TOTAL
[illegible] Current Research Projects:				
[illegible]	$375	$0	$0	$375
[illegible]	$375	$375	$200	$950
[illegible]	$300	$300	$100	$700
Subtotal	$1,050	$675	$300	$2,025
	$315	$203	$90	$608
Total	$1,365	$878	$390	$2,633
[illegible] agreements*	$250	$250	$250	$750
[illegible] cost [illegible]	750	$788	$788	$2,326
[illegible] Framework	$300	$300	$300	$900

* [illegible] from non-SR CRSP sources
[illegible] costs

Schedule H: Administration

(All Amounts Expressed in Thousands)

Category	Phase I 1990/93	Phase II 1993/96	Phase III 1996/99	TOTAL
Salaries & Wages	$425	$446	$446	$1,317
Staff Benefits	$165	$173	$173	$511
Total Salaries & Staff Benefits	$590	$619	$619	$1,828
Supplies & Expense	$400	$420	$420	$1,240
Equipment	$15	$16	$16	$47
Travel	$85	$89	$89	$264
Committees	$110	$116	$116	$341
EEP	$75	$79	$79	$233
Contingency	$100	$105	$105	$310
Subtotal	$1,375	$1,444	$1,444	$4,263
Indirect Costs	$413	$433	$433	$1,279
TOTAL	$1,788	$1,877	$1,877	$5,542

Prepared: 9/15/88 jws
FN:TFSCHEDG

SCHEDULE I - SUMMARY OF SR CRSP FUNDS

(All Amounts Expressed in Thousands)

Category	Phase I 1990/93	Phase II 1993/96	Phase III 1996/99	TOTAL
HAIR SHEEP PRODUCTION SYSTEMS	$3,132	$2,877	$3,021	$9,030
SUSTAIN. PROD.- ARID/SEMI ARID AREAS	$2,016	$1,703	$1,789	$5,508
ANIMAL HEALTH	$1,580	$1,638	$1,684	$4,902
PRESENT RESEARCH BASE	$1,365	$878	$390	$2,633
COLLABORATIVE RESEARCH ~~REQUIREMENTS~~	$250	$250	$250	$750
CONTINUING HOST COUNTRY SUPPORT	750	788	788	$2,326
SMALL RUMINANT SCIENCE NETWORK	$300	$300	$300	$900
Subtotal	$9,393	$8,434	$8,222	$26,049
ADMINISTRATION	$1,788	$1,877	$1,877	$5,542
TOTAL	$11,181	$10,311	$10,099	$31,591

FN:TFSUM
Prepared: 1/13/89 jws

SCHEDULE J - SUMMARY OF NON-SR CRSP FUNDS

(All Amounts Expressed in Thousands)

Category	Phase I 1990/93	Phase II 1993/96	Phase III 1996/99	TOTAL
RESEARCH RELATED ACTIVITIES				
DPG Program*	$1,500	$1,000	$0	$2,500
New Research (BOA's, etc.)	$250	$250	$250	$750
Total	$1,750	$1,250	$250	$3,250
MATCHING CONTRIBUTIONS - U.S. INST's	$3,208	$3,093	$3,029	$9,330
HOST COUNTRY CONTRIBUTIONS	$1,069	$1,031	$1,010	$3,110
TOTAL	$6,027	$5,374	$4,289	$15,690

* Possible USAID Mission Support

FN:TFSUMII
Prepared: 1/13/89 jws