Small Ruminant Collaborative Research Support Program

Request for Extension

1990 - 1995

University of California, Davis

UNIVERSITY OF CALIFORNIA, DAVIS

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SMALL RUMINANT
COLLABORATIVE RESEARCH SUPPORT PROGRAM
TEL (916) 752-1721
TWX 493 0495

DAVIS, CALIFORNIA 95616

June 30, 1989

TO: Joyce Turk

FROM: J. W. Oxley

On behalf of SR-CRSP, the Management Entity is pleased to submit six copies of the request for extension of Grant No. DAN 1328-G-SS-4093-00. Also, the following items are to accompany the proposal:

1. Letter to you relative to additional budget information.
2. Management Entity Response to the Report of the Administrative Review.
3. Summary of the ME's response to the 1986, 1987, and 1988 EEP Reports.
4. SR-CRSP Communications: 1978-1988.
5. SR-CRSP Training Information: 1978-1988.

Please let me know if you desire further information or copies of the above. We are indebted to Dr. Frank Byrnes for his assistance with the document and for personally delivering these six sets to you.

I plan to be away from the office for a needed rest from June 29 to July 7.

cc: Dr. Charles Lassiter
Dr. Peter Burfening

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June 28, 1989

Ms. Joyce Turk
USAID/S&T/AGR/AP
Room 420
Department of State
Washington, D.C. 20523

Dear Joyce:

Based upon our earlier discussions with you, we included on page 41 of our proposal for extension of the SR CRSP, the budgets approved by the Board each year for the current grant year, 1984/5 through 1989/90. In response to your request today for the budgets for the first grant period, 1978 through 1984, we have prepared the attached table. Our historical records do not include the budgets broken down by line item; therefore, it is not possible to submit the approved actual budgets by line item.

In 1987, when we received notification from USAID that the first grant, (USAID/DSAN/XII-G-0049) was officially closed, all historical data was purged. Similarly, the line item budgets for the current grant are considered as planning, working documents and only the program summary budgets approved by the board are retained as the official budgets. The budgets approved by the Board are included in this submission. I trust the official, approved budgets will meet USAID's needs for this proposal.

Sincerely,

James W. Oxley

James W. Oxley
Program Director

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APPROVED PROGRAM BUDGETS FOR SMALL RUMINANT CRSP

GRANT NO. AID/DSAN/XII-G-0049

Institution	Discipline	Year 1 10/78-5/80	Year 2 6/80-9/81	Year 3 10/81-9/82	Year 4 10/82-9/83	Year 5 10/83-9/84	Total
California	Breeding	$206,786.00	$266,666.00	$185,104.00	$220,000.00	$200,000.00	$1,078,556.00
California	Health	$196,145.00	$233,333.00	$175,000.00	$190,000.00	$175,000.00	$969,478.00
Cal Poly	Physiology	$60,000.00	$100,000.00	$97,761.00	$0.00	$0.00	$257,761.00
Colorado State	Health	$150,000.00	$233,333.00	$175,000.00	$190,000.00	$175,000.00	$923,333.00
Missouri	Sociology	$174,992.00	$253,333.00	$200,000.00	$275,000.00	$225,000.00	$1,128,325.00
Montana State	Breeding	$200,000.00	$200,000.00	$149,999.00	$165,000.00	$150,000.00	$864,999.00
North Carolina	Nutrition	$109,435.00	$266,666.00	$200,000.00	$295,000.00	$250,000.00	$1,121,101.00
Ohio State	Forages	$166,016.00	$233,000.00	$150,000.00	$0.00	$0.00	$549,016.00
Texas A&M	Breeding	$160,000.00	$212,800.00	$150,000.00	$240,000.00	$200,000.00 *	$962,800.00
Texas A&M	Systems	$184,000.00	$253,333.00	$200,000.00	$240,000.00	$150,000.00 *	$1,027,333.00
Texas Tech	Range	$200,000.00	$266,666.00	$200,000.00	$295,000.00	$250,000.00	$1,211,666.00
Tuskegee	Management	$104,000.00	$153,000.00	$115,000.00	$0.00	$0.00	$372,000.00
Utah State	Range	$196,081.00	$266,666.00	$200,000.00	$295,000.00	$200,000.00	$1,157,747.00
Utah State	Physiology	$99,800.00	$160,599.00	$124,000.00	$220,000.00	$200,000.00	$804,399.00
Washington	Health	$200,000.00	$233,333.00	$175,000.00	$190,000.00	$175,000.00	$973,333.00
Winrock Int'l	Economics	$175,000.00	$265,333.00	$200,000.00	$220,000.00	$153,000.00	$1,013,333.00
Winrock Int'l	Management	$100,000.00	$153,333.00	$215,000.00	$240,000.00	$200,000.00	$908,333.00
Subtotal:		$2,682,255.00	$3,751,394.00	$2,911,864.00	$3,275,000.00	$2,703,000.00	$15,323,513.00
Management Entity		$516,691.00	$468,154.00	$515,429.00	$435,000.00	$435,000.00	$2,370,274.00
Prolific Sheep Proposal		$0.00	$0.00	$0.00	$100,000.00	$0.00	$100,000.00
Contingency Funds		$0.00	$200,000.00	$200,000.00	$240,187.00	$522,000.00	$1,162,187.00
Site Development		$196,000.00	$0.00	$0.00	$0.00	$0.00	$196,000.00
Overseas Sites		$0.00	$50,000.00	$100,000.00	$100,000.00	$425,000.00	$675,000.00
Subtotal:		$712,691.00	$718,154.00	$815,429.00	$875,187.00	$1,382,000.00	$4,503,461.00
Total:		$3,394,946.00	$4,469,548.00	$3,727,293.00	$4,150,187.00	$4,085,000.00	$19,826,974.00

* Texas A&M in Brazil was changed from "Breeding" to "Management while Systems was not funded but Breeding of goats was funded.

FILENAME: C:\123\YR5DOWN\1-5BUD

CREATED BY: Lucia Lojewski (6/27/89)

Response to the Report of the Administrative Management Review of the Small Ruminant Collaborative Research Support Program

Management Entity
University of California, Davis
June 30, 1989

General Comments.

The report reflects thoughtful review of a considerable amount of data gathered in a very short time. The reviewers are to be commended for their observations and assessments and their helpful insights as we plan the extension of the SR-CRSP into the 1990s. While we are particularly appreciative for the recognition of SR-CRSP achievements over the past decade, we value the comments pointing out opportunities for improvement.

It is reassuring to note that several of the committee's recommendations confirm actions or decisions recently made or already in process; other recommendations warrant further study and consideration.

Response to Recommendations on Pages 45 and 46 of Document.

Recommendation 1. "...complete and adopt a 'strategic plan for 1990-2000' with revised objectives, logical framework, global plan, program priorities, and clearly delineated courses of actions with funding estimates to guide and support the CRSP during the proposed extension period, 1990-1995."

Response to Recommendation 1: The ME agrees and the global plan will be updated to reflect revised objectives, program priorities, and courses of actions with funding estimates set forth in the extension proposal that will be formally submitted to AID/W, June 30, 1989. Many of the concerns cited by the committee are addressed in the proposal. The final long range plan should comply with the committee's recommendation.

Recommendation 2. "The priority attention afforded research on hair sheep in the 'Strategic Plan' should be maintained."

Response to Recommendation 2. The ME is in a agreement and the extension proposal gives high priority to exploiting the potential of hair sheep in the humid tropics.

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Recommendation 3. "The Team recommends that CRSP and AID officials move to resolve outstanding issues and shortcomings within the spirit and framework of these CRSP documents." The documents referred to are BIFAD/AID CRSP Guidelines, the Grant Documents, and the SR-CRSP By-Laws.

Response to Recommendation 3. The ME agrees and will strive to resolve as many of the issues as possible with the appropriate personnel concerned.

Recommendation 4a and 4b. "UCD and AID officials should review:

a. The staffing of the office of the Management Entity to determine the numbers and kinds of personnel needed to carry out the responsibilities and duties of the Management Entity in a fully satisfactory manner.

b. The appropriateness and suitability of the present organizational location of the SR-CRSP within the structure of the university, with special regard to concern for securing the academic disciplinary location which would be most supportive of the scientific and technical work of the CRSP and professional stimulating and rewarding to the CRSP staff."

General Response. The findings of the Review Team, with regard to the ME (page 31, titled "Shortcomings in Governance") indicate mixed performance. The ME is highly rated with regard to administrative matters. Technical program matters are rated less than satisfactory. We believe the dichotomy results from a lack of understanding of the role of management in a collaborative research program. The function of the ME is to support and facilitate the programs of research. Collectively through the Technical Committee and individually, the principal investigators develop the program of research. The Board of Directors and the Administrative Council approve the research program. These entities determine the direction of the overall research effort. This structure is what fosters the collaborative nature of the program as the record of SR-CRSP accomplishments clearly demonstrates. The Director (ME) participates in the deliberations of the governing bodies but does not independently determine the program priorities. The Director (and ME) is responsible for the conformance of the program to the provisions of the grant.

With respect to technical program matters, the findings refer to "...several clearly undesirable situations/circumstances," but describes only one, the sociology program in Peru, which was acknowledged to have extenuating circumstances. The findings then go on to "add to the list of possible management shortcomings" the location of the ME offices within the organization structure of the University of California, Davis. Our response is discussed below. A final statement is made that the perceived shortcomings are in

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part due to the unsettled conditions regarding the director's position and possible program overload on the current Director. There is no explanation of the findings which underlie this statement. Nor is there sufficient evidence to justify a less than satisfactory rating.

Response to Recommendation 4a. This recommendation needs further study. Some adjustments have been made in staffing and it is appropriate to review the staffing of the ME, particularly since a new strategic plan will change the current patterns of activity within the ME. A review will be undertaken with the goal to have appropriate staffing in place for the new grant period.

Response to Recommendation 4b. The committee's recommendation reflects concern for support of scientific and technical work, and professional stimulating surroundings. However, placing the ME within a department in the College of Agricultural and Environmental Sciences or the School of Veterinary Medicine may or may not result in support of scientific and technical work, and professional stimulation. In every other respect such a move would work against the SR-CRSP. It would add another layer of bureaucracy to activities of the ME. It might place the SR-CRSP in competition with departmental and school/college priorities. Visibility of the program on and off the campus would diminish. The direct involvement and support of high level campus officials would be lessened. Such support is essential and has been forthcoming during the current grant. With the Dean of Graduate Studies and Research as the permanent member of the SR-CRSP Board, the highest level of the campus administration has been available. Recently the decision was made that the SR-CRSP grant will be administered under the new Vice Chancellor of Research--a powerful position in the cabinet of our Chief Campus Officer.

<u>Recommendation 5a and 5b</u>. "The ME and CRSP governing entities should consider:

a. Discontinuing formula budgeting/funding of CRSP programs and adopt a system of funding on the basis of well established program priorities.

b. Instituting budgeting and accounting procedures for projects within programs which fully document the uses of CRSP funds."

Response to Recommendation 5a. The SR-CRSP has recognized the weaknesses of the so-called formula funding and has been gradually moving away from it over the past two years. Should the program be approved for extension, it is appropriate to study the system that seems to meet best the needs of the program structure at that time.

Response to Recommendation 5b. The ME will give this

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recommendation further study in view of the fact that budgeting and accounting procedures have been working effectively and efficiently given the integrated disciplinary approach to each country's program. While it may be highly desirable to have as detailed accounting reports as possible, there is a considerable workload and cost factor that needs to be evaluated in relation to benefits.

Recommendation 6. "Delays in providing forward funding have been and continue to be a problem for the CRSP. AID officials should move to reduce funding characteristics by providing forward funds well in advance of expiration dates of current funding."

Response to Recommendation 6. As this has been a serious problems for the SR-CRSP, the ME applauds this recommendation.

Recommendation 7. "The ME should develop scopes of work for the EEP in accordance with the provisions of BIFAD/AID CRSP Guidelines to ensure comprehensive evaluations of the SR-CRSP."

Response to Recommendation 7. This is being done with the 1989 report.

Recommendation 8. "...the need exists for the CRSP to transmit its research results to non-technical audiences such as policy makers, assistance donors, and producers. CRSP officials, Principal Investigators, and collaborating Host Country officials should explore and pursue means to reach and influence these non-technical audiences."

Response to Recommendation 8. The ME agrees with this recommendation and a concerted effort will be made to find cost effective means to transmitting research results to potential users within the resources available.

Summary of 1986, 1987, and 1988 Recommendations of External Evaluation Panel for

Small Ruminant Collaborative Research Support Program Management Entity University of California, Davis

Introduction

The eight, ninth, and tenth reports (1986, 1987, and 1988) of the External Evaluation Panel (EEP) are available from the Management Entity (ME). A summary of the three follow with comments on recommendations relative to progress, implementation/ non-implementation and current status, particularly the 1988 recommendations which were formulated during late 1988 and presented to the ME in late January, 1989.

1986 Report

The major recommendations of the EEP and the ME responses are as follows:

a. **Development of the Kenya Technological Package for Dual Purpose Goats.** This was being organized with anticipated completion in two to three years.

b. **A project phase down and contingency planning.** This was not implemented because funding of the SR-CRSP continued.

c. **Development of Program Administrative Committees, referred to by the Future Directions Committee.** These were gradually being implemented in host countries and were gaining acceptance as their function and purpose becomes clear and the PIs and Co-PIs acquired experience with this new mode of operation.

d. **Strengthening SR-CRSP relationships with other international organizations through collaboration in research, and sponsoring workshops and conferences.** Examples of such collaboration were SR-CRSP cosponsoring the IV International Conference on Goats in Brazil and continued interaction of ILCA and SR-CRSP scientists in Kenya.

e. **Promotion of regionalization of projects.** This was not possible with the budgetary situation at that time.

f. **Implementation of the Future Directions Committee's recommendation to replace the Board of Institutional Representatives with a Board of Directors and the**

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Administrative Council as an alternative mode of operation. This was to be tried for one year and if proved successful would be continued.

g. **Program management.** A new director was hired and the concept of designating a lead PI for each country program proved useful.

1987 Report

The ME responded to the following recommendations reported in the 1987 report. The EEP found the responses useful in the preparation of the 1988 report.

a. **Status of Technological Packages.** Tech Pack development ranged from the first one completed on goat production in Brazil to planning and initiation of additional ones for Peru and Kenya. Funds were budgeted for support of four of the six packages with most to be completed in 1989.

b. **Revision of Logical Framework.** Revised during the year to cover period FY 10/87 to FY 10/90, the termination of the present grant.

c. **Measuring progress toward program goals.** Further accomplishments/achievements were documented by the PIs but there was need for additional examples. A section in the ten-year strategic plan is devoted to significant research results.

d. **Response to previous EEP recommendations for strengthening the SR-CRSP.** The Director used the 1987-89 report as an evaluation instrument and as a guide and for background information during the first ten months of his administration of the program.

e. **Implications of recent changes in by-laws.** Minor changes in the wording of the by-laws concerning the Board and Administrative Council were made to clarify the roles of each. The SR-CRSP continues under this mode of operation.

f. **Cooperation with field missions.** SR-CRSP personnel, including the Director, have kept USAID missions informed of program activities during each country visit. The Director has found the missions in Peru, Indonesia, and Bolivia supportive of the SR-CRSP. The Kenyan Mission plans to commit some resources to the continuation of the DPG project in the early 1990s. The Morocco Mission prefers to see the small ruminant program more involved

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with the Ministry of Agriculture as contrasted to Hassan II Institute of Agronomy and Veterinary Sciences.

g. **Publications, workshops, and reports.** The progress report "Communications: 1978-1987" was updated to show the types of publications and oral presentations for the past ten years. A workshop conducted by SR-CRSP Peruvian scientists and held in Spanish in Bolivia was the first attempt to regionalize SR-CRSP efforts. A series of papers covering the scientific, historical, and future perspectives of the SR-CRSP were presented at the 1988 meeting of the American Society of Animal Science by SR-CRSP PIs and co-PIs. The publications will receive worldwide distribution.

i. **The training component.** With the uncertainty of funding beyond September, 1990 and the prospective phase down of research activity in most countries, the decision was made to complete the training of those students currently supported by SR-CRSP funds. Only two new students were programmed for master's training. Eighteen Ph.D. and 17 Master's candidates were in training in the U.S. or overseas in 1988. A number of non-degree training activities were carried out under SR-CRSP sponsorship, cosponsorship at all sites.

j. **Phase down of SR-CRSP projects.** The 1987-88 annual reports reflected full activity at all sites but the 1988-89 and 1989-90 workplans were expected to show phase down planning unless additional resources are forthcoming after September 1990. Each PAC will be addressing these issues, followed by the Technical Committee action in light of the ten-year strategic plan.

l. **New direction for development assistance.** The ME appreciated the EEP's response to a draft of the Strategic Ten-Year Plan. Many of their comments were incorporated into the plan which addressed concerns of sustainable agriculture and the role of small ruminants, development of a Small Ruminant Science Network, and innovative ways to supplement research funding.

The ME responded to several specific recommendations on technical program matters in Indonesia, all positive and supportive of the program there.

1988 Report

Response to the Strategic Plan

The ME and TC, in the development of the 5-year extension

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proposal, emphasized the issue of agricultural sustainability and resource conservation. The research planned for the agropastoral and hair sheep components address these important concerns within the concept of SR-CRSP research for development purposes.

Responses to Program Evaluation

a. Kenya

The ME concurs with EEP's recommendation to maintain focus on the continued development of the dual-purpose goat and framing plans for large-scale multiplication and distribution. Ancillary research interests in selection for Haemonchus resistant animals and the evaluation of goat cheese must be kept as lower priority items with encouragement to seek extramural funding for these efforts.

Recently the ME, in consultation with the PIs from Winrock International and Texas A&M, addressed research priorities in Kenya and the matter of integrating the breeding and production systems projects. The five-year extension proposal includes these strategies and if funded, implementation plans call for continuing the dual-purpose goat project through phase down in 1990-1993. It is anticipated that USAID/Nairobi will provide local currency and possibly some dollars comparable to SR-CRSP funding. These contributions are predicated on a similar commitment from SR-CRSP, and all fund sources are needed to institutionalize the program and ensure continuation by the host country after 1993.

Many of the suggestions related to the Animal Health Component also have been addressed in the 5-year extension plan which outlines the construction of a multivalent, recombinant, virus-vectored vaccine for goats. To accomplish this, the genes for CCPP, CAEV, and heartwater will be inserted in vaccinia virus as described in the plan. These and other diseases of sheep and goats have received full attention in the proposal.

Also, the socioeconomic components will address social influences that impact on vaccine use and animal health management practices. Cost benefit analysis will be started in year 4 and completed in year 5 after field testing the vaccines.

During the development of the ten year strategic plan, the Kenyan scientists responded to many aspects of the plan and they have had similar opportunities to collaborate while the 5 year extension proposal was being prepared. An excellent interchange of program plans, and research strategies occurred at the annual PAC in Nairobi in February.

b. Morocco

The 5 year proposal presents a three year phase down plan for

continuing research on prolific sheep. This work remains unfinished and shows much promise and will be continued through 1990-93. Plans call for inclusion of nutritional and socioeconomic factors in addition to the breeding component.

c. Indonesia

The 5 year extension proposal includes as one of its priorities a hair sheep production component and continuation of the prolific sheep studies as well as the study of small ruminant tree crop plantation systems. These activities are tentatively targeted for Indonesia, the preferred choice to continue research there. The plans calls for an agrostology input and the integration of these research projects.

d. Peru

The ME concurs with the EEP recommendations and notes that most of these items were addressed in the 1988-89 work plans. Many of the publications completed and underway do have appeal to the user, given the limited and ineffective extension organization in Peru. At least the PIs and their counterparts are getting their results translated into Spanish. With the completion of the Tech Packs in late 1989, information gained through the Community Project and allied disciplinary projects will be in a form designed for the practitioner. At least two workshops are being planned, one for Northern Peru and one in Ecuador. Drs. Burfening and Florez visited Ecuador in April to develop plans for a regional workshop in that country, presented by the Peruvians, later in the year.

As the SR-CRSP phases out its major research effort in Peru and phases into a linkage status by April, 1990, it becomes necessary to strengthen the small ruminant section of INIAA. Dr. Florez, with the support of the ME, is working closely with INIAA personnel, the co-PIs and their institutions, and the USAID mission to prepare INIAA for their future role as the liaison organization for the SR-CRSP in Peru.

In response to the recommendation to establish priorities for all projects in Peru, plans and the time frame for the fifteen months of activity left in Peru have been carefully and cooperatively developed by the PIs, co-PIs and the site coordinator. The Technical Committee endorsed the recommendations of the Peru group and the Board of Directors approved an orderly phaseout of the program at the Dallas meeting on January 25, 1989. The details of the discussions leading to these actions appear in the Technical Committee Minutes which were forwarded to Joyce Turk in preparation for the Triennial Review.

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Small Ruminant Collaborative
Research Support Program

June 1989

Highlights of Accomplishments and Dividends

Mounting world population in developing countries makes small ruminants, particularly sheep and goats, more important to rural families, the people who constitute the bulk of the poor majority.

About 52% of the world's more than one billion sheep, and 94% of the world's half billion goats, are in the developing countries. These animals annually provide about 4.4 million metric tons of meat and 10.6 metric tons of milk. By 1990, the world will need 30 to 40 million more sheep to satisfy rising demands for meat.

The growing dependence of rural people on small ruminants led the United States Agency for International Development (USAID) in 1978 to launch the Small Ruminants Collaborative Research Support Program (SR-CRSP). This program seeks to improve meat, milk, and fiber production from sheep, goats, and alpacas, and thus increase food supplies and raise incomes of smallholders in developing countries. The program also works to enhance research and training capacities of foreign and U.S. agricultural institutions.

USAID launched the program with a Title XII grant of $41,540,000 over a 13-year period ending in September 1990. To date, participating U.S. institutions have matched 37% of the USAID funds. When these funds are combined with resources provided by host countries with which the U.S. institutions collaborate, the matching funds represent 95% of those USAID provided.

Currently, the program operates with 10 U.S. institutions (9 universities and a private voluntary agency) in collaboration with institutions in Kenya, Indonesia, Morocco, and Peru, although Brazil earlier participated actively in the program.

Advances in Technology. Productivity of small ruminants depend upon genetic potential, nutrition, health, management, and other factors. Research has produced results such as these:

- A dual-purpose goat (DPG) developed in Kenya for milk and meat has increased food yield from goats by 66%. Each DPG generates an average of US$52 additional income per hectare annually. Potential benefits from use of these goats in the humid and subhumid zones of Kenya amount to $2.5 million annually.

- A highly prolific strain of Javanese Thin Tail sheep developed in Indonesia averages 2.8 lambs per litter, nearly double the average in West Java. This means a potential annual increase in sheep produced in this province of 1.5 million, adding $18 million per year to farmer incomes.

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- Scientists demonstrated that replacement of 10% of Morocco's 10 million ewes with crosses of the D'Man breed of sheep would generate $5 million per year in additional income to producers.

- Supplementation of diets with minerals and a low fiber feed improved growth and reproduction of Javanese Thin Tail sheep in Indonesia. Improved practices in use of green legume foliage led to weight gains of 120% and to increases in feed efficiency of 80%.

- The program developed in Kenya a highly effective vaccine against contagious caprine pleuropneumonia, an epidemic disease that affects at least 48,000,000 goats in Africa and Asia. If not treated, 80% of infected goats die. This new vaccine is safe, easily stored, and economical to produce.

Knowledge of Producers and Users. Information and insight gained in socioeconomic studies will help scientists and specialists make future research and extension programs more relevant and acceptable to producers. For example:

- Rural women in many countries play significant and often primary roles in the care, feeding, and management of small ruminants as well as in making major consumption and distribution decisions about them.

- The dominant proportion of livestock produced by highland peasant communities in Peru is raised in agropastoral communities, not almost exclusively by pastoral communities, as previously believed. These Peruvians value livestock most for the dung they produce (for fertilizer) than for meat, fiber, or cash value.

- The roles of various family members in crop and livestock farming systems in Peru, Kenya, Indonesia, and Brazil differ with respect to age and gender.

Increased Institutional Capacities. Developing country universities and research stations are able to plan and execute more effective research and training programs.

- **Training:** More than 300 individuals from 28 countries have completed university training in fields related to small ruminant research, about 20% being women. More than 1,000 host country participants attended some 20 short-term training sessions.

- **Publications:** SR-CRSP has produced nearly 2,000 technical publications. Another series of papers, summarizing current management recommendations based on research, are being published in English and the host country language.

- **Infrastructure:** Development of facilities and laboratory

support for infectious disease research and diagnostic activities in collaborating countries.

Benefits to the United States. Many dividends have accrued to U.S. agriculture and institutions because of SR-CRSP activities and findings.

To Agriculture:

- Adaptability of production and management of cultivated forages of the United States (orchard grass, timothy, rye grass, red and white clover, alfalfa).

- New methods for diagnosis of sheep diseases will lead to new vaccines for control of important diseases of sheep in the United States.

- Methods were developed to control spread of caprine arthritis encephalitis (CAE) virus infection more prevalent in dairy goats of the developed countries (including the United States) than in indigenous goats of the developing world.

- Four U.S. institutions currently use sheep and goat simulation models developed. These models, now being linked to models of forage dynamics and diet selection, will help the sheep industry produce and market products with greater consumer preference.

- A three-state dairy goat cooperative was established. It now effectively organizes the sale of breeding animals for export and has stimulated economic analysis of goat marketing in the United States.

To U.S. Universities:

- Through participation in SR-CRSP, staff and students at many universities gain knowledge, develop new interests, and work abroad.

- New subfields of research have been defined, e.g., ethnoveterinary.

- Presence of SR-CRSP supported students has led to increased teaching budgets and expanded research programs with improved laboratories and equipment.

- Some institutions have emerged as worldwide leaders in small ruminants, range livestock management, sheep and goat disease, and animal nutrition.

- Staff, students, and the public have been exposed to breeds and types of animals that normally would not have been available, e.g., hair sheep.

U.S. Agency for International Development

STAR

Office of Agriculture Bureau for Science & Technology

SCIENCE & TECHNOLOGY AGRICULTURAL REPORTER

Sharing Small Ruminant Knowledge in Andean Highlands

by Dr. James Oxley, University of California at Davis

"Walking bank accounts" could be a name for an estimated 2,500,000 alpacas, 14,500,000 sheep, 800,000 llamas, and 1,750,000 goats owned by Peruvians. These animals are also important to the economies of Bolivia, Ecuador, and Chili, while sheep and goats are significant to the well-being of Venezuela and Colombia.

Such small ruminants are the backbone of the highland agricultural system and are vital to its sustainability. They provide farmers in the Andean highlands with meat, milk, fiber, fertilizer and hides. Alpacas and llamas are primarily used for their fiber and as a means of transportation. They have the ability to survive on non-competitive feed resources that have few alternative uses. These animals can then become a source of high-quality protein especially in the diets of Peruvians.

An interdisciplinary program was initiated in 1979 with A.I.D. funding, under the Small Ruminant Collaborative Research Support Program (SR-CRSP), matched by resources from several U.S. universities. Why Peru? Peru was interested in collaborating in a research effort aimed at improving the productivity of sheep and alpaca in the highlands. Peru is representative ativeativeativeof the Central Andean agriculture and a country from which research results could be applied to other countries in the region.

Studies have shown that llamas and sheep complement each others' grazing habits, while alpacas tend to compete directly with them under certain range conditions. Animal health research is focused on the following concerns: chronic respiratory diseases in sheep; contagious lung tumor (ovine pulmonary carcinoma), which is responsible for severe losses; a viral disease in goats known as caprine arthritis encephalitis; and a bacterial disease called clostridium perfringens Type A (CPA), which causes neo-natal mortality in alpacas. The SR-CRSP scientists can now identify these diseases and are working towards developing tests for carrier animals, with the ultimate goal of

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developing vaccines where appropriate.

Of the approximately 85 Peruvians trained in the U.S. and Pe under the SR-CRSP many are now collaborating scientists and continue to conduct interdisciplinary research in the animal and social sciences.

Peruvian scientists and their U.S counterparts are developing "technological packages (teck-packs)" tha summarize the research results. The also publish recommendations in Spanish for implementation by exte sion agencies and educational institu tions. The ultimate beneficiaries of the "tech packs" are farmers and pas toralists who have limited resources with which to deal with their produc tion programs.

Peruvian animal scientists recen ly shared their discoveries at a series of seminars in Lima and Arequipa, Peru with over 150 attendees (approximately 100 in Lima, and 50 at Arequipa). Another 150 attended sessions in La Paz, Bolivia. The sem nar in Bolivia was the first time an SR-CRSP international symposium extended knowledge gained in Peru to another country with similar cond tions, limitations, and production problems.

Most of the attendees were shee and goat producers. Peruvian and Bolivian agricultural organizations and the SR-CRSP sponsored the mee ings. The speakers covered a wide range of topics including nutrition, breeding, and reproduction in sheep and alpaca; range management and improved forages; diseases and heal management; and social socio-economic aspects of production.

The Peruvian outreach program is a model for other countries where small ruminant scientists work. Currently, research programs are also located in Morocco, Kenya and Indonesia. Eventually, a network of small ruminant scientists will be linked together around the world. ★

In the Andean highlands of Peru, alpa and llamas are often produced along sheep and cattle, with the former gair importance as the altitutde increas Alpaca are kept primarily because of value of their fiber. White and light-fa colors often fetch higher prices at international mark

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FRONT LINES
THE AGENCY FOR INTERNATIONAL DEVELOPMENT
MARCH 1989

KENYAN COUPLE MULTIPLY ASSETS THROUGH AGENCY CRSP

In early 1977, then 27-year-old Luke Odhiambo lost his job as a porter for East African Airways (EAA) in Nairobi, Kenya. He could find no other employment in the city and was forced to return to the town of Masumbi in his ancestral homeland, the Siaya District.

At first, Odhiambo took up peddling and well-digging to earn the cash he was used to having when he was employed by EAA, but these ventures were not very successful. Then in 1984, he was one of several farmers in the area randomly selected to participate in the farming systems research project of USAID's Small Ruminant Collaborative Research Support Program (SR-CRSP). He was given two does to raise on his tiny one-half hectare farm.

Odhiambo saw the potential in goat-herding and took better care of his goats than did neighboring farmers in the program. The goats, fed entirely on forages and crop residues, soon multiplied. They yielded an average of one-half kilogram of milk each per day, almost twice the yield of other local does. By 1986, the milk produced was more than Odhiambo's family could consume, and he began selling the excess to fellow villagers. Through additional earnings from the sale of surplus adult goats and some of the offspring, he rented a plot for cultivation, purchased household items and food, paid debts and entertained visitors.

Farming and fishing are the two most common occupations in the Siaya District. In fact, on the horizon and within sight of Odhiambo's small farm is Lake Victoria, Africa's largest freshwater lake.

Yet, Luke Odhiambo never thought of fishing as a business until he had a conversation about the commercial possibilities of fishing with his father-in-law. In 1987, he sold five goats and, after purchasing necessities, had 850 Kenyan shillings to invest. He remembered that conversation and invested the extra money in setting up his wife, Mary, as a fishmonger.

At 36, Mary Odhiambo has a new and demanding role that holds a lot of promise. She travels to Usenge beach on Lake Victoria every week to purchase fish and then markets the merchandise in her home town of Masumbi, netting about 200 to 300 Kenyan shillings from each trip. Mary Odhiambo has invested some of her profits in women's cooperative saving schemes. She is currently a member of two savings societies whose members are mainly fishmongers.

Although household, food-raising and social responsibilities take precedence over her business routine, through the farming systems research project, the SR-CRSP has indirectly transformed Mary Odhiambo into an entrepreneur. Now Luke has gained a business partner, and Mary has much more than just Lake Victoria on her horizon.

For more information on the SR-CRSP, call Joyce Turk in S&T/AGR at (703)875-4081.

—Patterson Semenye, resident scientist of the SR-CRSP in Kenya

Small Ruminant Collaborative Research Support Program

REQUEST FOR EXTENSION

Prepared and Submitted by the
Management Entity
Small Ruminant CRSP
University of California
Davis, CA 95616

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EXECUTIVE SUMMARY

This document presents the rationale for support of a 5-year extension of the Small Ruminant Collaborative Research Support Program (SR-CRSP). It reviews accomplishments of the first decade, sets forth the programmatic lessons learned, outlines the benefits to U.S. institutions and agriculture, describes major research and development thrusts that will build upon and extend work underway, and discusses amounts of effort and achievement projected under three levels of financial support by the United States Agency for International Development (USAID).

Background. The SR-CRSP was initiated in 1978 with support from a Title XII grant of $41,540,000 over a 13-year period and with participating U.S. institutions providing a matching equivalent of 37% of the funds coming from USAID. When these funds are combined with those provided by the host countries, the matching funds represent 95% of those coming from USAID.

Initially, 12 U.S. universities, a private voluntary agency (PVO), and 5 host countries developed joint efforts on sheep, goats, and camelids (chiefly alpaca). Changes over time led to a reduction in number of participating universities and overseas work sites, as well as research program adjustments.

Currently, the program continues with nine U.S. universities, the PVO, and four developing countries (Kenya, Indonesia, Morocco, and Peru). Funding is obligated through April 1990 and authorized for expenditure through September 1990, the completion date of Phase I.

This proposal takes into account program achievements, changing country conditions, reductions in USAID resources, and a research agenda for the 1990s prepared in a 1988 strategic planning conference. The primary goal of SR-CRSP is to improve meat, milk, and fiber production from small ruminants (sheep, goats, and alpacas) and thus increase the food supply for and raise the incomes of smallholders who constitute the bulk of the poor majority in developing countries. A major objective of the program is to strengthen the small ruminant research capacity of overseas and U.S. agricultural institutions.

Major Accomplishments. Section II presents highlights of major project accomplishments, some with immediate practical application, others with potential long-term benefits and representing significant contributions to scientists' knowledge and understanding of processes and problems related to small ruminants.

Immediate benefits (developments and findings) include: the dual-purpose goat (Kenya); ability of D'Man sheep to transmit high prolificacy additively (Morocco); identification of high prolific sheep (Indonesia); response of Javanese Thin Tail sheep to

supplementation of diets with minerals plus a low fiber feed (Indonesia), a new vaccine, applicable worldwide, against a contagious disease of goats (Kenya); increased forage production under trees by thinning tree canopies (Brazil); and differences in grazing behaviors of sheep and llamas as contrasted with that of alpacas (Peru). Application of the results of the first three developments mentioned above would increase the annual incomes of farmers in the three countries by an estimated total of U.S. $25,000,000.

Results with long-term implications for research, development, and production of small ruminants include: enhanced knowledge of the primary and multiple roles of women and other family members in small ruminant production and management; establishment of modern laboratories for research on diseases and associated vaccines; identification of sheep breeds with propensity for multiple births; sustainable systems for managing goats and sheep under tree crops; improved grazing land management and forage utilization; discovery of resistances to diseases and parasites; and greater knowledge of reproduction problems and their treatment.

Other SR-CRSP accomplishments include the advanced degree training of some 300 individuals, 80% from developing countries, and more than 1,000 host country participants in short-term courses. Information from SR-CRSP-related activities was made available in more than 1,900 publications and 210 presentations. By the end of Phase 1, SR-CRSP will have published for each host country, in its language and in English, a report on research-based technologies that have been evaluated for social, economic, and technical feasibility. These summaries of management recommendations will be available for countries to distribute to local extension personnel who work with smallholder producers.

Lessons Learned. The many programmatic lessons learned in operation of SR-CRSP include these:

- Solution of small ruminant production problems requires knowledge of the total production system or context.
- Success depends upon commitment through participation of host country scientists and administrators.
- Close interaction of biological and social scientists in carrying out cultural aspects of technical research is extremely important.
- Complex, interdisciplinary projects require continuity in scientific and administrative staffing.
- Mutual and clear understanding among all parties with respect to extension activities is necessary.

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- Research efficiency and effectiveness depend upon the collaborative structure and level of funding.

- Continuing communication among all parties is critical to success of collaborative efforts.

Benefits to U.S. This project has contributed directly and indirectly to both U.S. universities and agriculture in numerous and significant ways.

Contributions and benefits to participating universities are reflected in such ways as: increased involvement in international activities; availability of courses with enhanced relevance for foreign students; development of subfields in university disciplines and increased interdisciplinary interaction; expansion of on-campus small ruminant research facilities; stimulation of faculty to seek research grants and foreign activities; and emergence of institutions in worldwide research leadership roles.

Directly related to the contributions to universities are the benefits to U.S. agriculture. The list is long, but some highlights are:

- Increased knowledge and understanding of sheep production on range lands, and the impact of sheep on cool season plants at high U.S. elevations; adaptability of production and management of cultivated forages of the United States; techniques for rapidly screening root growth and elongation; test for identifying immune response of the bacterium that causes caseous lymphadenitis, a worldwide disease of sheep and goats, and numerous other developments in animal health having direct application to the U.S. livestock industry.

- The sheep and goat simulation models are being used by U.S. scientists and the sheep industry, and work is in progress to link these models with forage dynamics and diet selection models. These models will help assess critical issues confronting the livestock industry and provide direction to producing products with greater consumer preference.

- Work with dairy goats has led to development of a producer cooperative, which, in turn, has been active in organizing breeding animals for export and stimulating research and economic analysis of goat marketing in the United States.

Projected Activities. SR-CRSP activities in the extension period will be concentrated in six high priority areas:

- Completion of two promising research and development

projects currently underway:

- -- Finishing the development and integration of dual-purpose goats into farming systems in Kenya.
- -- Research and development of more prolific sheep, particularly in Morocco and Indonesia.

- o Continuing and expanding research in three project areas:
  - -- Development of hair sheep production systems
  - -- Development of sustainable agropastoral systems for producing small ruminants on marginal and fragile lands.
  - -- Development of animal health management systems through use of biotechnology.
- o Development and application of more knowledge and understanding of the role of women in small ruminant management.
- o Continuation of training of small ruminant professionals in academic programs and shortcourses.
- o Development of the small ruminant science network for information exchange and collaborative efforts.
- o Development of links with international agricultural research centers and other CRSPs.

The role of women, training, networking, and linkage details are presented in Section III, while comprehensive discussions of the small ruminant research areas are in Section V.

Proposed Research. The proposed research activities, as described in detail in Section V, are summarized briefly here.

Dual Purpose Goats. The present Kenya dual purpose goat (DPG) herd, developed under this project, shows great promise for producing both milk and meat. Further development and spread of the DPG to farmers will depend upon broadening the genetic base and managing the gene pool for several years. Three primary traits require genetic selection and stabilization: growth, milk, and adaptability. Concurrently, DPG performance will be monitored. The 3-year goal of the project is an established farming systems unit, a nucleus herd of about 1,000 does and 75 bucks, release of 500 does and 1,000 bucks to farmers, and a sustained DPG multiplication unit.

Prolific Sheep. SR-CRSP has identified and characterized

prolific strains and breeds of sheep in Morocco and Indonesia, and scientists have determined the mode of prolificacy inheritance. In Morocco, the D'Man breed has a mean litter size approximately double that of several other Moroccan breeds. In Indonesia, ewes with exceptionally higher prolificacy throughout their lifetime occur in most if not all strains. The next step is to exploit this knowledge for the benefit of producers and to evaluate the germplasm in intensive farming systems.

While breeding programs in the two countries will differ, work in both countries will include development of new feeding strategies, giving more attention to the critical reproductive phases of the ewe and early growth phases of lambs. Research will focus on late pregnancy and early lactation phases to prevent abortion and lamb mortality, two common problems. Efficiency of growth and fattening of weaned lambs will be another research component. Improving prolificacy leads to increases in the number of lambs to be fattened and a higher demand for feed. Studies will be based mainly on locally available byproducts such as beet, citrus, and carob pulps; molasses, wheat bran, and sunflower and palm oil meals.

Hair Sheep Production Systems. Widely distributed in the tropics, hair sheep are important sources of income and food for small farmers. Little has been done to develop and exploit their potential. Phenotypic and genetic variations exist among types of hair sheep; these can be used to develop more suitable animals for warm, humid areas.

SR-CRSP has preliminary evaluations of hair sheep in Brazil and Kenya, and after introducing them to Indonesia, currently is evaluating them there. Methods used in Kenya in developing the dual purpose goat will be applicable directly to working with hair sheep.

Of special interest in Malaysia and Indonesia is the high potential for small ruminant production of grazing animals under plantation tree crops, particularly rubber. Research will focus on management of animals and forages under trees of various ages. Effects on the crops and the animals will be studied, as well as labor requirements in managing flocks so grazed.

Sustainable Agropastoral Systems for Marginal Lands. The goal is to develop comprehensive strategic interventions for the development of grazing and livestock management systems on marginal and fragile lands. Such systems would optimize offtake consistent with sustainable ruminant livestock production and contribute to the equitable economic and social well being of all participants. While most of the world's small ruminants are produced in agropastoral systems on such lands, research has not defined suitable management strategies or how such might be implemented.

The proposed research will attempt to define climate-centered management strategies. Whereas data-gathering methods will differ only slightly from those SR-CRSP has employed in previous grazing studies, the research design and the analysis of data will be in the light of a new approach to range ecology and management.

Animal Health Management through Biotechnology. Infectious diseases continue as a significant constraint to sheep and goat production. Few farmers in the developing world vaccinate their animals because of the difficulties of obtaining local supplies of reliable, economical univalent (single disease) vaccines. SR-CRSP will mount an interdisciplinary approach to develop multivalent vaccines and for applying these vaccines. If such were available, small ruminant producers could treat, at one time and at low cost, several of the most important infectious diseases that affect small ruminants.

This work will draw upon SR-CRSP experience in Kenya in developing a univalent vaccine, as well upon the established technology for construction of recombinant vaccinia virus vaccines that will induce immunity against multiple infectious diseases. The technology needed to produce conventional virus vaccines exists in most developing countries. This technology can be used to produce a recombinant vaccine, once SR-CRSP constructs and tests it.

Related Program Activities. In addition to the biological research described above, SR-CRSP will engage in the four other research and research-related activities described below.

Women in Development. Given the varied and significant roles women play in small ruminant production and management, SR-CRSP will expand its work in this area, not as a separate project, but as an integrated part of all SR-CRSP activities. In so doing, SR-CRSP scientists are building a model of "biosocial roles in crop/livestock development" to provide direction and focus to its efforts to document and analyze the diverse roles all actors play. The model will be field-tested and refined at SR-CRSP work sites; information obtained will be used to "fine-tune" new research and to ensure results will be more relevant to and acceptable to small ruminant producers, particularly women.

Training and Professional Development. Training will continue, both in academic programs and through workshops, in field days and shortcourses for extension workers and farmers, and in other ways. The overall volume of training, particularly for advanced degrees, will depend upon budget and availability of eligible candidates. This proposal provides for 31 advanced degrees.

Small Ruminant Science Network. Activities will be initiated to support formation and operation of a network or networks.

Networking has proven to be an effective means for overcoming the professional isolation of scientists and providing for continued professional growth and development.

It is proposed that SR-CRSP fund a network secretariat, a newsletter, office supplies, annual workshops, travel for workshop participation or other professional development experiences, and some research awards.

Collaboration with IARCs and Other CRSPs. Established working relations will be continued with IRRI, ILCA and CIP, while the potential for collaboration in the agropastoral program will be explored with ICRISAT and ICARDA. Of particular interest is the research on pigeon peas, pasture legumes utilization, and use of barley and wheat stubble for sheep.

Similarly, SR-CRSP will continue its collaboration with the TropSoils CRSP in Indonesia and expects to develop working relations with other CRSPs on the use of crop residues for animal feed from groundnuts (Peanut CRSP), from beans (Bean/Cowpea CRSP), and from cereals (Sorghum/Millet CRSP).

Cost Proposals. Budget information for three levels of funding is set forth in Section IV and is summarized here, as follows:

- Plan A presents an incremental funding scenario in which a 5% increase is planned for year 2 and an additional 28.9% in year 3.

- Plan B presents a 5% annual compounding formula that allows for some growth, particularly after year 3 when two of the continuing research efforts will be completed and terminated.

- Plan C, a level-funding scenario, will not permit growth or keep pace with inflation.

Plan A would allow for expansion in training and networks, extension of research activities to additional sites, and increase the probability of short-term economic payoff for smallholders through integration of research results into host country outreach programs. Plan A offers the best opportunity to maintain the global perspective of SR-CRSP, to meet research goals, to reach a desirable training level, and to embrace collaboration with and among IARCs and other CRSPs.

Details for Plans A, B, and C are presented in Annexes A, B, and C, respectively. Other annexes, D through L, provide background on other aspects of SR-CRSP as indicated in the table of contents.

GLOSSARY

AARD	Agency for Agricultural Research and Development (Indonesia).
ACIAR	Australian Centre for International Agricultural Research.
ADAM	Asociacion de Artesiania y Moda (Bolivia); Association of Handicrafts and Fashion.
AFSRN	Asia Farming Systems Research Network.
ANCO	Asociacion Nacional de Criadores de Ovinos; National Sheep Breeders Association (Ecuador).
BIFAD	Board of International Food and Agricultural Development.
Booroola	A gene associated with prolificacy in sheep; it results in a large increase in ovulation rate and in litter size. The name comes from the merino sheep stud in Australia where it was discovered.
BPP	Balai Penelitian Perkebunan; Research Institute for Rubber Plantations (Indonesia).
BPT	Balai Penelitian Ternak; Research Institute for Animal Production (Indonesia).
Caatinga	A low scrubby forest with thorny legumes. It occurs on shallow soils, often underlaid by hardpan at 50-60 cm (Brazil).
Camelids	Llamas and alpacas.
CIP	Centro Internacional de la Papa; International Potato Center.
CONCYTEC	Consejo Nacional de Ciencia y Technologia; National Council of Science and Technology (Peru).
Coppice	Tree growth originating mainly from stumps, shoots, or root suckers.
DPG	Dual purpose goat.

Ecological Zone	A geographical boundary irrespective of political boundaries, representing common climate, ecology, soils, and other natural features for growing crops, raising animals, or engaging in aquaculture.
FAO	Food and Agriculture Organization of the United Nations.
Global Plan	The overall plan of a CRSP for research on problems and constraints, global in nature, the results which are applicable and transferable regionally and globally (worldwide).
Host Country	A developing country in which a CRSP has formal activities.
IAEC	International Atomic Energy Commission.
IAV	Institute Agonomique et Veterinaire; Institute of Agronomy and Veterinary Sciences (Morocco).
ICARDA	International Center for Agricultural Research in the Dry Areas.
ICRAF	International Council for Research on Argoforestry.
ICRISAT	International Crops Research Institute for Semi-Arid Tropics.
IDRC	International Development Research Centre (Canada).
ILRAD	International Laboratory for Research on Animal Diseases.
INIAA	Instituto Nacional de Investigacion Agraria y Agroindustrial; National Institute of Agricultural and Agroindustry Research (Peru).
IPAL	Integrated Project for Arid Lands.
IRRI	International Rice Research Institute.
JCARD	Joint Committee on Agricultural Research and Development.
KARI	Kenya Agricultural Research Institute.

Matching Requirement	That sum of resources, financial or in-kind, that participating U.S. institutions collectively contribute to a CRSP program as defined in the grant document.
ME	Management Entity of SR-CRSP.
Medics	Leguminous herbs of the genus Medicago, e.g., alfalfa.
NARES	National Agricultural Research and Extension Systems.
OICD	Office of International Cooperation and Development (USDA).
PANESA	Pasture Network for Eastern and Southern Africa.
PSTC	Program in Science and Technology Cooperation, a USAID-funded activity that provides research grants to foreign nationals and U.S. citizens.
PVO	Private Voluntary Organization.
SR-CRSP	Small Ruminant Collaborative Research Support Program.
SRSN	Small Ruminant Science Network.
Title XII	The section, "Famine Prevention and Freedom from Hunger" of the International Development and Food Assistance Act of 1975, and as amended.
Triennial Review	A formal review by USAID of a CRSP with joint participation of JCARD/BIFAD, which takes place every third year and is used as a basis for roll-forward authorization and funding.
USAID	United States Agency for International Development.
USDA	United States Department of Agriculture.

I. INTRODUCTION

The Small Ruminant Collaborative Research Support Program (SR-CRSP) was established in 1978 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 providing meat, milk, hides, fiber, and fertilizer to a large percentage of the world's population, especially the rural poor. 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 in 1980 to about 1,160,000,000 in 1987 according to the Food and Agriculture Organization (FAO); about 53% of these animals were in developing countries. During the same period, the number of goats increased from 465,000,000 to 503,000,000; about 94% of these were in developing countries [annex D].

In 1986, sheep worldwide produced 6,200,000 MT of meat, 8,600,000 MT of milk, 3,000,000 MT of grease wool, and 1,200,000 MT of sheepskins. During the same year, goats yielded 2,100,000 MT of meat, 7,700,000 MT of milk, and 405,196 MT of goatskins. About 44% of the world's mutton, 57% of its sheep milk, 30% of its wool, and 46% of its sheepskins were produced in developing countries. About 78% of the world's goat meat, 74% of goat milk, and 94% of the goatskins were produced in these countries [annex D].

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 4,400,000 MT of meat and 10,600,000 MT of milk to people in the developing countries. In aggregate this production signifies an immense, valuable, and critical contribution because it provides animal protein to people who have limited access to this important nutrient. Nevertheless, FAO estimates that by 1990 the world demand for meat will <u>exceed</u> production by approximately 600,000 MT, equivalent to the production from 30 to 40 million sheep and goats. The urgency for action is obvious.

The importance of small ruminants does not reside principally in their large numbers. Other characteristics of these animals make them extremely beneficial to producers, especially to the poor smallholders who constitute the great majority of the producers in developing countries. These "family animals" provide labor for children and elders, and income for women who are often the owners of the livestock and decision makers in the enterprise. Many producers use their animals as a reserve cash source, relying on them for quick cash or barter value when needed. Among other

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characteristics is the ability of small ruminants to survive on noncompetitive feed resources and in fragile arid lands. Small ruminants have a high rate of productivity based on the efficient utilization of low quality fibrous feeds for which there are few other uses.

In addition, small ruminant production is often an integral component of agropastoral production systems with livestock intrinsically linked to crop production. Often, the animals represent the primary source of capital investments in crop production and thus serve to subsidize and stabilize the crop sector.

Close integration between small ruminant and crop production in many parts of the world requires that efforts at preserving natural resource bases or at developing sustainable agricultural systems consider the important roles of small ruminants. In many places sustainable crop production systems cannot succeed unless they are integrated with sustainable small ruminant production systems.

In addition to providing fertilizer, these animals also are a desirable alternative to tillage as a means of producing food from marginal areas. Properly managed, they can help preserve desirable types of vegetation as a means of reducing soil erosion and fire hazards. In their roles as gleaners and scavengers, small ruminants reduce the need for use of chemicals (herbicides). They also provide high quality edible nutrients in concentrated form for humans; these complement the foods obtained from crops.

A. The Small Ruminant CRSP

1. Background and Status

SR-CRSP was initiated in 1978 with support from a Title XII grant of $41,540,000 projected over a 13-year period and with participating U.S. institutions providing $15,559,000, a matching equivalent estimated at 37% of the funds provided by the U.S. Agency for International Development (USAID). Host country contributions for the same period are estimated to be $23,857,000 (Table 1).

SR-CRSP developed as a joint effort among USAID, 12 U.S. universities, Winrock International Institute for Agricultural Development, and governmental agencies in 5 host countries. Through the years, changes in research activities have resulted in the reduction of programs and the number of universities and overseas sites. Today, 10 U.S. (9 universities and Winrock International) and 4 overseas institutions are involved in SR-CRSP research. Brazil's program has moved into a linkage status in which scientist-to-scientist contact continues, but only limited resources are committed to the program (Table 2). (Figure 1)

Table 1. Financial Support for the Small Ruminant Collaborative Research Support Program FY 1978 - FY 1990

Name of CRSP and Year	AID Contribution	University Matching	Host Country Contribution	Total
Small Ruminants				
1978	$ 356,000.00	$ 250,000.00	$ 0.00	$ 606,000.00
1979	2,026,000.00	938,000.00	400,000.00	3,364,000.00
1980	4,491,000.00	1,740,000.00	600,000.00	6,831,000.00
1981	4,054,000.00	1,498,000.00	825,000.00	6,377,000.00
1982	4,040,000.00	1,393,000.00	825,000.00	6,258,000.00
1983	4,140,000.00	1,576,000.00	1,445,000.00	7,161,000.00
1984	4,085,000.00	1,408,000.00	1,500,000.00	6,993,000.00
1985	3,515,000.00	1,399,900.00	3,821,878.00	8,735,878.00
1986	3,631,000.00	1,369,000.00	4,052,238.00	9,052,238.00
1987	2,702,000.00	1,043,000.00	4,321,507.00	8,066,507.00
1988	2,700,000.00	970,000.00	2,066,417.00	5,736,417.00
1989*	2,800,000.00	975,000.00	2,000,000.00	5,775,000.00
1990*	3,000,000.00	1,000,000.00	2,000,000.00	6,000,000.00
TOTAL	$41,540,000.00	$15,559,000.00	$23,857,040.00	$80,956,040.00

*Projections based upon data available at the time this table was prepared.

Table 2. SR-CRSP Collaborating Institutions.

Overseas Collaborators:

BRAZIL--Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA) [Linkage Status]

INDONESIA--Agency for Agricultural Research and Development (AARD)

KENYA--Kenya Agricultural Research Institute (KARI)

MOROCCO--Institute Agronomique et Veterinaire, Hassan II University (IAV)

PERU--Instituto Nacional de Investigacion Agraria y Agroindustrial (INIAA)

U.S. Institutions:

Institutions	Research Discipline
University of California, Davis	Breeding and Genetics
Colorado State University, Ft. Collins	Animal Health
University of Missouri, Columbia	Rural Sociology
Montana State University, Bozeman	Breeding and Genetics
North Carolina State University, Raleigh	Animal Nutrition
Texas A&M University, College Station	Animal Breeding, Systems Analysis
Texas Tech University, Lubbock	Range Management
Utah State University, Logan	Range Management
Washington State University, Pullman	Animal Health
Winrock International Institute for Agricultural Development, Morrilton, Arkansas	Agricultural Economics, Production Systems

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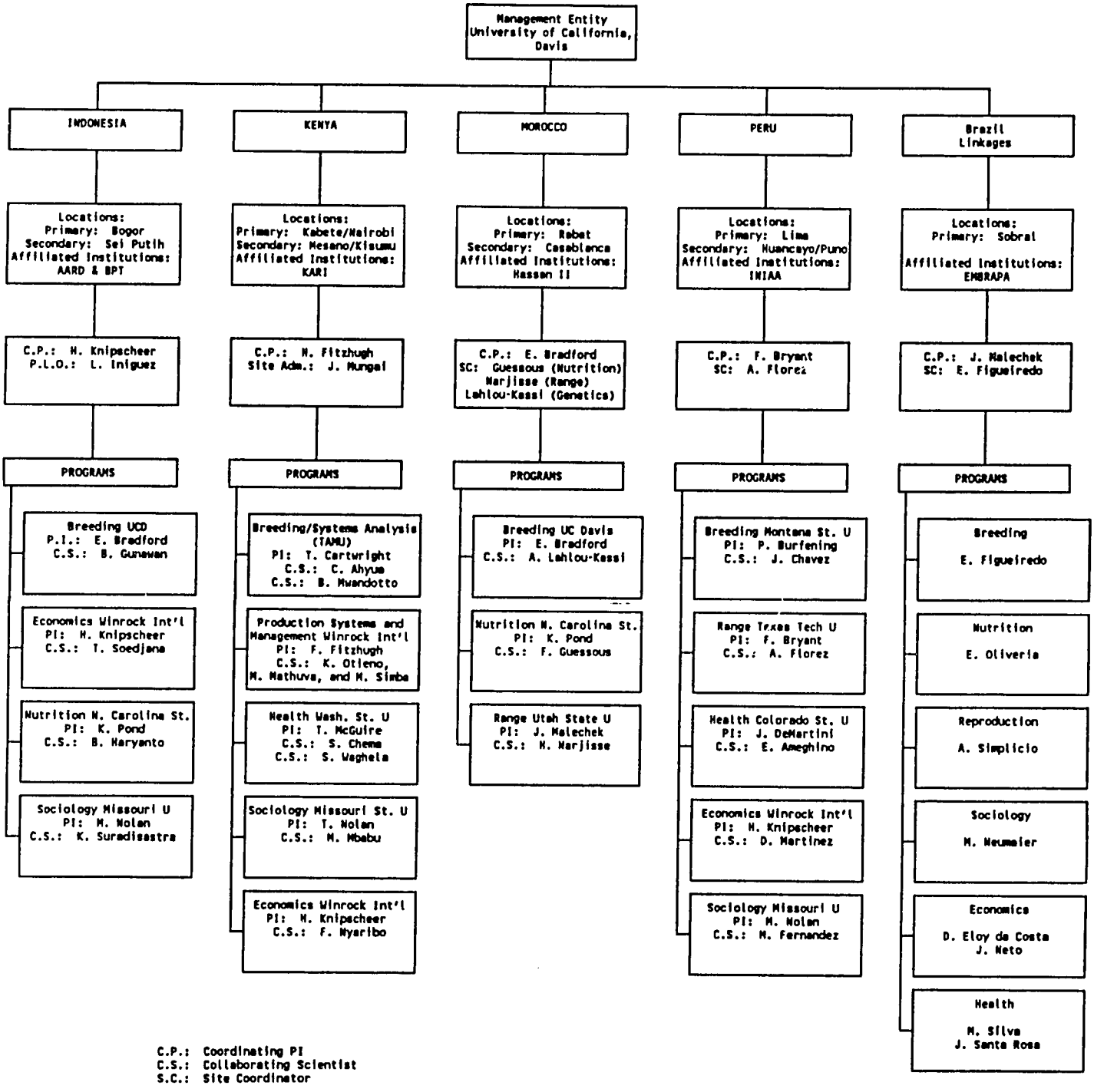

Figure 1. SR-CRSP current work sites and programs.

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The program is administered as a grant to the University of California, Davis, which, acting as the management entity (ME), maintains fiscal accountability and makes subgrants to U.S. participating institutions. Funding is obligated through April, 1990, and authorized through September, 1990--the completion date for the first phase of SR-CRSP. [See annex E for further details on SR-CRSP organization and management.]

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 programs, in Indonesia and Peru, have been in place for 9 years. The life span of these programs has permitted their 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 focused on the collaborative nature of work with host country scientists, supporting the priorities they identified, and emphasizing CRSP's role as a research program. The U.S. participating institutions have concentrated on research and training. The goals have been to develop self-sustaining host country research programs and to help people to help themselves. To that end, much SR-CRSP research has been on small farms, and in places where new ideas could be tested, adapted, altered, and implemented to benefit small producers who depend on sheep, goats, or camelids for their well being or survival.

Since the early 1980s, SR-CRSP has attracted substantial funds to complement its ongoing program. Such support has benefited research, workshops, special studies, and training. Donor organizations included International Development Research Centre (IDRC), Rockefeller Foundation, Australian Center for International Agricultural Research (ACIAR), International Atomic Energy Commission (IAEC), Food and Agricultural Organization (FAO), Integrated Project for Arid Lands (IPAL), Pasture Network for Eastern and Southern Africa (PANESA), International Council for Research on Agroforestry (ICRAF), Office of International Cooperation and Development (OICD), and United State Department of Agriculture (USDA).

Private organizations, such as the Association of Handicrafts and Fashion (ADAM) in Bolivia and National Council of Science and Technology (CONCYTEC) in Peru, cofunded a workshop for sheep and alpaca producers and researchers. The National Association of Sheep Breeders (ANCO) plans to assist with similar workshops in Ecuador later in the year. USAID missions in Kenya, Indonesia, Peru, and Bolivia have provided supplementary funding of specific SR-CRSP activities. Moreover, U.S. participating institutions have funded equipment, training stipends, and travel grants above and beyond their matching contributions.

SR-CRSP consistently has exceeded its minimum matching requirement of 25%. Amounts averaging 37% of those supplied by USAID illustrate the tangible commitment of the U.S. participating institutions (table 1).

2. Program Organization and Management

SR-CRSP activities are organized and managed to encourage and facilitate multidisciplinary research on specific projects at designated worksites. This stimulates cooperation among scientists of different disciplines in U.S. participating institutions, and also collaboration between them and host country scientists.

Each U.S. participating institution has a specific research area, e.g., nutrition, forage, and feeding, for which it is responsible in all research programs where such a research component is relevant and needed. Thus, an institution may be involved in all or some research programs underway at any given time.

Program coordination within a research program is achieved through a coordinating principal investigator (PI), a staff member of one of the participating institutions. The coordinating PI, in turn, works with the principal investigator for each research component.

Within host countries, research is conducted at one or more research sites in collaboration with one or more local institutions. There is a local collaborating scientist for each research component and also an individual who serves as site coordinator, although the terminology may vary by country.

3. Financial Management

The total funds authorized by USAID are allocated to each of the research programs, host country research and administrative operations, and the ME, including administrative subunits, e.g., Technical Committee, Board of Directors, Administrative Council, External Evaluation Panel, Workshops and Conferences, etc. The allocations are based on annual work plans and budgets that are reviewed by the Technical Committee and approved by the board.

Subgrants/subcontracts are issued annually by the ME to the participating institutions. The subgrants/subcontracts include the standard provisions of the grant document issued by USAID as well as the detailed budgets totalling the amount approved by the board for that program and institution.

The subgrant/subcontract institutions manage and control funds allocated to them in accord with USAID and SR-CRSP regulations. Participating institutions report expenditures periodically, usually monthly, to the ME. UCD maintains separate accounts for

each institution.

Each host country submits an annual budget for in-country administrative and research activities that complement the participating institutions' projects. Host country expenses are local currency expenditures. Each site has an administrative person who monitors local expenditures and submits monthly reports. The host country administrator is responsible for assuring that the expenditure complies with USAID regulations and SR-CRSP policies. The host country operates from a cash advance from the ME and(or) the participating institutions.

B. Global Plan and 1990-1999 Strategic Plan

In 1979, the management entity, with suggestions from the Technical Committee and Board of Directors, developed a global plan for SR-CRSP. Brief and sharply focused, the plan provided the criteria and framework within which the program has functioned. It included key concepts such as collaborative work, quality of research, support for country priorities, identification of constraints, global ecosystems, multidisciplinary programs, smallholder focus, and institution building. [See annex F for summary of global plan.]

Revised in 1985 and 1987, the plan has served SR-CRSP well through the 1980s. With large reductions in agency resources in the late 1980s, the program reduced the number of overseas sites project activities, and volume of training. As a result, the program in Brazil changed to linkage status in which scientist-to-scientist contacts were maintained but operational funds curtailed. In Morocco, the program was limited to fewer disciplines and the administrative expenses reduced. In mid-1988, terrorist activity in Peru resulted in termination of field studies; this limits the potential for continuation of collaborative research.

Given these circumstances, the scheduled program and management review in early 1989, and the grant expiration on September 30, 1990, the board, acting on behalf of the Administrative Council, directed that a Strategic Planning Conference be held in early 1988 to prepare a research agenda for the 1990s. The outcome of the conference, and subsequently, the efforts of a task force, was to develop a strategic plan for SR-CRSP for 1990 to 2000. Used as an internal working document, the plan served as the basis for developing this 5-year extension proposal. It also will be used to revise and modify the global plan now scheduled for redrafting in late 1989. The plan will address strategies for continuing research, expanded research thrusts that build on previous experience and knowledge, networking concepts and implementation plans, and priority designation for future research activities.

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C. Goals, Constraints, Priorities, and Research Area Needs

The primary goal of SR-CRSP is to improve meat, milk, and fiber production from sheep, alpacas, and goats, to increase the food supply for, and to raise the income of smallholders who constitute the bulk of the poor majority. The objectives are to gain more knowledge, a better understanding, and increase the efficiency and sustainability of subsistence-level small ruminant production systems, as well as to strengthen the research capacity of overseas and U.S. agricultural institutions.

Individual projects were designed to help alleviate some of the major problems that severely reduce small ruminant productivity in the developing countries.

Early in the program, problem areas were identified. Small ruminant scientists worldwide long have agreed that the major constraint to improving production is inadequate feed supply throughout the year. The problems of infectious diseases and parasitism likewise limit production. Both limited nutrition and disease problems reduce reproductive performance of male and female animals, and reduce the number of animals available for milk, meat, and fiber production, and sales. These factors contribute to the high cost of small ruminant production.

A summary of the problem and research areas are summarized briefly as follows:

Problem Area	Research Area
Inadequate year-round feed supply	Nutrition, forage, and feeding
Improper grazing practices	Range management
Disease and parasitism	Animal health
Poor reproductive performance	Research on reproduction in male and female animals
Non-selective breeding	Genetic improvement of local breeds and crossbreeds
Poor utilization of available resources	Management
Production unit constraints and policy issues	Socioeconomic research
Lack of coordinated and integrated improvement efforts	Systems research

This summary presents a number of interrelated problems for which viable operational solutions depend, in most cases, on an integrated approach to research. Such an approach involves

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studying a specific problem or issue in the context in which the animals are produced. In so doing, the scientists take into account the effect of other variables (problem areas) on the specific variable (problem) under study.

Given the general practice in which smallholders integrate sheep and goats into their basic, but sometimes rather complex, production systems, SR-CRSP scientists find it difficult, and perhaps sometimes not productive, to develop and adhere to rigid priorities and/or subject disciplinary areas. This, in turn, leads to strong interdisciplinary interaction between and among biological and social scientists. The research projects presented in this proposal illustrate these principles. Two of the projects will concentrate on issues necessary to make the results more relevant and available to producers, while the others will give priority to completion of research already in progress.

II. MAJOR ACCOMPLISHMENTS

A. RESEARCH

The SR-CRSP has conducted research for almost 9 years. In each of the five host countries, the program has supported concurrently numerous research efforts. 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 scientists of various disciplines. All research has been oriented to development, not research for the sake of research.

Equally important has been the collaborative emphasis between SR-CRSP and host country scientists. In each project, they jointly planned, implemented, and evaluated the research. Much of the success of SR-CRSP can be attributed directly to the participation of host country scientists, including many trained in the program.

Numerous projects required long-term (5-10 years) research agendas before yielding results. Some projects only now are beginning to provide answers. Data from other projects became the basis for ensuing research and for long-term potential benefits and for contributing to the body of knowledge. Some projects of shorter duration already have provided information of direct practical use to producers.

1. Results

Examples of results with immediate practical applicability have included:

a. Development in Kenya of a composite breed dual-purpose goat for milk and meat production in higher potential farming areas. Though another 3 years are needed to fix the breed genetically, the work has combined successfully into a single stock two locally adapted meat breeds and two imported dairy breeds. The introduction of dual-purpose goats and of improved forage production practices has resulted in a 66% increase in food yield from goats for smallholder families. Each DPG generates an average of US$52 additional income per hectare. Assuming that only about 10% of the humid and subhumid zone (Zone II) in Kenya would be available for food crops and fallow, the potential annual benefits to farmers would amount to $2,500,000.

b. Development of a high prolific strain of Javanese Thin Tail sheep in Indonesia. This strain yields an average litter size of 2.8 lambs/litter, nearly double the average litter size in West Java. For the 3 million sheep being kept in this province, this means an average increase in sheep production of 1.5 million sheep per year, adding $18,000,000 per year to

the revenues of sheep farmers.

c. Demonstration 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 accord with requirements of management and feeding systems. If 10% of Morocco's 10,000,000 ewes were replaced with D'Man crosses, this would generate an estimated US$5,000,000 in additional gross annual income to producers.

d. Development of a new vaccine against contagious caprine pleuropneumonia (CCPP) in Kenya. This epidemic disease affects at least 48,000,000 goats in Africa and Asia and, if untreated, has a mortality rate greater than 80% The vaccine is safe, easily stored, economical to produce, and highly efficacious. If this vaccine were available widely, it would prevent an average of 82 annual local outbreaks involving an estimated 300,000 goats in Kenya alone.

e. Demonstration in Indonesia that supplementation of tropical grasses improved growth and reproduction of Javanese Thin Tail sheep and growth of Kacang goats. The supplementation consisted of a complete mineral mixture plus a low fiber feed, practices that village farmers could supply at low cost. Adoption of improved practices for the use of green legume foliage led to weight gain increases of 120% and to increases in feed efficiency of 80%.

f. Demonstration that forage production and goat nutrition in Brazil's semi-arid forest regions was enhanced through vegetal manipulation. Thinning tree canopies resulted in significantly more production of forage biomass beneath the trees. A partial clearing of the canopy was just as effective as complete clearing. Increases of up to 600% in herbaceous vegetation on the ground were obtained by totally clearing the tree canopy.

g. Identification of the competitive and interactive grazing behavior of sheep, alpacas, and llamas on Peruvian highland ranges. Alpacas, having the most opportunistic feeding strategy, compete directly with llamas and sheep when range conditions vary; llamas and sheep can be grazed together, while alpacas are best managed alone. Moreover, research demonstrated that properly used, cultivated forages could boost animal production by 15 to 20%.

h. 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 important for the United

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States, where about 80% of dairy goats are affected. The control of this disease represents a US$20,000,000 savings for goat producers worldwide.

i. Identification of nutritional myopathy among sheep. In Morocco it was determined that this condition, previously unrecognized in the region, resulted from a dietary deficiency in selenium. Methods for correcting the deficiency previously developed in the United States were tested and found completely effective in Morocco.

j. Finding that the dominant proportion of the livestock produced by highland peasant communities in Peru is raised in agropastoral communities, not almost exclusively by pastoral communities, as previously thought. This finding will change the course of agricultural development strategies in the poorest Andean countries. The research also established that livestock in highland Peruvian agropastoral communities are valued most for the dung they provide (for use as fertilizer) rather than for their meat, fiber, or cash value.

k. Developed a grazing scheme for sheep under rubber trees in Sumatra that has reduced weed infestation as well as the use and cost of herbicides by 50%. Research is underway to test the possible uses of processed rubber seeds, an overlooked and potential source of energy, as a supplement for sheep.

l. Demonstrated that rural women in many countries play significant and often primary roles in the care, feeding, and management of small ruminants as well as in making major consumption and distribution decisions.

m. Trained in degree programs, through 1988, some 308 individuals, 240 from 28 developing countries, the balance from the United States. Of those trained, 63 were women, two-thirds of them from developing countries.

Examples of the results with long-term potential benefits and contributions to body of knowledge have included:

a. Development of facilities and laboratory support for infectious disease research and diagnostic activities in Brazil, Peru, and Kenya.

b. Development of a test in Brazil for identifying immune response to the bacterium that causes caseous lymphadenitis, a worldwide disease of sheep and goats.[1]* The test then was used to help assess the immune response of goats vaccinated

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* Superscript numbers refer to literature citations contained in annex L.

with an experimental toxoid vaccine, first experimentally and then later in naturally infected herds in Brazil.[2] It also was demonstrated that transmission of internal parasites occurred primarily in the latter part of the wet season and the early part of the dry season.[3]

c. Demonstration that caprine arthritis-encephalitis (CAE) virus infection was more prevalent in dairy goats of developed countries than in indigenous goats of developing countries.[4] Further studies on the epidemiology of CAE virus infection by SR-CRSP scientists in the United States and Kenya have resulted in methods to control spread of the virus. Results from the eradication program indicate that CAE virus-free herds can be established.

d. Identification of an ovine pulmonary carcinoma (OPC) virus-specific antigen in Peru that will be useful in isolating the causative virus, in developing a serological test for carrier animals, and eventually in developing a vaccine. This disease is responsible for severe losses of adult sheep in Peru.

e. Development of the capacity to induce rapidly experimental OPC as well as ovine progressive pneumonia (OPP) in neonatal lambs and have characterized the resulting lesions and immune responses.[5,6,7] OPP, caused by an ovine lentivirus, also was present with OPC.[8] This capacity will facilitate research leading to elimination of these diseases.

f. Demonstration that the high incidence of neonatal mortality in alpaca in Peru was related to Clostridium perfringens type A (CPA), enterotoxigenic Escherichia coli (EEC), and an increased susceptibility to infectious diseases because of failure of passive transfer of the maternal antibody.[9] To improve the methods for diagnosis and prevention of CPA, an enterotoxin produced by the bacterium was purified using monoclonal antibodies, characterized its in vitro and in vivo pathogenicity and developed an ELISA assay to detect its presence.[10]

g. Definition of the roles of the various family members in crop livestock farming systems. SR-CRSP social scientists in Peru, Kenya, Indonesia, and Brazil have identified and clarified further the age and gender responsibilities of household members.

h. Demonstration that the use of caatinga** forest in the Sertáo

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** A caatinga forest is a low scrubby forest with a high proportion of thorny legumes. It occurs on shallow soils, these often being underlaid by a hardpan at 50-60 cm.

region of northeast Brazil for both animal and wood production, could be an economically effective and sustainable enterprise. By selectively harvesting certain species, ages, and growth forms of trees (rather than wholesale clearing), commercially valuable trees could be left in the stand to reach the size and age of maximum economic value with virtually no reduction, and perhaps even an increase, in forage potential for small ruminants.

i. Discovery that caatinga forest in Brazil has a rapid speed of recovery and high potential sustainability. Virtually all trees and shrubs in this ecosystem possess the capacity for regenerating from dormant buds in the stump after cutting the adult plant. Further, seedlings of the important forage and timber species "sabia" were increased greatly. If protected from grazing for one growing season, sabia becomes well established in the forest plant community.

j. Learning that the major nutritional constraint in Brazil was digestible energy from mid-September through December. Dietary protein was adequate to only marginally deficient. The energy deficit was resolved partly by thinning areas within the forest, thereby promoting growth of the forbs and new coppice shoots arising from the stump.

k. Establishment of the importance of several native tree and shrub species as valuable forage plants for sheep and goats in Brazil. For example, sabia produces a nutritious foliage that animals prefer either as green browse or as dry leaf litter. Research established the potential importance of coppice in the year-round forage balance for sheep and goats, and introduced the possibility of "coppice management" as a new principle in small ruminant production systems worldwide.

l. Learning that farmers in northeast Brazil use goats mainly as "living bank account" and more of a form of drought insurance than as a market commodity. Goats, contrasted with cattle and sheep, provide a reasonably dependable animal resource that contributes to both economic stability and persistence in an inherently variable and unpredictable environment. Money invested in goats will not depreciate with inflation, and goats require little maintenance expense. Goats, with high probability of surviving the extended droughts that often grip the Sertáo region, can be used as an economic base to restock properties with cattle and sheep, the preferred animal species.

m. Assessment of indigenous and introduced small ruminants in terms of their ecological impacts, nutritional constraints and efficiencies, and proper stocking rates and animal mixes under range conditions in Peru.

n. Demonstration that camelids are better adapted to the ecosystem than sheep in Peru, yet sheep are the dominant herbivore raised by peasants and on social cooperatives. Overgrazing, primarily by sheep, has led to severe deterioration in the productivity of these grazing lands. Research also has shown that rotational grazing systems are important in the recovery of these lands and vegetation.

o. Development of strong and extensive cooperative working relationships between United States and host country scientists through collaborative research and professor-graduate student ties. Many of these bonds will continue into the next decade, maintaining a network of collaborators and "contributing alumni" to ongoing and future activities.

p. Demonstration in the early generations of the composite dual purpose goat population in Kenya that some individual animals display more resistance/tolerance to the common stomach worm, Haemonchus contortus, a worldwide problem in both sheep and goats.

q. SR-CRSP cohosted a world conference on sheep genetics and reproduction and published a new, comprehensive reference book, titled Genetics of Reproduction in Sheep, with contributions from 50 scientists from 17 countries.

r. Development and validation of computer simulation models for small ruminants that can have wide application in the United States and abroad. Social scientists also have designed a model for communicating SR-CRSP project results.

s. Demonstration that productive culling procedures to Morocco farmers to improve the size and quality of their flocks. Improving the method of mating management through establishing mating schedules has resulted, in some cases doubling production in poor-producing flocks.

t. Development of a successful pilot outreach program for smallholders in Indonesia. A total of 100 farmers form a network to follow recommended methods for improved sheep production. The demand already is great for SR-CRSP improved hair sheep. Presently, not enough sheep can be produced for the farmers who want them.

u. Movement of SR-CRSP scientists into major positions of research, education, or government, e.g., a SR-CRSP trained scientist working in Peru was appointed the Dean of Veterinary Science at the National Veterinary Institute.

v. Documentation of nutritional constraints during mid to late dry seasons on high elevation Andean grasslands, and determination of approaches to alleviate these problems.

2. Publications

Many of the program's substantive results have been documented in technical reports, journal articles, books, abstracts, and verbal presentations. A substantial number have been translated into the principal language of the host country. During the past 10 years, more than 1,900 publications and 210 presentations were prepared.[11] Publications were of the following types and numbers:

Books and chapters in books	86
Refereed journal articles published or in press	334
Journal articles submitted for review	117
Technical reports, bulletins and proceedings	811
Abstracts of papers presented at meetings	585

Through listing in the Department of Commerce Bibliography, the availability of these publications is distributed worldwide.

By September 1990, SR-CRSP will have published for each host country, in its language and English, a report of research-based technologies that have been evaluated for social, economic, and technical feasibility [annex G]. A prime example is the recent publication, in the Indonesian language, of management recommendations for small ruminants. These publications, in the form of "technical packages" summarizing current management recommendations, will be distributed to local extension personnel. They, in turn, will disseminate 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 dissemination envisioned by project planners at the beginning of SR-CRSP.

B. TRAINING

One of the most successful activities of 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 largely to host country personnel and, to some extent, United States students. This training ranged from simple technical non-degree instruction to advanced degree programs.

It is important to note that practically all training related to small ruminants has sufficient breadth and depth to qualify graduates to work with larger animals and in many other agricultural fields. While they concentrate on problems of small ruminants, most of the methods, principles, and concepts learned are transferable or adaptable to larger animals. Consequently, it is not uncommon for some of these graduates to be assigned or promoted to positions where they use their knowledge and skills to solve other problems or to manage multi-faceted research programs.

The investment in education is retained in the system and frequently results in increased attention to multidisciplinary efforts.

These trainees, a valuable scientific resource now in place, will continue to expand small ruminant research through collaborative projects and strong professional ties between themselves and their academic advisors. In addition, SR-CRSP provides for followup training after the degree. To capitalize on these relationships and reach out to other small ruminant scientists, SR-CRSP proposes to develop and (or) participate in a science network as described in section III.

1. Degree Training

Starting in 1979, SR-CRSP provided either full or partial financial and technical support for university training of more than 300 students. The training of such a large number was made possible through resources mobilized outside of the SR-CRSP funds, e.g., participating universities and donors frequently provided tuition scholarships while SR-CRSP covered remaining costs. Approximately 80% of these students obtained advanced university degrees (Table 3). Slightly more than half of them were enrolled at U.S. institutions, mostly at SR-CRSP participating universities.[12]

Table 3. SR-CRSP Supported Degree Training, 1980-1988.

	Training Site			
	United States		Host Country	
	International Students	U.S. Students		TOTAL
B.S.	1	0	71	72
M.S.	55(8)	32(1)	73(1)	160(10)
Ph.D.	58(5)	27(3)	11(2)	96(10)
TOTALS	114(13)	59(4)	155(3)	328(20)

Note: Numbers in parentheses are additional students enrolled at the time of the survey.

The U.S. students represented about 20% of the total who received university training. The remainder came from 28 countries [annex H]. Approximately 20% of the students were females, most being host country nationals.

The cost of this training component amounts to U.S.$10.1 million ($30,000 per U.S. M.S./B.S. degree; $50,000 per U.S. Ph.D. degree; $15,000 per non-U.S. M.S./B.S. degree; $30,000 per non-U.S. Ph.D. degree). The real value of the degree training program goes

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beyond the costs and the number of students trained. A large number of the students from the host countries conducted thesis research in their own countries, thus contributing significant knowledge about local production of small ruminants. Many participants with M.S. and Ph.D. degrees currently serve as co-principal investigators in SR-CRSP activities. Still others hold key positions in their research institutions.

2. Non-degree Training

At the same time, 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 8 years, approximately 1,000 host country participants attended 23 sessions supported or sponsored by the project.

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 are annual events.

C. PROGRAMMATIC LESSONS LEARNED

Over the last 9 years, SR-CRSP scientists, specialists, and managers gained extensive knowledge and insight about planning, managing, and executing collaborative, multidisciplinary small ruminant research at an international level. This experience, skill, and insight provide a solid foundation on which to plan and execute the next decade of research.

Among the important programmatic lessons learned are these:

- This type of research requires much time. Scientists spend 7 to 10 years to generate knowledge and to validate it -- through on-farm testing, demonstrations, or repeated observations -- before reliable technical packages can be produced; sometimes, it takes longer. Several factors affect the time required to obtain reliable results with animal research in developing countries:

  - Small ruminant production cycles are 3 years or more.

  - Fragile arid lands require 5 to 10 years to show recovery from improved management practices.

  - Demonstration research, especially on-farm trials, requires more time than on-station controlled experiments because of yearly repetitions to compensate for site variabilities.

  - Research pace may be slow because of limited resources, deficient infrastructures, and lack of trained host

country personnel.

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

- Long-term funding commitments (at least 5 years) enable U.S. participating institutions to commit people and resources.

- Complex, interdisciplinary projects require continuity in scientific and administrative staffing. Frequent turnover of key personnel prevents accumulation of experience and knowledge about target systems that are essential for appropriate sequencing and analysis of research trials.

- The solution of small ruminant production constraints depends upon knowledge of the total production system within which the animals are produced. Problems must be understood from the producers' points of view, and must be resolved in ways acceptable to them. This lesson has underscored the program's commitment to interdisciplinary and multidisciplinary research. The recognition and understanding of constraints and development of appropriate solutions require the participation of agronomists, ecologists, and social scientists, as well as animal scientists.

- Host country scientists and administrators also must be committed to the research goals. They develop such commitments by participating in the planning, design, and implementation of projects. Development of detailed research plans should proceed only with participation of host country collaborators.

- Development relevance, not scientific relevance, must be the primary requisite for any SR-CRSP scientific activity.

- Continuing attention is required to develop and maintain links between SR-CRSP and international agricultural research centers.

- Research efficiency and effectiveness depends upon the collaborative structure and level of funding. The original SR-CRSP was near its upper limit of manageable funding, as well as number of institutions, projects, and work sites. If funding is reduced lower than at present, SR-CRSP will suffer critical setbacks.

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D. CONTRIBUTIONS OF SR-CRSP TO U.S. INSTITUTIONS AND AGRICULTURE

1. Contributions to U.S. Institutions

For the past decade, a dozen universities and a PVO have worked diligently to develop a strong network of collaboration and cooperation. This accomplishment did not happen easily nor spontaneously, nor without stresses and strains. Working in such a manner represents a learned behavior of how to function effectively in a multidisciplinary, multi-university, and multi-country environment. With an experienced and stable governance and management system in place, SR-CRSP is now poised to make even greater contributions, having established an effective working mode.

The Small Ruminant CRSP, a Title XII initiative, has enabled participating universities to become more involved in international development. During the past decade, all but two of SR-CRSP universities have held either strengthening or program support grants, all of which has provided complementary financial support in the form of travel grants, courses, and curriculum development.

SR-CRSP has been the driving force in some U.S. institutions in giving an international perspective to graduate and undergraduate programs. Material derived from host country research and development programs have been incorporated into lectures and seminars. At the University of Missouri, a campus-wide undergraduate major in international studies and development has been proposed. At several universities, interdisciplinary courses on international development have been instituted by SR-CRSP faculty. SR-CRSP has stimulated some institutions to develop academic exchange agreements with sister universities abroad, and led to exploration of possible new research collaboration with kindred organizations. Exposure to the small ruminant program has provided some faculty their first experience in international development in their fields.

SR-CRSP has increased the breadth and scope of training of international students and has been culturally enriching for U.S. students through interaction with foreign students. For foreign students, the close ties developed between themselves and their SR-CRSP professors constitute an effective, long-term relationship. Also, the presence of SR-CRSP projects on campus has contributed to the foreign students' feeling that they are a more integral part of the university...that the university now more clearly addresses issues and needs in their countries, not just the United States. Likewise, American students gained hands-on opportunities to work with in-progress development projects through internships and research for advanced degrees, some of which were at SR-CRSP research sites. SR-CRSP has increased the breadth and scope of training of international students and has been culturally enriching for U.S. students through interaction.

Involvement in SR-CRSP has led to the definition of new subfields of research within collaborating faculty's disciplines. For example, in sociology the field of ethnoveterinary research and development has emerged as an area of study where SR-CRSP can contribute knowledge and experience. In Peru, several indigenous plants have been used for years to "treat" internal and external parasites and some infectious diseases. Assessment of their efficacy and use of the indigenous agricultural knowledge could provide biological control alternatives and management strategies useful to U.S. agriculture, which faces increasing problems of environmental and food quality degradation.

At some universities, teaching and funding at the graduate level is formula-driven. Because of the numbers of SR-CRSP students, increased state revenue has enhanced teaching budgets. Because of SR-CRSP, some campuses have expanded research programs and laboratories and purchased equipment to facilitate graduate student research and instruction. These were contributions toward the university's matching requirements of SR-CRSP.

The presence of SR-CRSP on some campuses has stimulated faculty to obtain Fulbright research and teaching fellowships and National Academy of Science grants and USAID-funded grants from the Program in Science and Technology Cooperation; to participate in international task force and steering committees of professional societies; to develop joint projects with animal and social scientists at non-SR-CRSP universities; to use their expertise in other USAID projects and activities, and to become involved in World Bank projects in SR-CRSP countries. For example, because Texas Tech University already was involved in Peru's small ruminant program, it accepted the request of Peru that it also manage the livestock sector development program being financed by a $1.3 million World Bank loan.

Several SR-CRSP universities, because of their involvement in SR-CRSP, have become recognized worldwide leaders, particularly in the areas of small ruminants, range livestock management and production, sheep and goat diseases, and camelid nutrition and diseases. Many institutions have purchased animals (goats and hair sheep) for use in their collaborative research programs. As a result, faculty, students, and U.S. producers have had opportunities to see and work with breeds and types of animals that normally would not have been available to them.

SR-CRSP was related to and supported Winrock International's projects in Trinidad, Tobago, and Antigua where a ruminant production project was co-funded by Winrock and USAID. A similar situation developed in Haiti where the multiplication of improved goats for meat production was fostered through a project co-funded by USAID, Winrock, and the Arkansas Methodist Church.

Through another project, involving SR-CRSP scientists and co-funded by USAID and Winrock, training and technical assistance for PVOs were provided. A number of materials were developed in workshops, shortcourses, and training sessions including the "goat health handbook," and "tech notes" on goat management. The publication "Sheep and Goats in Developing Countries, Their Present and Potential Role," resulted from an effort funded by the World Bank.

2. Contributions to U.S. Agriculture

Strong linkages of collaborative research have been developed among numerous U.S. agricultural institutions, both public and private, thereby strengthening their contributions to U.S. agricultural research and extension programs. Participation in SR-CRSP research has increased knowledge and understanding of:

- Sheep production on U.S. rangelands, and the impact of sheep on cool season plants at high elevations in the United States.

- Llama nutrition and feeding, which is particularly helpful as llamas continue to gain popularity in the United States.

- Adaptability of production and management of cultivated forages of the United States (i.e., orchard grass, timothy, rye grass, red and white clover, alfalfa).

The development of the slant tube technique to rapidly screen legumes for root growth and elongation resulted from SR-CRSP research.

Major contributions of SR-CRSP have been manifested through attracting additional funds and involving scientists not directly associated with SR-CRSP. This has resulted in one such extramural activity that has centered on the initiation of a project at Texas A&M to identify genetic markers, which are correlated to the resistance of small ruminants to internal parasites. The implications of this have widespread potential in sheep and goat production worldwide.

Winrock International's early involvement with SR-CRSP enabled it to develop institutional expertise in small ruminant production. One of the results was the establishment of a model grade A goat dairy in Arkansas. Experience and information gained from operating the dairy assisted in the development of research plans for SR-CRSP and in the goals and objectives of SR-CRSP, which were then used as a means of influencing activities of the dairy. This led to development of a central states dairy cooperative involving producers from Arkansas, Missouri, and Oklahoma. The organization has been used effectively in organizing the sale of breeding animals for export and stimulated the Winrock staff to conduct an economic analysis of marketing for goats in the United States.

During the last decade, SR-CRSP has been the primary source of continued research support for sheep diseases at Colorado State University in its collaborative work with Peru. Most SR-CRSP research at CSU has led to new methods for diagnosis, and an increased understanding of such diseases as ram epididymitis, ovine pulmonary carcinoma, ovine progressive pneumonia, and neonatal enteritis of alpacas and llamas. An extension of some of the research currently underway eventually will lead to new vaccines for control of these important diseases of sheep in the United States.

Brazilian and University of California animal pathologists, through SR-CRSP support, have developed a test for identifying the immune responses of the bacterium that causes caseous lymphadenitis, a worldwide disease of sheep and goats. This finding is leading to the development of a vaccine that also can be used in the United States where the disease plagues both industries.

Veterinary scientists in SR-CRSP and collaborators from various countries demonstrated that caprine arthritis encephalitis (CAE) virus infection was more prevalent in dairy goats of developed countries, including the United States, than in indigenous goats of the developing countries.[13] In Kenya and Peru, most of the seropositive animals could be traced to importations from countries with a high prevalence of CAE. Further studies on the epidemiology of CAE virus infection by Washington State University and Kenyan scientists have resulted in methods to control spread of the virus.[14,15] Results from the eradication program indicate that CAE virus-free herds can be established.

The development of the Texas A&M sheep and goat simulation models is having an impact on the United States research community and the sheep industry. Four U.S. institutions currently use these models. At Texas A&M an additional project in the Range Science Department was initiated to link these models with forage dynamics and diet selection models. Issues being addressed by these models are: the production of lean lamb by manipulation of genetics, nutrition, and management; and evaluating the potential for sheep dairy enterprises in the United States. These simulations will help assess critical issues confronting the industry and provide direction to producing products with greater consumer preference.

III. GENERAL PLANS FOR FUTURE RESEARCH AND TRAINING

A. INTRODUCTION

1. Basis for Proposed Activities

Research and training to be undertaken in the proposed 5-year extension of SR-CRSP will build directly on the experiences of the first 10 years, the lessons learned, the infrastructures and links established, and the increased awareness of the importance of small ruminants in the developing and developed countries. Particularly relevant are the following points:

- Demonstrated effectivity of the collaborative mode in working internationally, across disciplines, among diverse institutions, on complex technical and socioeconomic problems, and in making economical use of human, physical, and financial resources.

- Improved abilities within and among the collaborating institutions to identify, evaluate, and address significant small ruminant production constraints for which solutions appear feasible.

- Increased numbers of scientists and specialists trained and experienced to plan and carry out small ruminant research.

- Extensive body of knowledge available in research publications to support new investigations and advanced academic study.

- Increased numbers of institutions equipped for and experienced in small ruminant research in foreign environments.

- Results of completed research already applied in improved breeds, breeding systems, grazing and feeding systems, health protection, and management practices.

- Established operating small ruminant research links among institutions and individuals in the United States and abroad.

- Continuing interest of USAID in supporting and promoting international collaboration in agricultural research.

2. Rationale for Future Research

The usefulness of small ruminants is so vast and varied that no single research program can hope to solve all the problems producers face, or exploit all of the potentials for improvements. But there are substantive agreements between producers and scientists about which problems are most important. Since its inception, SR-CRSP has focused on and made significant progress in many of these high priority problems. In some cases, it has

produced appropriate solutions, while in others it still seeks them.

Prospects for success with continued small ruminant research are enhanced by such factors as listed in the previous section. More scientists and specialists with experience and training are working interdisciplinarily from a wider scientific base. Many knowledge gaps have been filled and much basic research completed. Scientists now can focus SR-CRSP research on the major problems producers still face.

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 most serious and for which a technical solution appears possible. This is a difficult exercise. It requires concentrating efforts on specific areas, using different programming approaches, and simultaneously pursuing different research strategies.

The research agenda proposed reflects the application of practical criteria evaluated in the light of the program's experience and knowledge gained. The priorities mirror the problems of producers rather than the scientific interests of researchers. In each case, the research represents an extension or result of SR-CRSP work already initiated, or for which certain phases are complete.

3. Areas for Concentrated Activity

In the next 5 years, SR-CRSP proposes to concentrate in six high priority areas, as follows:

- Completion of two promising research and development projects currently underway:
  - Development and integration of dual-purpose goats into farming systems in Kenya.
  - Completion of research on more prolific sheep, particularly in Morocco and Indonesia.
- Building on progress to date, continuation, and expansion of research in three projects.
  - Development of hair sheep production systems.***
  - Development of sustainable agropastoral systems for small ruminant production, particularly on marginal and fragile lands.

*** The productive research on grazing sheep under rubber and other tree crops will be continued under the project, as discussed in Section V. C. Feed Resource Component.

- Development of animal health management systems through the use of biotechnology.

- o Development and application of more knowledge and understanding of the role of women in small ruminant management.

- o Continuation of training of small ruminant professionals (foreign and United States) in academic programs and short-term courses at home and abroad.

- o Extension and improvement of the small ruminant science network for information exchange and collaborative efforts.

- o Increased collaboration with international agricultural research centers and other CRSPs.

B. COMPLETION OF ONGOING RESEARCH PROJECTS

1. Dual Purpose Goats

Research in Kenya clearly shows that the dual purpose goat (DPG) has the potential for contributing significantly to the nutritional and economic welfare of households of small farmers. The milk-producing potential is the most important factor in the adoption of DPG by such farmers.

The present DPG herd shows great promise. As the genetic base is still narrow, the gene pool must be managed carefully for a few years. During this period the performance of DPGs will be evaluated continuously. Partial support for continuing this work may come from non-CRSP sources. Further, the USAID mission in Kenya has expressed interest in sustaining the project for up to 5 years. Such support will depend on obtaining complementary SR-CRSP funds.

At the end of 3 years, the additional work is expected to have: (a) established a nucleus herd of 1,000 DPG does and 75 bucks; (b) released 500 DPG does and 1,000 bucks to farmers; (c) tested up to 50 technical interventions; (d) in operation a sustained DPG multiplication program; and (e) established a farming systems unit within the Kenya Agricultural Research Institute (KARI).

2. Prolific Sheep

Research on prolificacy in sheep (number of lambs born per female per unit of time) has anticipated further commercialization and intensification of small ruminant production in many areas. Such intensification will enable many small farmers to derive a major part of their income by specializing in livestock.

Some sheep and goat management systems already are becoming intensive. By focusing on forage cut-and-carry systems for small ruminants, SR-CRSP correctly anticipated emerging animal husbandry constraints in heavily populated areas of the developing countries. This necessitated taking in account such other factors as nutrition and cultural acceptance of these animals.

SR-CRSP has identified and characterized prolific strains and breeds of sheep. Research has identified the mode of prolificacy inheritance. This information will permit more precise control of prolificacy. The next step is to exploit this knowledge for the benefit of producers and to evaluate this germplasm in intensive farming systems.

Work will continue for 3 years in both Morocco and Indonesia with emphasis in both countries on development, testing, and release of technological packages for farmer flocks with increased prolificacy. While work in Morocco will focus on development of a new breed based on crossing with the D'Man and Sardi breed, activities in Indonesia will concentrate on selection criteria for prolificacy among existing breeds, progeny testing of rams, and release of performance data on animals of known prolificacy genotype under farm conditions.

Because more prolific sheep will increase the pressure on feed supplies and overall management systems, the collaborative research will include attention to nutritional and socioeconomic factors.

C. BUILDING ON RESEARCH PROGRESS

1. Hair Sheep Production Systems

Results of SR-CRSP research in Brazil and Indonesia suggest that by improving feed supplies, health practices, management techniques, and genetic potential, the productivity of hair sheep can be increased and made more cost-effective.

Widely distributed in the tropics, hair sheep are important sources of income and food for small farmers. While they constitute about 10% of the world's sheep population, little has been done to develop and exploit their potential. Unlike wool sheep, which do poorly when exposed to heat, humidity, diseases, and parasites of the lowland tropics, hair sheep evolved under such conditions and do well.

Preliminary evidence indicates considerable phenotypic and genetic diversity among types of hair sheep. Scientists can use such variations to develop more suitable animals for warm, humid areas, and research results can be extended easily to other sites in the tropics.

SR-CRSP has made preliminary evaluations of hair sheep in

Brazil and Kenya. It has introduced them in Indonesia where their performance now is being evaluated. SR-CRSP has gained considerable experience in developing the dual-purpose goat production system in Kenya. The methods established in that effort will be applicable directly to research on hair sheep.

In Indonesia and Malaysia, for example, the high potential for small ruminant production in conjunction with plantation tree crops has been well-documented. Present research focuses on management of animals and forages under trees of various ages. The important research areas include: Long-term impact of grazing and of manure on tree growth and primary crop productivity; screening of grasses and legumes for shade tolerance; and minimization of labor requirements in managing grazing flocks while maintaining their security.

The projected 5-year research and development activities will produce information useful in the development and adaptation of hair sheep production systems to the needs of small farmers in the humid and semi-humid regions. These systems will be based on local vegetation and feed by-products because of the close integration between the cropping system and livestock components.

2. Sustainable Agropastoral Systems on Marginal Lands

Most of the world's small ruminants are produced in agropastoral systems on marginal and fragile lands. The key to development of sustainable agricultural systems in these regions depends on the implementation of suitable management strategies for the livestock sector.

SR-CRSP scientists have gained much knowledge and experience in natural resource management and small ruminant production systems in Brazil, Kenya, Morocco, and Peru. Other development agencies are not engaged in significant research relating to effective use of small ruminants on marginal and fragile lands.

The goal of this SR-CRSP research is to develop new approaches to strategic interventions for the development of grazing and livestock management systems on marginal and fragile lands. Such interventions must have greater likelihood of success than previous development efforts and must optimize offtake consistent with sustainable ruminant livestock production in an ecosystem context and contribute to the equitable economic and social well being of all participants.

It is not only necessary to gain knowledge and understanding of how to improve animal production, but also to learn how grazing and browsing animals affect their environment. Such knowledge is basic to determining how management practices can be changed or mitigated and production sustained.

The proposed research will attempt to define climate-centered management strategies. Nine project components (research areas) will address four specific objectives:

- To define how small ruminant production systems function with respect to abiotic and biotic constraints in the specific area under study.
- To determine the specific role of small ruminants in system persistence and stability, or, conversely, land degradation.
- To develop methods for analyzing agropastoral production systems and identifying important constraints.
- To develop and disseminate recommendations for improved production systems, practices, and land use programs.

The scope of this work will necessitate continuous collaboration among scientists of several disciplines, both in the United States and the host country, this to be selected in the first year.

The innovative approach proposed is designed to produce information and understanding relevant to formulation of public policy, management of lands and animals in production systems, and strategies for sustainability and persistence of productivity. Processing and dissemination of information obtained will receive attention throughout the project and high priority in the latter half of the 5-year period.

3. Animal Health Management through Biotechnology

Mortality and morbidity rates at SR-CRSP worksites show that infectious diseases continue as an important constraint to sheep and goat production. Because of the difficulty of obtaining and applying local reliable, economical univalent (single disease) vaccines, few farmers vaccinate their animals. Lessons learned in SR-CRSP research in Kenya provide the foundation for proceeding.

The proposed work represents a concerted interdisciplinary effort to develop multivalent vaccines for small ruminants. Such a vaccine would provide small ruminant producers with low cost multivalent vaccines that can be used to treat, at one time, several of the most important infectious diseases that affect small ruminants. Moreover, SR-CRSP scientists expect to obtain results in a relatively short time amd to evaluate the economic potential and acceptibility of new multivalent vaccines.

The solution lies in construction of recombinant vaccinia virus vaccines that will induce immunity against multiple infectious diseases. The research to develop this vaccine can best

be done under a program such as SR-CRSP, because scientists already are working with recombinant vaccinia vectors and isolating relevant genes from sheep and goat pathogens.

Currently, SR-CRSP scientists are defining the genes necessary for insertion into a virus vector to induce protective immunity against CCPP and heartwater of goats and sheep, as well as ovine pulmonary carcinoma and ovine progressive pneumonia. Other genes will be obtained as they become available, thus allowing the project to capitalize on efforts of other research programs.

The technology needed to produce conventional virus vaccines exists in most developing countries. This technology can be used to produce a recombinant vaccine, once it is constructed and tested.

The approach is to make (i) a single multivalent vaccine for goats that will protect against several important infectious diseases, and (ii) another single multivalent vaccine for sheep. These vaccines will be designed to protect against the major diseases occurring in the areas where SR-CRSP is working. When developed, the goat vaccine will be evaluated in the dual purpose goat production system in Kenya, and the sheep vaccine will be evaluated in the hair sheep production system in Indonesia. In addition, the animal health scientists will continue to collaborate with SR-CRSP scientists in other research components.

D. WOMEN IN DEVELOPMENT

1. Women's Roles Recognized from Beginning

From its inception, SR-CRSP has paid close attention to the roles of women in livestock management. It did not create a stand-alone Women in Development (WID) or women-specific projects within the program because to do so would have separated both women and livestock from the sociostructural, cultural, and economic milieu they inhabit and in which they function. Instead, SR-CRSP systematically and successfully has woven a conscious concern for women into all its endeavors. A few examples of the many ways in which this has been achieved include the following:

> In both Kenya and Peru, a number of socioeconomic studies of intrahousehold dynamics regarding the division of labor, resource distribution, and decision-making authority by sex and age were conducted. These have included not only stockraising but also cropping; and not only production, but also processing, consumption, and distribution (marketing/exchange) of agricultural products. Among other things they conclusively demonstrated that in highland Peru women are the principal managers of small ruminants, and specific technology transfer strategies will need to be developed to reach them.

In Indonesia, SR-CRSP investigations documented a strong male bias in earlier survey research on women's roles in agriculture. Socioeconomic studies that interviewed women as well as men revealed that Indonesian women play a much larger part in livestock labor and decision-making than earlier documented. These findings have guided outreach efforts to bring small ruminant technology to Indonesian producers--both men and women--rather than focusing exclusively on men as had previously been the case.

In Kenya, farmers participating in on-farm trials with improved goats have been selected statistically to reflect the local demographics of women-headed households, with the result that approximately one-half of the sample are women.

In highland Peru, since 1985, SR-CRSP has helped to organize, and then work with, women's groups in collaborative research on design, testing, and transfer of new technology for small ruminant production and marketing in peasant communities. Women's goat production groups were also a focus of study in Kenya in order to determine how they might be used as a vehicle for disseminating information.

These and other efforts by SR-CRSP sociologists and economists have demonstrated that women in many countries play significant or even primary roles in the care and feeding of small ruminants and often in major consumption and distribution decisions as well.

In some societies, e.g., Peru, women own and control small ruminants. Along with children, they are responsible for the daily herding and health care of flocks, while men see to cultivation. Women in these contexts make many of the production and marketing decisions and control most of the technological knowledge relating to animal health, reproduction, nutrition, grazing grounds, and forages, etc. In other societies, although women traditionally have not been in charge of ruminants, they are becoming the de facto stockraisers as male outmigration increases, e.g., Kenya. A related development is the growing numbers in many countries of female-headed households.

Such findings have played a vital part in directing SR-CRSP efforts to the "real" stockraiser when it comes to gathering information on management systems or trying out new technology. At the same time, however, these findings have pointed to the need for a broader, more culturally contextualized, yet comparative approach to gender roles in agricultural development.

SR-CRSP has provided full or partial support for professional training of 63 women (two-thirds from developing countries) during the past 8 years. Currently, SR-CRSP is sponsoring two women from Peru and Indonesia in masters programs and two from Peru in

doctoral programs in the United States. A recent survey of all SR-CRSP alumni (men and women) in Peru, Indonesia, and Kenya showed that, of those identified in the study, 75% of the women currently are working for SR-CRSP or for a government organization related to small ruminant research.

2. Biosocial Roles in Crop/Livestock Systems

It is impossible to define accurately women's place in crop/livestock systems apart from those of other biosocial actors. Likewise, an understanding is needed of production vis-a-vis processing, consumption, distribution, and management of the natural resource base upon which these activities depend.

Hence, no unitary, simplistic approach to agriculture and gender issues is adequate to explain and provide for development needs. In a step beyond such approaches, SR-CRSP is building a model of "biosocial roles in crop/livestock development." This model takes equal account of all the elements noted above and also situates women's development concerns in the social, cultural, economic, and environmental context of which they are part.

The SR-CRSP model of biosocial roles eschews cultural categories such as "women," "men," "children." For development purposes, such categories must be defined in relative terms (e.g., who does what within a family production unit). The practical value of this approach is threefold.

First, research guided by such a model will yield a clear definition of the principal actors and their role parameters in a given agricultural sector. With this knowledge, development and extension efforts can be targeted to the groups who have the authority, administrative position, technological background, and self-interest to best institute desired changes in that sector. Simply put, developers can then get the right information to and from the right people, and test out new ideas with the most appropriate population.

Second, this more "fine-tuned" understanding of role dynamics means that development and extension programs can be designed to ensure that benefits and information in fact flow to the intended population(s) and are not misappropriated by other groups.

Third, this model will have the predictive power to forestall inadvertently negative impacts of development efforts with one sector or group upon other sectors or groups. Because of the interlocking net of dynamic relationships within and among crop, livestock, and human social systems and their physical environment, change in any one of these areas typically implies changes in another.

In sum, the strategy SR-CRSP has followed for the past decade

has been to focus attention on women as part of a broader analysis strategy. SR-CRSP will continue to refine this model and approach by (a) synthesizing the insights gleaned from a decade of SR-CRSP research on agropastoral systems and women's roles; (b) a worldwide literature review of women in livestock development; (c) field testing and refinement of the model in new SR-CRSP sites; and (d) applications of the model to design new research and the anaylsis of findings.

This will be carried out as part of the mandate of the SR-CRSP sociology project that will have responsibilities for providing sociological analysis for all of the SR-CRSP thrust areas. The ultimate objective is to formulate policy recommendations and guidelines for use of development programs and agencies in (a) determining the appropriateness of a livestock project for any given population of women; and (b) designing such a project in a context-sensitive way to ensure that planned benefit flows, quantities, sustainability, etc. are those that actually result.

E. TRAINING AND PROFESSIONAL DEVELOPMENT

Continuing professional development is an important part of the SR-CRSP contribution to developing individual and institutional capacity in host country partners. At the present stage of human resource and institutional development, the problems include professional isolation, lack of incentives to apply acquired skills, maintaining professional abilities, "brain drain," and low replenishment rates if institutions do not provide adequate opportunities for research and advancement.

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

Four major reasons for including a well-funded training component (Section IV, Plan A) during 1990-1995 are:

- Students benefit by having SR-CRSP scientists participate both technically and administratively in the supervision of their academic progress.

- The majority of the students have opportunities to conduct thesis research in their own country.

- Academic relationships evolve between SR-CRSP scientists and students into collaborative research relationships after the student's training. This provides them with an important source of technical support and advice while they develop and conduct their own research programs.

- In the long term, trained participants who return to their countries and continue in small ruminant research often assume administrative responsibilities and can be influential in the institutionalizing the program, thus assuring continuity and vitality and outreach.

Table 4. Proposed degree training, 1990-1995.

Research Component	Year 1 1990-91		Year 2 1991-92		Year 3 1992-93		Year 4 1993-94		Year 5 1994-95	
	M.S.	Ph.D.	M.S.	Ph.D.	M.S.	Ph.D.	M.S.	Ph.D.	M.S.	Ph.D.
Dual Purpose Goat	1	1	2	1	1	1	-	-	-	-
Prolific Sheep	1	1	2	1	1	1	-	-	-	-
Hair Sheep	1	1	2	2	3	3	2	2	1	1
Sustainable Agropastoral Systems	1	1	1	1	2	3	3	3	3	3
Animal Health	1	1	1	1	2	3	4	3	2	3

Table 4 shows that approximately 19 students will be trained at the master's degree level (2 year program) and 12 at the Ph.D. level (3 year program) during the 5-year period. In some years, and with the addition of funding, postdoctorates may be programmed in special 1- to 2-year fellowships. The numbers of trainees can be expanded, if additional resources become available under budget plans A and B, Section IV.

In addition to advanced training, SR-CRSP will continue to provide non-degree, technical training through workshops, farmer/extension work sessions, and other informal training activities as research results become available and technological packages evolve. The activities associated with developing and extending the Small Ruminant Science Network (next section) will contribute substantially to continued professional development.

F. SMALL RUMINANT SCIENCE NETWORK

1. Introduction

The long-term success of SR-CRSP in aiding the producers of small ruminants throughout the world rests in the ability of participating institutions to establish and maintain a Small Ruminant Science Network (SRSN). Such a network would serve small ruminant scientists and specialists, in the United States and

abroad, by providing for:

- continuous professional development
- prompt flow and exchange of research results, experience, and methods
- mechanisms to facilitate collaboration and cooperation in planning and executing research on a multi-country, regional, or global basis
- identification of sources of funds to support research
- increased attention to issues involved in the rapid and efficient transfer of new technology from laboratories and research stations to application in farmers' flocks and fields.

Experiences of SR-CRSP illustrate both the significance of these topics as well as some of the possibilities for renewed action.

Continuing professional improvement has been and will continue to be an important part of SR-CRSP contributions to strengthening individual and institutional capacities in its host country partners. Scientists trained under SR-CRSP are encouraged to apply and augment their skills after returning to their home institutions. In addition to continuing to develop professional skills, it also is important that they maintain and expand interaction with each other. U.S. institutions also benefit by maintaining professional and personal communication with the most promising prospects for future leadership positions in each host country.

An important accomplishment of SR-CRSP has been the development of extensive collaborative working relationships between U.S. and host country scientists. This was done by (a) establishing collaborative research projects and (b) developing strong professional ties between U.S.-based academic advisors and their former students. This pool of experienced host country scientists provides a solid foundation on which to plan and execute new research projects.

Many host country scientists work under conditions of professional isolation and limited technical and financial support. These issues continue to be of concern to SR-CRSP.

SR-CRSP scientists as well as host country scientists periodically have had opportunities to meet colleagues from other countries at conferences or workshops, some of these being co-sponsored by SR-CRSP. Many such interactions have occurred haphazardly without systematic focus, long-term strategic purpose, or little attention to follow-up. As a result, many sheep and goat

scientists in various countries are unable to keep abreast of developments, fail to benefit fully from SR-CRSP activities, and do not communicate their experiences or research results to colleagues in other countries.

Where host country scientists operate in research environments that lack sufficient resources, this poses great difficulties, especially for those who are young and newly-trained. Without some continued professional stimulation and support, the human resources already developed through SR-CRSP in these host countries may be underutilized or even misapplied. It appears both prudent and productive to fund some research activities of these SR-CRSP collaborators, both to build upon and to strengthen a professional resource already in place. In some cases, all that may be necessary will be to identify potential sources of funds and to help these young scientists and their institutions prepare appropriate grant proposals.

These and related activities for increasing scientific exchanges among small ruminant scientists and for enhancing their opportunities for research provide the rationale and agenda for development of the Small Ruminant Science Network.

2. Network Objectives

Networking has proven to be an effective means for overcoming the professional isolation of scientists in various countries and providing for continued professional growth and development. Large networks of scientists are established or being established in Africa by ILCA and in Asia by IDRC. A network, as proposed here, could be based on existing small networks or upon other regional associations of small ruminant scientists. If feasible, the network should be developed in collaboration with other organizations having similar interests.

The projected minimum set of network objectives includes the following:

- To encourage small ruminant scientists to conduct research that seeks to solve sheep and goat production problems in developing countries.

- To develop regional networks of small ruminant scientists that can stimulate interaction and provide peer review of research and teaching activities among scientists in the same region.

- To draw knowledge-generating groups of small ruminant scientists into a partnership with agency administrators who can apply knowledge to action. Non-governmental community level service organizations, as well as financial and private business interests may, in time, be brought into the dialogue with a view to finding non-confrontational means of solving

conflicts and reaching equitable compromises.

- To stimulate continued professional development by short-term continued training and to support current collaborative research that already has produced some results but needs additional support for completion or as leverage to obtain funds from other sources.

3. Network Activities

Each regional network will provide a forum for identifying 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 while protecting the environment. The regional networks also will translate local research findings into relevant teaching materials and into documents for use in agricultural policy decisions.

Special attention will be given to the inclusion of women scientists in the networks. The significant role of women in animal husbandry has been documented in several SR-CRSP host countries (Indonesia, Kenya, and Peru); in some projects, women scientists are engaged in research.

Networks will be region-oriented and based at one of the present host country institutions, as a core group of SR-CRSP scientists (e.g., member of the Program Advisory Committee) already have been collaborating. Regions with already well-established national research systems (Latin America, Asia) seem the likely places to establish networks. The priorities for the establishment of the networks are: (1) Latin America, (2) Africa, and (3) Southeast Asia. Further, in Latin America SR-CRSP would take a leading role in establishment of a small ruminant network, while in Africa and Southeast Asia SR-CRSP network activities might well collaborate with and support networks presently initiated by ILCA in Africa and IDRC in Asia.

Networks establish working relations among scientists, research institutions, and development agencies. Networks have been especially successful when they have been able to make small research awards for younger professionals to study topics relevant to the needs of development agencies or farmers.

4. Methods

The tentative work plan consists of three phases, each involving a regional workshop.

Phase I (year 1): Workshop to assess the range of researchable topics, listing of priorities, and formulation of terms of

reference for invited proposals, composition of complete list of regional small ruminant "stakeholders."

Phase II (year 2): Workshop to screen and approve a limited number of research awards.

Phase III (years 3, 4, 5): Workshops on research results as they become available. During these three workshops, research findings will be communicated to a larger group, and synthesized into farmer or policy recommendations.

Each network will be chaired by a host country scientist elected to the position, with one of the U.S. PIs serving as advisor. Host country institutions will be providing office space, furniture, and general logistic support. SR-CRSP will fund a bilingual secretary, communications (including a newsletter), and office supplies (including one personal computer, plus a high-quality printer), annual workshops, travel for participants to attend the workshops and for short-term professional development, and research awards.

Short-term professional development for scientists would be provided. These 4- to 6-week periods will permit a scientist to come to the United States to work with colleagues, to develop new techniques necessary for continuing their research, to bring their bibliographies up-to-date, to prepare materials for publication, etc. Each scientist will prepare a detailed proposal of activities to be accomplished, a project time frame, and a final report on completion.

Projects funded might support current research that already has produced some results and which maximized scientific contacts among researchers. Activities funded might range from host scientists spending professional development leaves in the United States to collaborative research projects in the host countries and support for travel to scientific meetings of high priority. Any activity requiring limited funding ($5,000 to $10,000), and which strengthens already established linkages, would be considered in addition to proposals that may provide seed money or leverage to obtain funds from other sources.

The role of the network secretariat, supported by SR-CRSP funds, would be:

- to develop and publish a newsletter on a regular basis
- to organize and conduct regional workshops on a yearly basis
- to be pro-active in organizing and applying for additional funds from donor agencies to apply to small ruminant problems identified by workshops or other working groups

G. COLLABORATION WITH IARCs AND OTHER CRSPs

In most country programs, SR-CRSP has benefitted from collaboration with international agricultural research centers (IARCs). In Peru, the Community Technology Validation Project was implemented in collaboration with the International Potato Center (CIP). The Kenya program always has been in close contact with ILCA, with frequent invitations to workshops, seminars, and network meetings. Indonesian collaborative scientists participated in the Asia Farming Systems Research Network (AFSRN), coordinated by IRRI. One of the tangible results of this cooperation was an OICD-funded project for the development of an on-farm livestock research method manual. Similarly, SR-CRSP has collaborated with other CRSPs, e.g., with TropSoils in a collaborative survey in West Sumatra.

In the future, SR-CRSP expects to expand this collaboration, especially with some of the other CRSPs in the agropastoral program. The use of crop residues from groundnuts (with the Peanut CRSP), from beans (Beans/Cowpea CRSP), and cereals (Sorghum/Millet CRSP) for animal feed will be evaluated in collaboration with each of these CRSPs. For the same reasons, contacts will be sought with ICRISAT and ICARDA. Of particular interest is the research on pigeon peas, pasture legumes utilization, and the use of barley and wheat stubble for sheep.

SR-CRSP is exploring ways to collaborate with other CRSPs and IARCs, both in Morocco and Indonesia. Currently, TropSoils CRSP has soil fertility studies underway in West Sumatra, and there may be opportunity with additional funding to use their expertise on similar soils in North Sumatra where SR-CRSP has interest in maximizing forage production under plantation trees.

Several possibilities will be examined for collaboration and links between SR-CRSP and the Institute for Agricultural and Veterinary Sciences (IAV) in Morocco and ICARDA in Syria. Of particular mutual interest is the research on barley and wheat stubble and pasture legume utilization by sheep. An ICARDA team in Morocco is working with medics (plants of the genus Medicago).

IV. COST PROPOSAL

A. Introduction

Through the early 1980s, SR-CRSP received USAID funds at levels sufficient to conduct research and support training as described in the global plan and defined in annual workplans. A 2-year funding and a 3-year planning horizon were the modus operandi. The resources provided by USAID, the institutions, and host countries (table 1) were sufficient to conduct vigorous research and training programs in five major ecosystems representative of the world's small ruminant systems.

During those years USAID's annual contribution to SR-CRSP was approximately $4.0 million. In 1984-85 and 1985-86, however, three budget reductions occurred. USAID's allocation fell from $3.6 million in 1985-86 to $2.4 million in 1986-87. These reductions necessitated program cuts across all disciplines and all sites. Research support to Morocco was reduced substantially and on October 1, 1987, SR-CRSP activity in Brazil was placed on "linkage" status. Since 1987-88, the annual budget has remained at $2.8 million.

The prospects for continued limited funding were among the major factors considered when developing the strategic plan for the 1990s. With fewer resources, SR-CRSP faces the prospects of working in fewer sites, becoming less global, further limiting training, and, perhaps even reducing the number of participating institutions.

Table 5 shows program budgets for the previous and present grant periods. Currently, the program is predicated on receiving $2.8 million; funding is obligated through April 30, 1990 and authorized through September, 1990. When the next increment of funds is forthcoming, it is hoped that the grant obligation year will be adjusted to coincide with the fund authorization year.

B. Basis for Proposed Extension Budget

During the development of this proposal, USAID instructed SR-CRSP to present three budget scenarios:

- Base funding of $2.8 million per year with 5% inflation factor compounded annually plus an incremental growth factor.
- Base funding of $2.8 million per year with 5% inflation factor compounded annually.
- Base funding of $2.8 million per year for 5 years.

These guidelines were followed. Plan A presents the incremental funding scenario, in which a 5% increase in resources is planned for year 2, and an additional 22.7% in year 3. This

SMALL RUMINANT CRSP
USAID GRANT NO. DAN-1328-G-SS-4093-00
APPROVED PROGRAM BUDGETS

Institution	Discipline	Year 6 84/85	Year 7 85/86	Year 8 86/87	Year 9 87/88	Year 10 88/89	** Year 11 89/90	Total
California	Breeding	$242,034.00	$226,100.00	$165,900.00	$160,000.00	$210,000.00	$210,000.00	$1,214,034.00
California	Health	$170,000.00	$150,750.00	$73,100.00	$0.00	$0.00	$0.00	$393,850.00
Colorado State	Health	$170,000.00	$153,450.00	$126,400.00	$160,000.00	$160,000.00	$160,000.00	$929,850.00
Missouri	Sociology	$307,800.00	$295,700.00	$173,400.00	$210,000.00	$210,000.00	$210,000.00	$1,406,900.00
Montana State	Breeding	$145,000.00	$144,000.00	$126,400.00	$100,000.00	$125,000.00	$125,000.00	$765,400.00
North Carolina	Nutrition	$235,178.00	$240,488.00	$165,900.00	$160,000.00	$179,500.00	$190,000.00	$1,171,066.00
Texas A&M	Management	$185,000.00	$121,500.00	$67,200.00	$114,000.00	$0.00	$0.00	$487,700.00
Texas A&M	Systems	$185,000.00	$187,026.00	$142,200.00	$11,000.00	$140,000.00	$140,000.00	$805,226.00
Texas Tech	Range	$297,000.00	$239,850.00	$126,400.00	$160,000.00	$150,000.00	$150,000.00	$1,123,250.00
Utah State	Physiology	$195,000.00	$161,030.00	$21,900.00	$0.00	$0.00	$0.00	$377,930.00
Utah State	Range	$190,000.00	$168,750.00	$126,400.00	$120,000.00	$118,505.00	$150,000.00	$873,655.00
Washington	Health	$170,000.00	$165,150.00	$126,400.00	$160,000.00	$160,000.00	$160,000.00	$941,550.00
Winrock Int'l	Economics	$235,000.00	$258,829.00	$165,900.00	$210,000.00	$210,000.00	$210,000.00	$1,289,729.00
Winrock Int'l	Management	$232,000.00	$234,900.00	$169,900.00	$180,000.00	$180,000.00	$180,000.00	$1,176,800.00
Subtotal:		$2,959,012.00	$2,747,523.00	$1,777,400.00	$1,745,000.00	$1,843,005.00	$1,885,000.00	$12,956,940.00
Management Entity*		$450,000.00	$432,000.00	$300,200.00	$450,000.00	$440,000.00	$500,000.00	$2,572,200.00
Contingency Funds		$89,200.00	$27,412.00	$55,600.00	$220,000.00	$183,295.00	$122,800.00	$698,307.00
Overseas Sites		$501,788.00	$393,065.00	$316,000.00	$300,000.00	$333,700.00	$292,200.00	$2,136,753.00
Linkages		$0.00	$0.00	$0.00	$93,000.00	$0.00	$0.00	$93,000.00
Subtotal:		$1,040,988.00	$852,477.00	$671,800.00	$1,063,000.00	$956,995.00	$915,000.00	$5,500,260.00
Total:		$4,000,000.00	$3,600,000.00	$2,449,200.00	$2,808,000.00	$2,800,000.00	$2,800,000.00	$18,457,200.00

** Proposed budgets for year 11.
* Allocations include funding for External Evaluation Panel, Board Meetings, Technical Committee, and other Meetings.

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CREATED BY: Lucia Lojewski (June 14, 1989)

Table 5

increase is proposed to develop additional sites in other ecozones. Plan B presents a 5% annual compounding scheme that allows for some growth, particularly after year 3 when two of the continuing research efforts will be terminated. Plan C is the flat-funding scenario in which resources will not permit growth, or even keep pace with increasing costs of operations. Further disadvantages are noted under the Plan C budget.

All plans give priority to completion of the dual-purpose goat and prolific sheep activities. However, in the case of the goat program in Kenya, it is anticipated that USAID/Nairobi will provide local currency and possibly some dollars comparable to SR-CRSP funding. These contributions are predicated on a similar commitment from SR-CRSP, and all fund sources are needed to institutionalize the program and ensure continuation by the host country after 1993.

Without sizeable incremental increases in 1992-93, it will not be possible to establish possible additional sites as discussed on pages 77-90. Additional sites will broaden the scope of SR-CRSP and reach into other ecosystems. Also more sites would enable SR-CRSP to collaborate with IARCs that can provide complementary expertise. In addition, cross-CRSP collaboration will be enhanced with the adoption of more sites. Plan A allows for expanded training and networking, and will increase the probability of short-term economic payoff for smallholders through integrating the results of research into host country outreach programs.

Plan B addresses the priorities identified in Plan A but would not permit expanding to additional sites. This plan gives some momentum to research, will help defray the cost of inflation, and maintain the critical mass of participating scientists. However, it will reduce the capacity for graduate student training, and delay working collaboratively with other CRSPs and IARCs until year 4.

Plan C places the program at a disadvantage and will limit the more productive activities included in the other plans. Priority still would go to the components as described earlier. Fewer resources for the hair sheep and agropastoral components would slow implementation and subsequent output. Graduate student training would be at a minimum. It would limit the global scope of SR-CRSP and reduce the capacity for collaboration with other CRSPs and IARCs. In all, the plan would maintain the program at an operational level but at less productive levels than that for the other two plans.

In summary, Plan A offers the best opportunity to maintain the global perspective of SR-CRSP, to meet the research goals of the program, to reach a desirable training level, and to provide resources for enhancement of collaboration among CRSPs and IARCs.

C. Budget Plans

Each plan shows the projected contributions from USAID, participating institutions, and host countries, with line item estimates for each major research and training component. Annexes A, B, and C provide further budget details for each component of Plans A, B, and C, respectively.

The estimates for the participating institutions' contributions are based on the minimum 25% matching requirement. One would expect 8-10% more based on the history of contributions and commitment of present institutions. While the ME sought estimates from the present host country institutions if they continue as collaborators during 1990-93, it was not possible to obtain these by the proposal deadline. Also, with one site undetermined for the agropastoral component, estimates are provided based on previous levels of commitment by host countries.

For budget projections, host country contributions were conservatively estimated at 15% of AID's allocation. Indirect costs were assessed at 30% of the total expenditures, not including training or equipment.

1. Plan A

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
	ALL AMOUNTS EXPRESSED IN THOUSANDS					
	FROM USAID					
Dual Purpose Goat	$400	$300	$200	$0	$0	$900
Prolific Sheep-Moroc.	$60	$50	$40	$0	$0	$150
Hair Sheep	$650	$750	$825	$970	$982	$4,177
Agropastoral	$470	$550	$650	$700	$764	$3,134
Animal Health	$450	$480	$500	$600	$650	$2,680
Networking	$170	$180	$210	$280	$280	$1,120
Add Site Development			$600	$800	$400	$1,800
Subtotal	$2,200	$2,310	$3,025	$3,350	$3,076	$13,961
Management	$600	$630	$662	$695	$729	$3,316
TOTAL	$2,800	$2,940	$3,687	$4,045	$3,805	$17,277
	FROM U.S. INSTITUTIONS					
TOTAL U.S. INSTITUTIONS CONTRIBUTION	$700	$735	$922	$1,011	$951	$4,319
	FROM HOST COUNTRY INSTITUTIONS					
TOTAL HOST COUNTRY CONTRIBUTION	$420	$441	$553	$607	$571	$2,592
TOTAL SUPPORT TO SR CRSP	$3,920	$4,116	$5,162	$5,663	$5,327	$24,188

Priorities addressed:

- Completion of on-going research projects in Kenya and Morocco.
- Development of hair sheep research currently proposed in Indonesia.
- Initiation of agropastoral research in a selected country in Africa or Latin America.
- Initiation of animal health research in Kenya.
- Maintains number of SR-CRSP sponsored graduate students at 31.
- Maintains network development in three geographical regions.
- Increased opportunity for additional research sites from two to three or more.

Other advantages:

- Increased commitment of SR-CRSP to respond to buy-in invitations from two or three USAID Missions.
- Increased CRSP and IARC collaboration, particularly with ILCA, ICARDA, ICRISAT, TropSoils CRSP, and Sorghum/Millet CRSP.
- Short-term economic payoff for smallholders in Indonesia, Kenya, and Morocco.
- More opportunities for socioeconomic and outreach activities in Indonesia and possibly other sites.
- Enhanced contributions from U.S. and host country institutions through increased matching and direct collaborating country resources.
- Increased resources to help defray inflation.
- Enable project to reach 5-year goals.
- Opportunity for program to return to its original global mandate.

2. Plan B

Component	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
	ALL AMOUNTS EXPRESSED IN THOUSANDS					
	FROM USAID					
Dual Purpose Goat	$400	$300	$200	$0	$0	$900
Prolific Sheep-Moroc.	$60	$50	$40	$0	$0	$150
Hair Sheep	$650	$750	$825	$967	$980	$4,172
Agropastoral	$470	$550	$650	$700	$764	$3,134
Animal Health	$450	$480	$500	$600	$650	$2,680
Networking	$170	$180	$210	$280	$280	$1,120
Subtotal	$2,200	$2,310	$2,425	$2,547	$2,674	$12,156
Management	$600	$630	$662	$695	$729	$3,316
TOTAL AID CONTRIBUTION	$2,800	$2,940	$3,087	$3,242	$3,403	$15,472
	FROM U.S. INSTITUTIONS					
TOTAL U.S. INSTITUTIONS' CONTRIBUTION	$700	$735	$772	$810	$851	$3,868
	FROM HOST COUNTRY INSTITUTIONS					
TOTAL HOST COUNTRY CONTRIBUTION	$420	$441	$463	$486	$510	$2,320
TOTAL SUPPORT TO SR CRSP	$3,920	$4,116	$4,322	$4,538	$4,764	$21,660

Priorities addressed:

- o Completion of on-going research projects in Kenya and Morocco.
- o Development of hair sheep research program currently proposed in Indonesia.
- o Initiation of agropastoral research in a selected country in Africa or Latin America.
- o Initiation of animal health research in Kenya.
- o Maintains number of SR-CRSP sponsored graduate students at 31.
- o Maintains network development in three geographical regions.

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Advantages:

- o Improves opportunity for response to buy-in invitations from one or two USAID Missions.
- o Provides some potential to collaborate with one or two CRSPs and IARCs.
- o Increased resources to help defray inflation.

Disadvantages:

- o Precludes development of second site(s) in other geographic locations.
- o Limits contributions from U.S. and host country institutions.
- o Diminishes opportunity to realize global mandate.

3. Plan C

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
			ALL AMOUNTS EXPRESSED IN THOUSANDS			
			FROM USAID			
Dual Purpose Goat	$400	$300	$200	$0	$0	$900
Prolific Sheep-Moroc.	$60	$50	$40	$0	$0	$150
Hair Sheep	$650	$700	$750	$800	$800	$3,700
Agropastoral	$470	$510	$550	$600	$600	$2,730
Animal Health	$450	$470	$490	$520	$520	$2,450
Networking	$170	$170	$170	$280	$280	$1,070
Subtotal	$2,200	$2,200	$2,200	$2,200	$2,200	$11,000
Management	$600	$600	$600	$600	$600	$3,000
TOTAL AID CONTRIBUTION	$2,800	$2,800	$2,800	$2,800	$2,800	$14,000
			FROM U.S. INSTITUTIONS			
TOTAL U.S. INSTITUTIONS' CONTRIBUTION	$700	$700	$700	$700	$700	$3,500
			FROM HOST COUNTRY INSTITUTIONS			
TOTAL HOST COUNTRY CONTRIBUTION	$420	$420	$420	$420	$420	$2,100
TOTAL SUPPORT TO SR CRSP	$3,920	$3,920	$3,920	$3,920	$3,920	$19,600

Priorities addressed:

- Priorities remain the same as in Plans A and B but productivity will be slower with less likelihood of meeting program goals in 5-year period.

Disadvantages:

- Precludes development of second site(s) as in Plan B.
- Further erodes present and planned research.
- Restricts opportunity to collaborate with other CRSPs and IARCs.
- Potential loss of one or two participating institutions and a research site.
- Removes the ability of SR-CRSP to respond to buy-in invitations.

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V. SPECIFIC PLANS FOR PROPOSED RESEARCH

A. INTEGRATION OF DUAL-PURPOSE GOATS INTO KENYAN FARMING SYSTEMS

1. Introduction

a. Background

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

The advantages of the DPG are major. Socioeconomically, farmers will benefit from increased milk availability for the family, and the added income from sales of milk and offspring. Biological advantages, such as small size, short gestation, and higher litter size, underlie the importance of goats to smallholders. Society benefits because of the ability of DPGs to convert low cost nutrients from marginal lands into a high valued product.

Multidisciplinary research by SR-CRSP in Kenya determined that the feed resource fluctuated in quality and quantity seasonally and was deficient or marginal in some seasons. But with appropriate interventions, the feed resource could be developed and other constraints overcome without compromising offtake of crop products. These interventions, feasible technically, presently are being tested for economical viability and social acceptability. Health, nutrition, and other constraints are being identified through research from a set of integrated projects with emphasis on on-farm testing with close monitoring and reports from the farmers. Results of the integrated program of placing DPG does on farms for initial testing are encouraging. The project has the potential for expansion into an effective extension or development project that will deploy DPG throughout appropriate areas of Kenya.

b. Justification for Proposed Research and Assumptions that Work Can Be Done

Critical to the development of an integrated set of practices for DPG production is the goat itself. DPG production in the farming area was not traditional so that the two native breeds had not been historically developed to produce sufficient milk for family consumption. The imported dairy breeds are ill-adapted to the production environment and were not a viable choice. Early SR-CRSP research determined that the first cross (F^1) between native and imported dairy breeds was not the ultimate choice but a

satisfactory intermediate and, as it was easily made available, was used for the on-farm testing.

On the basis of the considerable data collected during the initial SR-CRSP years on native and dairy breeds and their crosses, plus a systematic compilation of research information on goats from around the world, a new breed was designed specifically for western Kenya and its production constraints. About 800 to 1,000 DPGs are planned for the research flock by 1990. Animals produced in the intermediate generations of breed development have been popular for use on other projects and for use by farmers.

The present herd of DPGs shows great promise. The genetic basis is still narrow, however, 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 supporting the program for up to 5 years, but to obtain such support, complementary SR-CRSP resources will be required.

2. Objectives

The goal of the DPG research in SR-CRSP is to continue to improve the contributions of dual-purpose goats to the nutritional and economic welfare of families on small farms in Kenya and elsewhere in the humid tropics.

The general objective is to continue to improve productivity (milk, meat) of DPG through breeding and management and to evaluate the technical feasibility, social acceptance, and economic profitability of research-based interventions involving DPG in limited resource farming systems.

3. Project Activities

The breeding component will involve the private sector in the development of the genetic pool of DPG. Release of selected DPG will begin in late 1989 or early 1990 under a plan of using bucks to upgrade flocks. The formation of an independent set of DPG breeders is anticipated. As soon as the progeny test data bank has been built up, genetically improved bucks will be identified especially for use on the DPG does planned for release in 1991-92.

The research program, located at Ol Magogo, is planned to be the nucleus flock for the breed. It will release bucks and does to Kenyan DPG breeders. It also will establish and provide guidelines and other information for private DPG breeders. The breed cannot be expected to develop genetically without this nucleus flock.

The base for this nucleus flock is in place with good facilities, SR-CRSP trained KARI personnel in charge of operations, and a KARI geneticist assigned to the project. Although the breed is at a critical stage of development, no constraint is evident that will prevent successful accomplishment of objectives.

The production systems component will complete the recently started large-scale evaluation of DPG under smallholder conditions in western Kenya. It will continue to provide leadership for the multidisciplinary team, presently in place, that is focusing research on crop-livestock-tree components of small farming systems. Interaction among the components of the farming system contributes to the distinct advantages of DPGs. Various technologies are fine-tuned into "tech packs," comprehensive descriptions of new technical interventions geared for extension workers and farmers.

The socioeconomic component will work closely with the production systems component of the DPG research. Economic profitability of new technologies before and after on-farm testing of these technologies will be evaluated. Similarly, the social acceptability of the DPG, its feeding, milking, and economic management, will be measured. New methods to involve private farmers and extension personnel in the DPG research will be explored, as well as new areas for DPG testing and distribution.

The health component will continue to develop management practices and be involved in on-farm evaluation research in collaboration with the production systems and socioeconomic components. It also will collaborate with the breeding component in the development of a DPG with higher resistance against parasites, particularly Haemonchus contortus.

a. Specific Objectives

The specific objectives to be pursued are:

- To improve productivity (milk, meat) of DPG through breeding by breed improvement and stabilization through individual and progeny testing for performance by
  - establishing the population structure of the DPG required for sound widespread utilization of the nucleus flock as a genetic resource.
  - to release systematically nucleus goats to breeders for multiplication and sale to farmers and to provide technical advisory support (including a "tech pack") to breeders.
  - to collaborate with Kenyan institutions to use the selected DPG as a genetic base for adaptation to specific

geographical areas or specialized uses.

- establishing genetic mediation of immunity/tolerance to H. contortus (common stomach worm) discovered in the early generations of the composited DPG population.

o To evaluate the technical and socioeconomic feasibility of research-based interventions to DPG in limited resource farming systems by

- developing and adapting goat production systems to the needs of smallholder agriculturists in the humid and semihumid tropics emphasizing the use of dual-purpose goats to produce milk and meat.

- designing and testing appropriate feed production and preservation techniques.

- developing nutritional and management strategies to match the feed resources available through the year with the requirements of the goats (year-round breeding, growing kids, replacements, lactating does, and providing a continuous milk supply for farm family use).

- conducting economic feasibility analyses of component technologies and management practices.

- developing economic models of small farms in western Kenya to assist in post-trial evaluations.

- determining through on-farm evaluations under farmer management that production systems are technically and economically feasible for small-scale farmers in the high-potential tropics.

- determining social acceptability of the DPG management systems by involving active farmer participation in the testing of new DPG technologies.

- evaluating the impact of the DPG production systems on women and children.

- assessing the feasibility of the DPG production systems in high potential areas of Kenya outside the present two research regions.

- identifying indigenous animal management technologies used in Kenya and applicable to DPG production.

b. Requirements

The DPG research will continue a decade of production research

in Kenya. There is the need to complete the research or at least to leave with KARI the capacity to: (i) maintain a genetic pool of DPGs and (ii) to establish within KARI the capacity to conduct multidisciplinary on-farm research. No other sites are contemplated, although improved communication with similar efforts in other countries (e.g., Burundi) will be pursued.

The main requirements for the breeding component are:

- adequate maintenance of the facilities at Ol Magogo and a reasonable number of scientific and technical staff available.
- opportunities to collaborate with the private sector in order to establish a DPG breeders group.
- opportunities to import additional germplasm if this is deemed desirable.
- strong liaison with the KARI staff involved in on-farm evaluation.

The requirements for the production systems and socioeconomic components are:

- willingness of host country scientists to conduct multidisciplinary research.
- adequate number of collaborating KARI staff.
- improved communication and collaboration between the commodity research programs of KARI (e.g., crops and livestock).
- continuation of present core group of resident scientists.
- continuing collaboration with the veterinary services of the Ministry of Livestock Development, especially at the Maseno station.
- continuing participation by SR-CRSP health scientists.
- training funds.

4. Methods

Three primary traits of the DPGs require genetic selection and stabilization: growth, milk, and adaptability. Growth (weight/age relationships) is already near optimal design. Milk yield is currently satisfactory but must be increased 25 to 30% in order for the DPG to produce best for farm families. As milk yield can be measured only from does, progeny testing sires by their daughters' milk yield is required. Accurate progeny testing can be done in Kenya only at a controlled research location.

Testing under farmers' conditions is equally important. Adaptability is a broad term implying the capability of goats to thrive under these conditions. New farm management methods are a necessary complement to the development of the DPG, as otherwise the gains in genetic material will not pay off -- and, therefore, the genetic pool would be unlikely to be sustained.

Individuals produced in the early generations of the composite have been monitored, and the population appears to be segregating genetically for immunity (or some form of tolerance/resistance) to the common stomach worm, H. contortus. These parasites are the major source of debilitation of goats, and medicine for treatment is the major health expense of DPG production. Further research is required to verify genetic mediation of the immunity and its nature.

DPG kids to 1 year of age will be infested by this common stomach worm using both natural and artificial infestation. The level of resistance/tolerance will be evaluated using packed red blood cell volume and fecal egg counts. Those few individuals that segregate out of the unique four-breed composite as not requiring treatment will be selected and tested via traditional genetic methods for number of genes segregating, degree of dominance, expressivity and penetrance. In addition, separate funding is being sought to employ genetics methods to seek understanding of the immune response at the gene product level and(or) to identify genetic markers associated with any major gene(s) identified.

The production systems research will be concerned primarily with on-farm evaluation of "tech packs" in western Kenya. Evaluation will be conducted by a four-person, multidisciplinary team -- animal scientist, agronomist, economist, and rural sociologist. All four resident scientists are Kenyans with PhD degrees and at least 2 years experience working with SR-CRSP. Each of the resident scientists has one or more collaborating scientists (MS degree) assigned by KARI.

On-farm evaluation involves small farms in four clusters in Western and Nyanza provinces. Two ethnic groups (Luo and Luhya) are represented in these communities. Prior to distribution of DPG, participating farmers meet with the evaluation team to review the details of the "tech packs." These details have been described in a document suitable for extension agents to use in transfer of the tested "tech packs" to farmers elsewhere in Kenya. Farmers are provided with DPGs. However, they are required to purchase supplies and equipment available in the local markets.

Evaluation is designed to determine the economic feasibility and social acceptability of DPG production systems. The "tech packs" have been evaluated for technology feasibility under station and scientist-managed, on-farm trials. However, the issue at

question is to determine if the "tech packs" suit farm families' preferences, labor availability, and other factors that cannot be known except through on-farm evaluation.

Monitoring of DPG and farmer acceptance of "tech packs" are conducted in communities by field assistants with the equivalent of a high school degree. These field assistants observe farmer activities and survey farmers and their neighbors to determine reactions and responses to the DPG. They give particular emphasis to the attitudes of neighbors of participating farmers. Neighbor use of "tech packs" is strong evidence of their acceptability.

Enumerators also observe if and how farmers modify recommendations of the research team. Farmer modifications provide a basis for additional research to determine if they, in fact, are more suitable than the original recommendations. Consequently, farmer participation is an integral part of the research process.

The first DPGs were placed on farms in the fall of 1988. The typical production cycle for DPG (birth through at least two lactations) is between 3 and 4 years. Therefore, adequate evaluation will require monitoring on-farm performance of DPG, through at least 1992. Preliminary analyses of results from the evaluation already are underway. Final analyses and writing by the multidisciplinary team will require approximately a year following completion of the on-farm evaluation.

The evaluation, analysis, and writing will not be done in a discrete, step-wise basis. Instead, as sufficient information becomes available from the on-farm trials, those "tech packs" that have proven to be socioeconomically feasible are made available through extension to farmers elsewhere in Kenya.

Research on agronomic and nutrition-health-management interventions will continue, both on the research station at Maseno and with scientist-managed, on-farm trials. These trials are conducted with cooperating farmers and in different communities than those used for the evaluation of tech packs. Priorities for this research include:

- Multipurpose food/livestock feed crops, fuelwood/green manure forage legumes, and other interventions to cropping systems.

- Management of kids, replacement doelings, and lactating does.

- Low cost, low labor health management, etc.

This research is applicable to dual-purpose goat production in other parts of Kenya, and often to sheep and cattle on small farms in Kenya.

In addition, the multidisciplinary team serves as a useful

model for the farming systems approach to research and extension. KARI scientists working with the team are expected to move on to research units elsewhere in Kenya with responsibility for evaluating livestock, crop and agroforestry technologies under other farming systems. In addition, SR-CRSP activity serves as a training and demonstration unit for the farming systems approach. The multidisciplinary team also will develop training modules for DPG production systems and for other elements of the farming research activities. These training modules can be used in the academic programs of Kenyan universities.

5. Time Frame

The time frame initially covers 3 years. Additional funding is being sought to extend this period.

1990-91 Performance data from DPG analyzed and reported; first characterization of genetic potential of the breed.

Genetic evaluation program (Estimated Breeding Value: EBV) of sires completed for first year.

DPG doe selection initiated based on performance.

Release of 200 to 300 DPG bucks.

Selection for Haemonchus tolerance.

1991-92 Goats produced from intensified selection for milk yield.

Genetic evaluation program (EBV) for sires completed for second year and does added.

Release of 300 to 400 sires with EBV including first sires identified as elite genetic improvers.

First DPG does released to selected private multiplication farms.

Continuing selection for Haemonchus tolerance.

1992-93 Release of 300 to 400 sires of upgraded EBV.

Doe release increased to 300 plus.

Selection for Haemonchus tolerance.

6. Expected Results in Time Frame

After another 3 years of activities under SR-CRSP in Kenya,

the expected outputs can be summarized as follows:

- an established farming systems unit within KARI which will be a model for other KARI research programs.
- a nucleus herd of about 1,000 DPG does and 75 selected bucks.
- the release of about 500 DPG does and 1,000 bucks to selected farmers.
- about 40 to 50 technical interventions having been tested on-farm for technical feasibility, economic profitability, and social acceptability; about half of them are expected to be profitable and the majority of these also acceptable to smallholders.
- a sustained DPG multiplication program.

B. COMPLETION OF RESEARCH ON PROLIFIC SHEEP

1. Introduction

a. Background

A major component of the ongoing SR-CRSP research in Morocco and Indonesia has been studies of the mode of inheritance of prolificacy in populations of local sheep. In Morocco, the D'Man breed has a mean litter size approximately double that of any of the several other Moroccan breeds (2.0-2.5 vs. 1.0-1.25). In Indonesia, ewes with exceptionally higher prolificacy throughout their lifetime occur in most if not all strains, although the mean litter size is not as high as that of the D'Man or of several other known prolific breeds.

SR-CRSP research has shown that the D'Man breed transmits its prolificacy additively. This is indicated by litter sizes of approximately 1.1, 1.35, 1.60, 1.85, and 2.10 for ewes carrying 0, 25, 50, 75, and 100% D'Man inheritance, respectively, with the remainder from the Sardi breed. These values are for relatively young ewes, with values up to 20% higher expected for adult ewes on good feed.

This knowledge provides the means of developing stocks with any desired mean litter size; (there is considerable individual variation around those means, which is more difficult to control). This mode of inheritance is similar to that in the two most studied prolific breeds, Finnsheep and Romanov. The suggested method of exploitation is the same: higher percentage of prolific breed inheritance in more favorable production environments, lower percentage in less favorable.

Highly prolific ewes in Java have been mentioned frequently by animal scientists and agricultural observers for many years, dating back more than a century. However, flock average litter sizes reported generally have ranged from 1.5 to 2.0, which are not exceptional. SR-CRSP scientists examined the variation in litter size between and within ewes, and found some exceptionally prolific ewes, with mean litter sizes for their lifetime of 2.5 to 4. However, the majority of the ewes have quite conventional mean litter sizes of about 1.5.

b. Justification of Proposed Research and Assumptions that Work Can Be Done

The most important factor determining productivity of sheep kept for meat production is number of young raised per breeding female per year. This is determined by fertility (conception rate), number born per parturition (prolificacy or litter size), lamb viability, and frequency of parturition. Key among these components is prolificacy, which, in addition to setting an upper

limit to the number of young that can be raised per reproductive cycle, generally is correlated positively with fertility and with frequency of parturition.

Prolificacy represents a special case among quantitative production traits. First, it is a discontinuous variable; a female gives birth to one or two or three (or sometimes more) young. This alters the approach to defining optimum genetic potential, compared to that for continuously distributed variables such as growth rate or milk yield.

Second, prolificacy is a trait with an intermediate optimum, which varies with the production environment, particularly level of nutrition and management. Under conditions of scarce forage, climatic extremes, and limited care, one young (single) is usually the optimum. In such environments, young born as twins or higher multiples may suffer such high mortality that the net offtake rate is reduced compared to that with single births.

Under more favorable conditions, typically found in areas of higher rainfall and which can be created with strategic supplementation in many crop-livestock systems, birth of twins usually results in a substantial increase in productivity. Production is not doubled, because of slightly higher mortality and lower weaning weights of individual twin lambs compared to singles, but increases of 55 to 60% in weight of lamb weaned per ewe have been documented in many cases.

Under favorable conditions, where nutrition is not limiting at any time, with close supervision at lambing, and a market that justifies the costs of extra management, higher multiples may be advantageous. However, these conditions are likely to apply only in a limited portion of the range of sheep production systems. The intermediate situation, where twins are advantageous but higher multiples are not, is the principal target of SR-CRSP prolificacy research.

The genetics of prolificacy represents a paradoxical situation. Heritability, an indicator of the possibility of making improvement within populations by selection, is usually quite low, 5 to 10%. However, the large differences in mean prolificacy among breeds suggests a high degree of genetic control.

a. Morocco

From observations of agricultural systems in Morocco and experience, in California (with similar latitude and climate), it appears that there are large sheep-producing areas where an infusion of some percentage of D'Man is expected to increase amount and efficiency of meat production from sheep.

As Morocco has a deficit in meat production, a situation

forecast to increase, it is important to continue research and development in this area, from which the potential gains are large. At the same time, there are other areas where an increase in prolificacy may be disadvantageous. A focus of the proposed continuation of the prolific sheep research in Morocco is to identify those areas and production systems that can benefit from use of this tool, and to develop sheep production management systems for the country.

b. Indonesia

Measurement of ovulation rate and of the pattern of transmission of ovulation rate from dams to daughters has shown the high prolificacy of certain ewes to be related to the presence of a "major" gene, tentatively designated F^J (for fertility in Javanese sheep). F^J+ (and presumably F^JF^J ewes) have a high incidence of twins and triplets, with some litters $\geq$ 4, while ++ ewes have mostly singles at first lambing and about equal numbers of singles and twins at maturity.

This gene has the advantage of greatly increasing the heritability, and two lines are being developed rapidly by the project: high (H) (F^J-) and low (L) (++). The gene has the disadvantage of providing only two options, a mean litter size between 2 and 3 (occasionally more), or a mean litter size $\leq$ 1.5; neither genotype will consistently produce twins. Thus in some respects it is not as easy to use prolificacy inherited in this form as that from the D'Man in Morocco that transmits its superior prolificacy additively. However, the knowledge of the inheritance gained from this research provides for much better control than when the basis of the extreme variation was unknown. There are production systems in Indonesia where it appears the H line will be more productive than the L; in others, the L stock almost certainly will be more useful.

2. Objectives.

a. Morocco

To develop a 50% D'Man, 50% Sardi synthetic stock, for potential use as such in the more favorable production environments in Morocco, and to provide rams to sire 25% D'Man ewes, for systems where a lesser increase in twinning rate is desired. To evaluate these levels of D'Man inheritance under field conditions in selected areas.

To develop feeding and management systems suitable for a Mediterranean climate for sheep of improved prolificacy potential, and to evaluate the acceptance by farmers of the sheep and the management systems.

To evaluate the retention of F_1 and F_2 performance levels in the F_3 and later generations.

To begin selection for improvement of growth, wool production, and other performance traits in the DS stock.

To characterize physiological parameters of the D'Man and Sardi breeds relating to breeding season and to heat tolerance, with a view to using this information for more effective selection of the DS population.

b. Indonesia

To develop lines of sheep fixed for the normal allele (++) and, insofar as possible, for the F^J allele (F^JF^J). This will involve work on development of criteria to discriminate between animals homozygous and heterozygous for the F^J gene.

To compare F^Jf^J, F^J+ and ++ sheep with regard to important performance traits: puberty, lambing interval, lamb growth rate and total productivity per ewe.

To compare F^J- and ++ genotypes in farmer flocks with regard to performance parameters.

To develop feeding and management systems, through the OPP or similar program, to use the advantages of highly prolific sheep, and to evaluate the technical and economic feasibility of using these systems with these sheep.

To use advances in knowledge of the Booroola (F^B) gene to

- increase the efficiency of research with the F^J gene; and
- determine, if possible, whether the F^B and F^J genes are allelic (the notation used is tentative, for reasons of convenience, and allelism has not yet been tested).

3. Project Activities

a. Morocco

SR-CRSP prolific sheep research in Morocco has been conducted at the experimental farm at Tadla. SR-CRSP has had a major role in developing this facility as an effective sheep research center. IAV scientists in several departments have active research programs there, and prospects are excellent for continuing the proposed research there. The only serious constraint is an operating budget for research.

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A flock of 120 DS ewes, based on F_1's, F_2's and F_3's from earlier phases of the project, will be maintained at the Tadla Farm. One or more purebred flocks of 60 to 100 ewes each of the Sardi and D'Man breeds will be maintained; one of the Sardi flocks will be unselected and will serve as a control to measure environmental changes, for all groups. Maintenance of purebred Sardi and D'Man flocks also will provide the opportunity to produce F^1's at intervals as needed.

Surplus F_1, F_2 etc. ewes, and ewes from the DS synthetic line when available, will be placed with farmers and the ewes' performance monitored (an activity begun January 1989). Assessment of economic returns from these and conventional non-prolific sheep will be made as available data permit, assuming availability of economics expertise from IAV or SR-CRSP.

Field testing of the D'Man X Sardi (DS) crossbred stock has just been initiated by SR-CRSP in Morocco, and one large parastatal farm with several thousand ewes recently initiated a crossbreeding program with the D'Man breed, to increase productivity of its flock.

b. Indonesia

The BPT flock of approximately 150 ewes, currently housed at the Cicadas Station, is being used to develop F^J- and ++ lines. A small nucleus of ewes believed to be ++ is now identified, and several rams with a high probability of being ++ are available. The F^J- line of course segregates in the absence of established criteria for distinguishing F^JF^J from F^J+ ewes.

Ten rams from the Cicadas flock, including rams expected to be F^JF^J, F^J+ and ++ currently are being progeny tested in an unrelated flock at the Sei Putih Station in North Sumatra. This is the site where St. Croix hair sheep currently are being evaluated, and where the proposed expanded hair sheep project may be conducted. Classification of ram genotype will be based on ovulation rate of daughters as determined by laparoscopy. Assuming unequivocal identification of F^JF^J and ++ rams from this (and planned additional) progeny tests, the rams will be returned to Cicadas and used in the respective lines. F^JF^J rams will be mated to ewes with the highest ovulation rates (presumed F^JF^J ewes), towards the goal of establishing a homozygous flock. F^JF^J rams mated to known ++ ewes will produce known $F^J\pm$ ewes for comparison with the F^JF^J ewes. To date, no ewes are known for certain to be F^JF^J, but based on results with the Booroola, it is expected they will be substantially higher than F^J+ ewes in ovulation rate, and highly variable in litter size.

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4. Methods

a. Morocco

The DS flock at Tadla will be maintained with eight single sire mating groups each season. Mating will be for autumn lambing, the most common lambing season in Morocco.

Multitrait Selection. Multitrait selection will be practiced, with the objectives of improving lamb production, primarily with secondary emphasis on wool. Rams, which account for most of the selection pressure applied in sheep flocks, will be selected on dam's performance and own performance. The criteria listed below are the planned basis of selection initially. As data are gathered and parameter estimates obtained for these sheep, selection objectives and criteria will be refined.

Ewes meeting the following criteria will be designated as potential dams of rams:

- first lambing by 16 months.
- at least three lambs weaned by age 30 months, and two each year thereafter.
- lamb weights above flock average.

Numbers permitting, additional selections will be made on freedom from kemp (a fleece defect).

Among rams from such dams, those with above average weight for age, fleece weight, and fleece quality will be selected, based on a index to be developed for this flock.

Initially, some attention to color pattern and horns, which segregate in the DxS cross, will be needed to establish a phenotype that (a) can be readily standardized and (b) is likely to be accepted by Moroccan farmers. It is estimated that this will require only limited emphasis after the first generation, and that such a standard phenotype is important to the ultimate dissemination of the stock.

Physiological Factors. With regard to physiology, the D'Man has distinct advantages in terms of early puberty and lack of seasonal anestrum, and the Sardi is superior in heat tolerance. IAV physiologists on the breeding project team will continue studies of these and related processes, on the purebreds as well as the DxS, with a view to developing improved selection criteria for total performance. Specific techniques to be used in this research include:

- measurement of ovulation rate and embryo survival.
- studies on the endocrinological control of the breeding season, including both radioimmunoassay and ELISA

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techniques for measurement of hormone levels.
- measurement of water turnover rate and urea recycling.
- measurements of sweating, respiration rate and other responses to heat stress.

A particular interest in the environmental physiology area is the effect of kemp on adaptation to high temperatures. From a wool quality standpoint, it would be desirable to eliminate this defect, but its possible effects on adaptability will be assessed before a major effort to eliminate kemp from the DxS stock is undertaken.

b. Indonesia

Performance traits will be recorded for all sheep in the flock at the Cicadas Station, and data accumulated as rapidly as possible on comparative performance of the three genotypes.

Comparisons within farmer flocks probably will be restricted to F^J- (i.e., an unknown mixture of F^JF^J and F^J+) ewes vs. ++ ewes. These two groups will consist of (a) ewes surplus to the Cicadas flock placed in OPP flocks and (b) ewes classified on a combination of parentage information and own performance in the farmers' flocks.

As the F^JF^J and ++ lines are established at Cicadas and rams of known genotype become available, dissemination (and evaluation) of the different genotypes can be expanded to farms in any area of the country. This phase of the work will depend on the institute's interests and resources.

c. Morocco and Indonesia

Nutritional Factors. Ewe productivity can be enhanced by increasing number of lambs weaned per ewe and per year and by improving average lamb carcass weight. This is however a hard task to achieve in an environment where herbage production is dependent upon the rainfall and supplementary feeding is not a common practice.

The development of new prolific breeds suitable for the agropastoral regions of Morocco and humid tropics of Indonesia must be accompanied by the development of new feeding strategies, paying more attention to the critical reproductive phases of the ewe, and early growth phases of her progeny. Research in Morocco has focused so far on the mating phase, which coincides with the stubble grazing period. Different strategies of supplementation concerning ewes and lambs (both Sardi and F_1) have been tested for their effectiveness in avoiding weight losses and in achieving high conception rates. Research in Indonesia has focused on the use of byproducts from rubber and oil palm trees and on use of legumes and different energy products for feed supplements.

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Plans also include collaboration with SETAT, a Ministry of Agriculture experimental farm in southwestern Morocco where the research emphasis is with medics and nutritive evaluation of other legumes and barley straw.

Research in the coming years will look at the late pregnancy and early lactation phases to prevent abortion and lamb mortality, both common. Locally available by-products can be a good source of feed for supplementing rations for ewes. Creep feeding programs may be necessary to allow high lamb growth rate and early weaning. Different strategies for supplementing ewes during early and/or late gestation periods should be considered. Rotational grazing studies will be conducted in conjunction with studies exploring alternatives for improving quality of forage by introducing and testing new forages and shade-tolerant species in Indonesia.

Monitoring feeding aspects of more prolific ewes placed with farmers will be another component of the programs. Locally available feeds in areas where F_1 ewes are placed will be evaluated. Supplementation strategies developed in the Tadla and Sei Putih stations will be adapted to the local constraints. Consequences on sheep productivity will be assessed.

Efficiency of growth and fattening of weaned lambs will be the third component of the programs. Improving prolificacy leads to an increase in the number of lambs to be fattened for market and a higher demand for feed. Feeding programs adapted to this situation will be established, based mainly on by-products. Research will focus on evaluation of their nutritional characteristics and potential value as feed ingredients in diets for growing and fattening lambs. Some of them have potential as sources of energy (beet pulp, citrus pulp, carob pulp, molasses, etc.); others can be used as sources of protein (wheat bran, sunflower meal, palm oil meal, etc.).

Nutritional benefits and the economics of supplementing diets based on crop residues and by-products with protein and/or non-protein nitrogen need to be established clearly. Likewise, growth and fattening potentials of crossbred lambs will be assessed and compared to those of other genotypes under different feeding strategies.

Socioeconomic Factors. While the introduction of greater proficiency in Moroccan and Indonesian sheep holds great promise for improving the economic wellbeing of their raisers, many issues need to be resolved before final recommendations can be made. Among those questions are who, if anyone, will benefit from the "new" breeds, and what problems are anticipated in attempting to disseminate them among small producers?

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As many Moroccan agropastoral households already include sheep in their production strategy, issues surrounding the acceptability of sheep are largely moot. However, an increase in proficiency also will undoubtedly require a number of changes in management inputs. The effects of these, both economically and socially, will need careful study. Among the factors to be examined are:

- The need for increased household (or other) labor in the small ruminant portion of the production unit.
- The possible greater need (and the availability) for purchased inputs (e.g., feed supplements) in the new production system.
- The suitability of the prolific strain in the mixed species herding environment common to Morocco.
- The willingness of farmers to tolerate greater lamb death losses even if more lambs survive.
- The suitability of the production systems for limited resource farmers. More explicitly, on what types of farms will the prolific system be most likely to have a positive effect?

An assessment of these socioeconomic factors, along with the concurrent research on the biological questions, will provide the information necessary to formulate recommendations appropriate to various types of small farmers in Morocco and Indonesia.

5. Time Frame.

1990-91 DS line matings; develop preliminary selection index; initiate selections (Morocco).

Conduct physiology studies of D, S, DS (Morocco).

Develop technological packages for farmer flocks with increased prolificacy. Provide sheep and information to cooperating farmers.

Use proven F^JF^J and ++rams in H and L lines and continue progeny test to expand numbers of proven rams (Indonesia).

1991-92 Evaluate technological packages.

Identify cooperators to make intraflock comparisons of progeny of DS and S rams; place rams in flocks (Morocco).

Compare performance of presumed F^JF^J and known F^J+ and ++sheep (Indonesia).

1992-93 Continue selection in DS stock and all aspects of performance evaluation (Morocco).

Analyze 1990-92 data and develop improved selection index (Morocco).

Continue on-farm testing and evaluation of technological packages.

Summarize and report results for scientist and extension/producer audiences.

6. Expected Results in Time Frame

1990-91 Establishment of a program to develop a new breed with a combination of performance traits not existing in any present breed of the region, to permit utilization of higher potential production environments, and of advances in nutrition and management (Morocco).

Progeny tested rams of known genotype available for use in development of high and low prolificacy lines (Indonesia).

1991-92 Data on physiology of adaptation to the environment, to be utilized in improving selection in the new breed (Morocco).

Prolific sheep technological package available for on-farm testing.

Nutritional management package for prolific sheep.

First reports on performance of DS crossbreeds (base population for the new breed for the new breed) under farm conditions (Morocco).

1992-93 Scientific publications on genetic parameter estimates from the crossbred population and on performance of stocks under experiment station conditions (Morocco).

Scientific publications on nutritional management for prolific sheep.

Preliminary technological packages available to extension/producer groups.

Refined estimates of selection criteria, based on

parameter estimates and data from cooperating farms (Morocco). Performance data available on animals of known prolificacy genotype under farm conditions (Indonesia).

C. HAIR SHEEP PRODUCTION SYSTEMS

1. Introduction

a. Background

SR-CRSP experience suggests that by improving feed supplies, health practices, management techniques, and genetic potential, it is highly probable the productivity of hair sheep in the tropics can be increased and made more cost-effective.

Small ruminants nearly always are kept as part of an integrated farming system. They fit in nearly all of the basic agricultural systems (swidden, shifting, nomadic, transhumant, rainfed, irrigated, plantation, commercial, etc.). During the first 10 years of SR-CRSP, most of these systems were studied to some extent, and the rainfed and plantation systems identified as the two potentially most-productive systems for smallholder small ruminant production. Both systems operate in humid or semi-humid tropical environments.

The fragile lands under which such systems are managed can be productive when managed properly. Much of the vegetation is of high fiber content, and perennial plants are a desired element of these systems. Ruminants can transform the low- value vegetation into a high-value product and, at the same time, help to sustain the system of which they are a vital part.

Small ruminants provide unique opportunities for limited-resource farm families in the humid and subhumid tropical developing regions, such as sub-Saharan Africa and portions of Asia and Latin America. The small size of these animals, their low feed requirements, short generation interval, and high reproduction rates contribute to high returns on relatively low investments. A high potential exists for increasing the number of sheep in the humid and subhumid tropics by improving the efficient use of available feeds and using feedstuffs that can be generated by modifying traditional farming systems.

Increased demands for animal protein can be met, at least in part, by expanding the small ruminant population and by increasing its efficiency. There is also a high potential for integrating small ruminant production with such tree crops as rubber, oil palm, and coconut. Small ruminants can be a livestock component in the agroforestry systems now expanding in many tropical regions. In such situations, SR-CRSP can play a critical role in helping to enhance income as the crop and livestock enterprises are often complementary rather than competitive.

But not all small ruminants are equally productive in tropical environments. The familiar wool sheep breeds of the temperate zones fare poorly when exposed to the heat, humidity, diseases, and

parasites of the lowland tropics in contrast to hair sheep, which have evolved under tropical conditions. They survive reasonably well, are more fertile, and have the potential for high productivity under tropical environmental constraints. Preliminary evidence indicates considerable phenotypic and genetic variations among types of hair sheep. These variations can be useful in the development of more suitable sheep for warm, humid areas.

b. Justification of Proposed Research and Assumption that Work Can Be Done.

During the first 9 years of SR-CRSP, research concentrated on identifying the problems and limitations of small ruminant production. A collaborative effort to gain knowledge and understanding of the socioeconomic, nutritional, genetic, reproduction and health components of small ruminant production has resulted in increased knowledge of how small ruminants currently fit and potentially could support the agricultural systems.

Earlier work showed that the small ruminant is an economically viable unit and contributes significantly to the economic growth of the community. Inadequate feed quantity and quality with variation in seasonal availability led nutritionists to identify many feed resources (by-products, residues, special plants, etc.) to meet the nutritional needs for survival and moderate production.

An important constraint on small ruminant production has been a low reproductive rate, in terms of numbers of young weaned per female per year. Identified factors include long parturition intervals, high neonatal mortality, and low genetic potential for prolificacy. Genetic lines have been identified (high prolificacy and low prolificacy) that can be used to give more predictable lambing rate, and hair sheep have offered higher potential than wool sheep for growth and survival. Constraints on production from the health standpoint generally have been management problems. As more intensive systems of production are developed, health considerations become important.

It is clear that to improve the productivity of sheep a collaborative effort is needed to improve the nutrition, health, management, and genetics (Figure 2) within the socioeconomic constraints of the system. Such an effort will increase productivity and, therefore, economic value. As hair sheep have proven to be more productive (reproduction and growth), the research approach for the next phase will be to improve production through practices related to feeding, breeding and reproduction, and health management to fit into the current socioeconomic and marketing system or to develop alternatives. Projected obtainable goals are presented in Table 5. With improved breeding, reproduction, nutrition, health, and management, the goals are attainable.

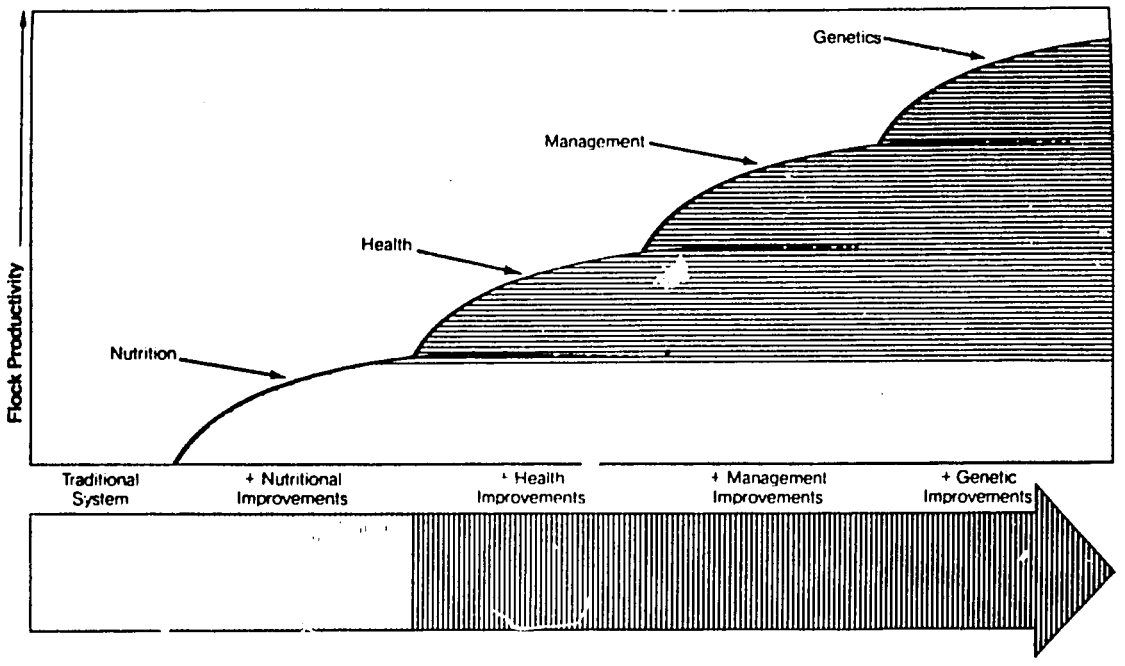

Figure 2. Cumulative and complementary effects of interventions to remove major constraints on flock productivity (from: Fitzhugh and Bradford, 1983. Hair sheep of Western Africa and the Americas: A Genetic Resource for the Tropics. Westview Press).

Table 5. Current Production Levels and Goals for Small Ruminant Production

TRAIT	NOW	UPPER/LOWER LIMIT	GOAL	%IMPROVEMENT
Age at puberty (months)	6-12	5	8	11
Lambing interval (days)	210-365+	180	240	16
Lambing rate (%)	130	400	200	54
Survival to weaning (%)	70	100	90	29
Growth rate (g/day)	40-100	250	120	58
Weight at market (kg)	15-25	40	30	50
Age at market (months)	8-15	4	6	52

2. Objectives

To develop and adapt hair sheep production systems to the needs of smallholders in the humid and sub-humid tropics. The systems will use local vegetation and feed by-products as the principal feeds because of the close integration between the cropping system and livestock components. Specific objectives include:

To develop a productive strain of hair sheep with superior genetic potential for resistance or tolerance to internal parasites that is well adapted to the climate and feed

resources of the humid and sub-humid tropics and lends itself to the management systems of both smallholders and plantation tree crop owners.

To develop feed production and preservation systems that permit hair sheep to achieve economically favorable levels of reproduction and growth.

To 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).

To develop a sustainable system integrating sheep production with tree-crop production including introduction of new forage species and grazing management.

To develop health management systems to control major diseases and parasites with low cost inputs to minimize losses from morbidity and mortality.

SR-CRSP scientists will provide limited but consistent financial and technical support to assure the successful implementation of the research effort. SR-CRSP also will provide training in US institutions as well as other types of support for the professional development of the national agricultural research and extension system (NARES) staff.

The general approach of the program will have three distinct features: (a) integration of disciplines by multidisciplinary formulation of research projects and proposals; (b) active participation by farmers in on-farm research; and (c) special attention to the role of women in small ruminant research, training, and on-farm testing activities.

Research results will be shared among participating NARES, thus establishing an international hair sheep research network. The benefits of such a network would include shared research plans and results, exchange of experiences through workshops, seminars, and conferences, and transfer of suitable genetic resources.

3. Project Activities

The proposed research for the feed resource, breeding and physiology, socioeconomics, and health components are as follows:

a. Specific Objectives and Requirements.

(1) Feed Resource Component (Nutrition and Agronomic Aspects)

The major limiting constraint to sheep production generally is quantity and quality of feed available. Seasonal shortfalls in

quantity and/or quality are prevalent, even where total annual production appears adequate.

Research on preservation of feeds is important. Major difficulties include making hay during rainy seasons, poor forage quality in dry seasons, and lack of inexpensive soluble carbohydrates for silage (people eat the grain).

Results of agronomic research will be applied to increase the quantity and quality of feed available to support hair sheep production without decreasing food or cash crop production. Therefore, innovative cropping systems, using various crop combinations and harvesting patterns, are required. Research will lead to more effective use of space (arable land is limited) and time (both within and across growing seasons, which primarily depend on amount and distribution of rainfall through the year).

Increasing feed production under tree crops will depend on innovative combinations of grasses and legumes and on managing their utilization. Research will address the issue of competition of sheep and pasture with tree crops during stages of tree development. High-value tree crops may require use of chemicals to control pests and fertilizers to increase production. How will these affect sheep production, or will sheep production help reduce the reliance on these inputs?

The specific objectives of the feed resource component are:

To develop a feed production and preservation system that provides feed throughout the year.

To identify grazing and shade-tolerant forage (grasses and legumes) species and cultivars that are productive, sustainable, or of high quality.

To develop feeding strategies (nutritional and management systems) using available feedstuffs and byproducts so that the small ruminant community develops as a complementary component of the cropping system and leads to long-term stability of the farming enterprise.

The requirements for the feed resource component are:

Interactions with agronomists and soil scientists.

Host country institution with scientists who are trained or willing to be trained in nutrition and/or agronomy and who are interested in small ruminant production.

Land area for forage testing plot work (both open land and land under plantation crops) and land available for grazing work.

Animal facilities for digestion, palatability, intake, and growth studies.

Laboratory facilities for nutrient analysis (nitrogen, fiber, mineral, etc.).

Commitment of host country institution to support a collaborative program.

Desire of host country to test new technologies under field conditions.

(2) Breeding and Physiology Component

Sheep are less numerous in the humid and semi-humid tropics than in semi-arid areas, but the potential for increased production is much greater in the more humid areas because of more abundant feed supplies. One reason for the current situation is lack of a readily available source of breeding stock adapted to the warm humid tropics. Such animals exist in the form of hair sheep. However, performance of different types of hair sheep is not well documented. No population of these animals currently is being selected systematically to make genetic improvement in performance. There is no identified source of breeding stock available for import into tropical countries wishing to expand sheep production.

As a result of this lack of availability of hair sheep breeding stock, tropical countries are importing unadapted breeds. Mortality of temperate area wool sheep breeds recently imported into Malaysia has been about 50% in the first year, whereas there has been little mortality of a small importation of hair sheep in 1985 by SR-CRSP into a similar environment in North Sumatra.

There is clearly a need to evaluate the different genetic stocks of hair sheep for their suitability in such environments, and for establishment of a genetic improvement program and a source of breeding stock for areas of the humid tropics wishing to utilize available and potential forage resources for expanded sheep production. Expansion of sheep numbers has the potential not only for increasing smallholder income and national meat supply, but also of reducing use of herbicides under estate crops and of improving soil fertility.

The specific objectives of the breeding and physiology component are:

To capitalize on variations among hair sheep breeds to identify a highly productive breed or breeds, or to develop by crossing and selection more productive types than presently exist.

To develop technology packages, for flocks of different sizes, applicable by farmers of the region for effective exploitation of hair sheep in this ecosystem.

In collaboration with the other components, the animal geneticists to lead an on-farm breeding component where farmers will raise sheep of the more productive types identified or developed. Under guidance of project scientists, a selected group of farmers will become a nucleus of private small ruminant multiplication farms.

In cooperation with veterinarians, to identify, select, and test animals resistant to the internal parasite Haemonchus contortus.

The requirements for the breeding and physiology component are:

A supportive host country institution with relevantly trained scientists committed to the project. Additional scientists can be trained by the project, but an initial core of small ruminant expertise is essential.

A commitment of U.S. and host country governments to a sustained effort.

An adequate land/forage resource at one site for a flock of a minimum of 350 breeding ewes, in the early years, and 500 later, plus rams, replacement ewes, and lambs.

Sufficient infrastructure to permit embryo transfer, animal health monitoring, environmental physiology studies, etc.

Feasibility of obtaining frozen embryos from desired stocks from other countries, and permission to import these.

(3) Socioeconomics Component (Rural Sociology and Economics Aspects)

The potential values of hair sheep to the economic wellbeing of farm families in the humid tropics can be substantial. Hair sheep are adapted to such climates, convert feed resources that have little alternative value, and require relatively small capital investment. Relative to cattle in the tropics, hair sheep have high reproductive rates (early maturity, short gestation, and large litter size) and thus potentially yield greater offtake.

Combining these attributes, hair sheep have significant potential as a "cash crop," perhaps the best one available to small farmers. Sales of sheep generate a cash flow much needed in an increasingly cash-based economy.

Private sector market development opportunities stem from

urban consumer demand for meat. Traditionally, meat has high income elasticity. This trend holds for sheep meat in most developing countries.

Emphasis will be on high-potential agroecological tropical conditions, i.e., those situations where neither rainfall (amount and distribution) nor soil fertility limit agricultural production. For our purposes, "humid tropics" means high potential for agriculture. Increasingly, high-potential areas in developing countries are populated densely. What is the appropriate role for hair sheep in densely-populated areas where there is major competition for use of common grazing land? Are there social issues? Are there ecological degradation problems on marginal lands? Can the system become sustainable over time?

The specific objectives of the socioeconomics component are:

To test the economic profitability and social acceptability of new technologies.

To develop innovative procedures that facilitate farmers' participation in research, e. g., group discussions, visual aids, etc.

To assist the formulation of research activities by the maintenance of Technology Information Files (TIFs) that provide a continuously updated state-of-the-art report on new small ruminant technologies. TIFs, a research management tool, are useful byproducts of the emphasis on the development of "tech packs" during the most recent 3 years of SR-CRSP.

To identify the role of women in small ruminant production and development in order to improve the lives of women through improved hair sheep production.

To provide information on the small ruminant economy to policymakers, agricultural administrators, and private businesses.

To evaluate methods of integrating social sciences and biological research in livestock research projects.

To identify and evaluate indigenous animal health and management technologies that might be incorporated into technology packages.

The above objectives cover more specific research questions, such as: What is the demand for sheep meat at local, regional, and export levels? What is the competitive potential for land farmers in these markets? Are there special, traditional tests and preferences that must be served (e.g., in most west Asian countries meat from fat-tailed breeds is worth roughly double that for

thin-tailed breeds)? What is the economic value of genotypes that have higher growth rates; higher reproductive rates (what are true opportunity costs of twins, triplets?); better adaptation (e.g., trypanotolerance)? Are these genetic "improvements" mutually complementary or competitive in terms of economic values? Do they increase production costs more than income? For example, what are opportunity costs for labor devoted to sheep production activities? Do improved genotypes require more labor-intensive management?

The requirements for the socioeconomics component are:

A supportive host country institution with sociology and economics trained scientists committed to the project. These scientists should be located at the project site(s).

Commitment by U.S. PIs and Indonesian collaborating social scientists to conduct multidisciplinary research and work in research teams.

Commitment by the host country institution to collaborate with extension agencies and/or private development oriented firms or farmers.

Firm indications that collaborative research with farmers is feasible.

Willingness of host country institution to accept U.S.-based Ph.D candidates and collaborate with them in thesis research activities that support the overall program.

Adequate data processing facilities.

(4) Health Component

Experiences gained in SR-CRSP animal health research in Kenya, Brazil, and Peru helped to evolve a strategy that will be applied in hair sheep production system research. 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 for which there is no readily available and feasible solution.

The specific objectives of the health component are:

To identify the sheep disease problems of major economic importance in the region (much of this information already is published). To supplement existing information, SR-CRSP animals will be monitored to identify the causes of morbidity and mortality. This will be done in existing facilities and resources in collaboration with host country veterinarians and government diagnostic laboratories.

To implement existing disease control procedures for the diseases identified above. Disease-control programs will be selected on the basis of a comparative cost/benefit analysis of the possible interventions and on their suitability to local production systems.

To develop effective control procedures for diseases currently lacking such procedures. Infectious diseases presently uncontrolled and representing important production constraints will be targeted for vaccine development through the Animal Health Management Through Biotechnology projects. (Section E)

To collaborate on research to identify in individuals and breeds that are resistant or resilient to the internal parasite H. contortus. As Haemonchus is a major problem in the tropics, the development of animals less susceptible to this condition is desirable.

b. Sites

Indonesia has proven to be a productive site for collaboration. As research activities on hair sheep as well as on small ruminant-tree crop plantation systems are underway, it is a preferred choice to continue research there.

Explicit reasons for keeping Indonesia as a research site are:

SR-CRSP, involved in Indonesia since 1980, has developed excellent collaboration with BPT (Animal Husbandry Research Institute) and more recently with BPP (Rubber Research Institute). Support from the directors of both institutes for CRSP activities, and particularly for the sheep-under-rubber project, is excellent. The integration of this program with the proposed program could be initiated without delay.

A collaborative hair sheep research project is well underway with promising results.

Strong interest exists in Indonesia, Malaysia and other countries of the region in developing technology for sheep production under tree crops, including use of more suitable sheep genotypes and more efficient use of existing feed resources. Networking of research results is expected.

The U.S. and host county participants of SR-CRSP in Indonesia have extensive experience working with smallholder farmers in raising small ruminants. In addition, there is keen interest among government officials in field testing the technologies developed.

The North Sumatran plantation ecosystem is characterized by

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a hot, humid climate year round. If a productive animal well adapted to this climate were developed, it would be expected to do well throughout the low elevation, humid tropics.

There is an under-utilized large potential forage resource in the estate tree crop (rubber, palm oil, coconut) plantations of countries in the region, including nearly 2 million hectares of rubber in Indonesia. Grazing under tree crops can increase the sustainability of the system. It reduces or eliminates the need for chemical herbicides, improves soil fertility, and the forage crops help to control soil erosion.

The Javanese Fat Tail breed of sheep, concentrated in East Java, has a moderate incidence of wool-free animals, providing a local type suitable for inclusion in a hair sheep research program.

Other sites may be explored to broaden the scope of sampling among genotypes of hair sheep and ecosystems. As Indonesia represents a sample of only a few of the numerous types of hair sheep and a limited number of ecosystems, it is desirable, if funds and priorities permit (see Section IV, plan A), to consider other sites involving additional breed types and ecosystems.

Several countries already have expressed strong interest in developing collaborative programs in hair sheep research. Additional sites would be selected using already established criteria and with particular attention to such in-country factors as: large choice of indigeneous hair sheep genotypes; under-utilized forage resources under tree crop plantations; and the national agricultural research system's demonstrated interest in collaboration. [See annex I for criteria on site selection.]

Possibilities for collaboration between international agricultural research centers and SR-CRSP are being explored as these organizations have potentially complementary small ruminant research programs.

4. Methods

a. Feed Resource Component Methods.

Forage Productivity and Quality. Cutting/grazing frequency experiments to compare forage productivity and sustainability of fast-growing tropical grasses, legumes, and leguminous tree shrubs (e.g., sesbania, leucaena). Measurement of sustainability of production and forage quality (digestible dry matter and digestible crude protein).

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

activities focus on management of animals and forages under trees of various ages. Important research areas are: long-term impact of grazing and of manure on tree growth and primary crop productivity; screening of grasses for shade tolerance; and minimization of labor requirements in managing grazing flocks while maintaining their security.

Feed Preservation. Develop means of preventing feed shortages by comparing the use of feed banks, alley cropping, intercropping forage with food crops, or hedgerow cut-and-carry forages. Seasonal feed surpluses will be conserved by stockpiling/deferred grazing, hay-making, and silage-making and will be evaluated as top quality and efficiency of feed storage.

Community Nurseries. Many farmers will not have ready access to adapted forages and tree legumes identified above. In collaboration with extension agencies, the project will establish community nurseries to propagate and distribute forages and trees. Farmers will be instructed in how to produce and harvest forages.

Dual-purpose Food/Forage Crops. Major sources of by-product forage include sweet potato, maize, and sorghum. Cooperative trials will compare the grain and forage characteristics of these and other potential varieties and hybrids.

Nutrient Values. On-farm and off-farm feed sources will be tested for quality, palatability, and the presence of anti-quality factors. *In vitro* nutrient analyses will be performed.

Lamb Rearing. The production potential of sheep often is limited by the milk yield of ewes. The possibilities of early weaning and the use of low-cost milk "replacers" will be studied.

Intensive Feeding. Combinations of locally available feedstuffs will be tested with the goal of achieving >120 g/d growth rate.

b. Breeding and Physiology Component Methods.

Selection of Breeds. The principal goal of the genetics component is to compare, in one location and on an adequate scale, adaptability and performance of strains of hair sheep. The possibilities include: Barbados Blackbelly, Santa Ines (from Brazil), Virgin Island White (St. Croix), "West African" (Caribbean area), Djallonte' or West African Dwarf (West Africa).

Acquisition of Stocks. It is proposed that breeds from a country distant from the work sites be introduced by transfer of frozen embryos. This has the advantage of reduced risk of transferring disease, and, by virtue of transferring embryos in fixed numbers to ewes of a single (local) recipient breed, comparison of first generation animals free of differential maternal or litter size effects. Total costs also should be lower than for live animal

importation, although still substantial.

Evaluation of Imported and Local Breeds. Traits to be measured on all stocks include: size and growth rate, ewe reproduction, ram reproduction, *Haemonchus* loads, wool cover and wool density scores, mortality by age and season, and, facilities and labor permitting, feed intake and feed conversion efficiency, and measures of heat tolerance or response to heat stress.

Selection Among Breeds and Crossbreeding. Based on the performance data collected, the relative suitability of the different breeds to contribute to the next phase will be assessed.

Definition of Breeding Objectives for the Composite. Data from the breed comparison phase will be used for estimates of phenotypic and genetic parameters, including estimates of correlations between *Haemonchus* infestation and performance. These parameter estimates will be used for preliminary definition of breeding objectives and development of selection criteria for the composite.

Selection in the Composite for Improved Performance in a Tropical Environment. Breeding animals will be selected based on estimated breeding values (EBVs) for the specified performance traits that will include measures of reproduction (prolificacy, frequent parturition) and growth rate.

Field Testing of Stocks. This will occur simultaneously as the station work advances. The Kenyan examples have shown the desirability of early evaluation of animals on the farm. It would be done in collaboration with the forage, nutrition, health, and economics components. In Indonesia, selected farmers among the OPP collaborative farms can participate in the breeding selection process under a contract arrangement.

c. Socioeconomics Component Methods.

Technology Information Files. Annually, the socioeconomic group will update the TIFs. Individual scientists will be teamed with one or more biological scientists according to the nature of the technology being developed.

Technology Testing. Technology will be tested in three ways: (a) by cost-benefit analysis, (b) by whole-farm modeling, and (c) by measuring farmers' responses to technologies being tested on-farm. This can be done through discussions, surveys, or other observations.

Policy. Policy studies will be formulated only after discussions with livestock services and private businesses or researchers, using interviews, surveys, and other methods. Some research will focus upon institutional arrangements that enhance interdisciplinary research; other types of policy studies will be

initiated only as a result of consultation with scientists. Policy research will be problem-driven rather than scientist-driven.

Role of Women. Presently women play a key role in the management of small ruminants, especially in cut-and-carry forage systems where the animals are kept continuously close to the homestead. During the testing and extension of new technologies, special attention will be paid to involve these women. The objective will be to maximize the chances that the benefits of the new technologies will flow to the members of the families who actually take care of the animals.

Multidisciplinary Research. This will include evaluation, with appropriate disciplines, of indigenous herd management and health care technologies that might contribute to a hair sheep production system appropriate for small producers. This will be done through surveys, interviews, and field experiments. In addition, the socioeconomic program will support and promote actively other multidisciplinary research topics identified by the research team.

d. Health Component Methods.

Disease Identification and Control. In collaboration with host country veterinarians and government diagnostic laboratories, the major sheep diseases of economic importance will be identified, and plans will be developed to control these diseases.

Uncontrolled Infectious Diseases. Infectious diseases that are identified that are uncontrolled and of economic importance will become part of the multivalent vaccine research described in the Animal Health Management Through Biotechnology section.

Haemonchus Contortus Resistance. In collaboration with the breeding and physiology component, rams will be identified and selected that are resistant or resilient to H. contortus. This could add genetic control to other control methods. If resistant sheep are identified, molecular markers may be identified with DNA probes.

5. Time Frame

1990-91 Identify host country scientists for collaboration. Identify worksites within country. Identify individuals and initiate training for advanced training. Begin establishment of forage plots. Establish facilities and flock of sheep. Decide on breeds and sources for importation. Collect, freeze, and ship embryos.

1991-92 Collect potential feed sources and determine nutritive value by chemical/in vitro methods. Begin cutting/grazing frequency experiments on small plots.

Transfer embryos to recipients. Raise lambs to initiate breed comparisons. Evaluate for Haemonchus resistance/ tolerance. Identify additional graduate students for training.

1992-93 Establish community nurseries with forages identified in 1991- 92 and begin distribution to farmers. Continue cutting/grazing frequency experiments on small plots. Feeding/growth trials on best feedstuffs identified 1991-92. Begin first mating of contemporary animals of three or four breeds. Initiate evaluation of heat tolerance. Identify farmers for contract breeding of hair sheep. Direct graduate student research in host countries where feasible.

1993-94 Conduct feed preservation experiments with feeds identified above. Develop feeding systems for small ruminants. Begin experiments on feedstuffs for early weaning. Make second and third matings of three or four breeds. Integrate degree trained personnel into research program.

1994-95 Develop feeding systems and extend to on-farm-test and evaluate with farmers. Select among breeds; initiate crosses. Integrate degree trained personnel into research program.

6. Expected Results in Time Frame

1990-91 Identification of worksite(s), participants, genetic stocks. Collection of embryos.

1991-92 Identification of forages that compete and have high quality. Transfer of embryos and establishment of stocks in one location.

1992-93 Report on success of frozen embryos as means of transfer of genetic stocks. Preliminary report on performance of different breeds. Preliminary report on feeding systems for growth.

1993-94 Scientific papers on: (1) physiology and parasite resistance/tolerance of different stocks; (2) phenotypic and genetic variances and correlation among traits, including between performance traits and measures of health and adaptability; (3) forages for use as feed/growth quality and animal preference and performance. Assist trained personnel with re-entry into research program.

1994-95 Scientific and technical papers: (1) summarizing performance of stocks as pure strains; (2) preservation of tropical forages; (3) local feedstuffs for early weaning; (4) feed production systems for maximizing utilization and production. Reports on community nurseries and use by farmers. Continue guidance to trained researchers returning to program.

D. SUSTAINABLE AGROPASTORAL SYSTEMS ON MARGINAL LANDS

1. Introduction

a. Background

More than 50% of the world's small ruminants live on marginal and fragile lands where animals depend for forage on grazing and by-products of dryland agriculture. These low agricultural productivity areas are characterized by seasonal shortages of forage and water, limited (or non-existent) commercial inputs, and periodic but unpredictable droughts that can decimate herds. More importantly, these droughts, along with inappropriate livestock management, can reduce the productivity and resiliency of natural grazing lands.

Under precisely these types of environmental constraints, properly managed small ruminants can return the greatest relative benefit. Small ruminants subsist in harsh environments, provide important sources of protein, and become the means by which some of the poorest people minimize risk, so as to cope with low standards of living. But the sustainability of these agricultural systems is questioned.

There is a need to increase productivity of small ruminants to help poor people, and there also are growing concerns about the effects of these animals on fragile environments. Desertification, loss of biological diversity, and overgrazing are terms encountered regularly in the press. Goats have an undeserved reputation as despoilers of the forests. While livestock tends to receive most of the blame for land mis-use; the combined impacts of shifting cultivation and over-harvesting of trees and shrubs for fuel are greater than that of livestock in almost every case.

Even well-intentioned efforts to improve range livestock production have been identified as contributing to (rather than alleviating) the problem. Reliable information is needed so that people do not do more harm than good in attempts to increase livestock production.

Problems and their solutions tend to be site-specific. SR-CRSP research has detected common biological and sociological principles among world ecosystems where sheep and goats are produced. The project will seek to identify these commonalities. The main goal will be new information that ultimately can lead to improved technology and more enlightened land-use policy.

The current state of knowledge and its application are inadequate for several reasons: (a) Some is founded on a United States-based paradigm inappropriate in many developing-country situations; (b) much has focused too narrowly, viewing small ruminant production as a entity in itself rather than a part of a

larger biological and socioeconomic system, and (c) too little attention has been given to the implications of governmental policy as it affects land-use and livestock production. The proposed research will address these issues and will build upon SR-CRSP experiences, particularly in Brazil and Peru where SR-CRSP research has led to major advances in knowledge for improving the productivity of these marginal ecosystems, summarized in section II.A.1., paragraphs h through l under long-term potential benefits.

In northeast Brazil, the herbaceous growth that follows traditional clearing of the caatinga forest can be sustained even if only half the tree canopy is removed. By favoring the more valuable tree species and exercising a little more control over goat grazing in the first year after woodcutting, the total economic productivity of the system is enhanced substantially. An interdisciplinary research approach led to more knowledge and a better understanding of the causative factors that shape both the biological and commercial productivity of the caatinga.

Resource degradation does not necessarily result from manipulation of the natural resource for commercial gain. On the contrary, appropriate management could serve to sustain the ecological integrity of the caatinga at the same time that economic production was being increased. Not every ecosystem has such fortuitous structure, but SR-CRSP experience in Brazil suggests that it is logical to obtain basic knowledge of how the total system functions in order to devise rational land management schemes before embarking on massive interventions that ignore the hazards of system interactions.

A systems approach to SR-CRSP research in the grazing lands of Peru generated management recommendations that address both productivity and land conservation issues. The camelids (llama and alpaca) are better adapted to the Andean rangelands than the sheep that have caused severe overgrazing. A rotational grazing system accelerated the recovery of deteriorated grazing land.

For optimum use of the range, one must consider the dietary habits of these ruminants. As llama and sheep complement one another, they may graze together. But alpacas compete directly with sheep and llamas and should be herded in pure flocks. By integrating the forage resources from irrigated pastures with natural grazing lands, the highly valuable alpaca fiber yield can be increased by 20%. The Peruvian SR-CRSP studies directed ruminant production back to the indigenous species to achieve a better compromise between economic harvest and ecological values.

The fact that most of the world's small ruminants are produced in an agropastoral setting (rather than in feedlot or stall-fed conditions) imposes serious considerations on how research is designed and how it is used. In other words, it is not only necessary to understand how to improve animal production, but also

to understand how grazing and browsing livestock affect their environment so that damaging practices can be changed or mitigated if production is to be sustained into the future.

The social and economic constraints that small ruminant producers face are key factors in this land-animal relationship. Knowledge of biological features will be of little help in improving sustained production unless these social/economic constraints are removed or minimized. Small ruminant production under agropastoral situations is a classic example of applied ecology. All parts of the system--livestock, plants, soils, climate, other animal species, and humans--and the major interactions among these parts must be considered.

b. Justification of Proposed Research and Assumptions that Work Can Be Done

Attempts to transfer North American range management and range-based livestock management techniques to the agropastoral zones of Africa and Asia too often have failed; in Central and South America they have been marginally successful, at best. Because these efforts generally have not resulted in increased livestock production or improvement in the producers' "quality of life," the wisdom of continued support of range/livestock development projects in the third world has been challenged.[16] Many problems associated with failures such as these can be addressed through improved management, communication, and cooperation. A more fundamental issue is the nature of the technical package itself, and the premises upon which it is based.

The technical foundation of range management in North America is a set of principles defining the dynamic interactions between rangeland and the grazing animal, namely (i) degradation of rangeland is the result of overgrazing by excessive numbers of domestic livestock, "excessive" being more than the long-term carrying capacity at which forage production is sustained and the health of the plant community maintained; (ii) by controlling (usually reducing) the numbers of livestock and restricting the grazing season, degraded rangeland will recover to its former high level of productivity.

In North America where government agencies and private landowners control land use, this model of range management has worked well. It has been exported with pride. The initial success of our range management programs masked the fact that assumptions of the North American model of range management is a special case of a more general model.

The stability underlying our model of range management may not be manifest in some of our arid and semi-arid ecosystems as well as in Africa.[17,18] There are valid theoretical reasons to suggest

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that the ecology of semi-arid ecosystems has been oversimplified.[19,20] With its emphasis on protection of natural resources at the expense of livestock production, the American approach to range management conveys an impression of ecological stability that is not evident in other agropastoral systems that suffer from dramatic shifts in productivity, especially in Africa.[18,21,22] SR-CRSP research on traditional third country range management found no sustainable systems based upon equilibria approaches.

Climate in most agropastoral areas, particularly rainfall, is highly variable and inherently unpredictable. Droughts are normal, periodic events. Under these conditions the plant-animal equilibrium (the goal of American range management) can only be achieved, if ever, for short periods of relative tranquility between sharp climatic fluctuations. Heavy grazing pressure during a drought exacerbates feeding problems, but in periods of heavy rainfall, livestock can not control the lush vegetation. Stability of a ecosystem thus becomes primarily a function of the vegetation's intrinsic tolerance of climatic variations.

In the context of this new paradigm, the historical degradation of rangelands in the American West is a special case of destabilization by the introduction of a foreign herbivore into the ecosystem. The growth of sheep and cattle numbers was checked finally by the exhaustion of a forage supply unprepared for this new demand. The pattern of animal population explosion followed by a rapid decline coinciding with major changes in the range resource (for example, the conversion of desert grasslands into mesquite and creosote-bush shrublands) was repeated in other parts of the world where domestic livestock in large numbers invaded a semi-arid ecosystem, such as Australia and Argentina. Throughout Africa, Asia, and the Middle East, however, the semi-arid ecosystems already have adapted to the presence of domestic and wild ungulates over thousands of years.

Livestock producers in most agropastoral regions, unable to influence substantially the forage supply, have adopted measures that enable them to persist in an unpredictable environment. Many agropastoralists move livestock long distances to find feed. With widely dispersed kinfolk, they can relieve the burden of a drought by distributing some of their herd among relatives. As in the United States, producers or members of the family will work in non-agricultural jobs to supplement the livestock enterprise. They will look for crop by-products, such as hay, to help their animals survive stress periods. In more developed countries, they often have access to emergency drought relief (money or feedstuffs), but typically not in third world countries where major herd losses may result during severe droughts.

If a climate-centered paradigm (as opposed to the paradigm

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centered on plant/animal interactions) is valid for agropastoral systems, there are profound ramifications concerning the management of these marginal lands and their associated livestock, and the design and conduct of development projects.

Development strategies that focus on adjustments in animal numbers, herd composition, scheduling the spatial distribution of livestock, etc., may be inappropriate and may even inflict penalties on the agropastoralist's ability to persist. Instead, measures should be taken that "build upon the best aspects of the traditional systems rather than imposing wholesale alterations on them."[18] Such measures would include facilitating herd mobility during droughts; improving economic flows between agropastoralists and other agricultural sectors to increase the potential for feed substitution during droughts, and strengthening the ties between agropastoralists and other farmers in particular; planting shrubs and trees for dry season fodder or as a drought reserve; or developing other commodity potentials, such as wood that is harvested from the caatinga of northeastern Brazil.

In a climate-centered approach to range/livestock development, "drought" becomes the focus of attention. During favorable years agropastoral systems scarcely need development. Perhaps the ultimate test of a development project would be its ability to alleviate or minimize the negative effects of a drought. Too often in the past the onset of a drought doomed a range development project to failure.

2. Objectives

To design management strategies for sustained small ruminant production in agropastoral systems of the developing world.

The specific objectives are:

a. To define how small ruminant production systems function with respect to abiotic and biotic constraints.

b. To determine the specific role of small ruminants in system persistence and stability or, on the other hand, land degradation.

c. To develop a methodology for analyzing agropastoral production systems and identifying important constraints.

d. To develop and disseminate recommendations for improved production systems, practices, and land use programs.

In addition to the generation of new knowledge and management recommendations, education is an integral goal of this project. Graduate students who participate in the project will become versed

in research theory and methods in various phases of sociology, small ruminant production, and natural resource management.

3. Project Activities

a. Functional Activities

The nine project activities or components identified below are functional activities that must be accomplished if the project is to achieve its goals. They do not represent nine disciplines. Individual scientists and institutions may possess expertise that transcends several of these activity categories. For each activity listed, one or more SR-CRSP institutions are capable of providing the necessary expertise.

Analysis of Ecosystem Structure and Processes. Scientists trained in plant and animal ecology and with an understanding of plant and animal populations dynamics, soil-climate-vegetation relationships, plant-animal interactions, and with a working knowledge of how whole systems function will conduct this analysis.

Analysis of Livestock Nutrition, Management, and Production. This analysis will be conducted by scientists with knowledge of ruminant nutrition, animal foraging behavior, and animal production.

Analysis of System Abiotic Components. This activity will be undertaken by scientists trained in soil science and climatology. Special disciplinary training in theory and principles of hydrology and soil erosion processes will be useful.

Monitoring of Temporal and Spatial Changes in Plant, Animal, and Human Populations. This task will be necessary to determine the impacts of small ruminants on other biotic components of the ecosystem, including people. The components involving humans will include contributions of social sciences. Geographers and plant ecologists will collaborate on components dealing with plant community change.

Analysis of Cropland-livestock Interactions. The type of analysis will depend upon the predominant cropping system in the research area. The degree of competition and complementarity between crop and livestock production will be assessed, and research will be conducted to identify ways to integrate the two activities. This research, requiring an agronomist, an animal nutritionist, and a social scientist, will include a analysis of abiotic constraints.

Analysis of Competitive Interactions of Livestock (Small Ruminants in Particular) with Wildlife. The necessity for this work will depend on the country or region chosen for study and the presence of wild native ungulates. The work will be done by wildlife ecologists.

Analysis of Social System Dynamics and Economics. Research will be conducted at the level of the individual producer and the region to assess the behavior of small ruminant producers in the face of social, economic, and climatic change. A social scientist will coordinate field research and monitoring activities.

Policy Analysis. This activity will assess the impact of government policies on the sustainability and persistence of small ruminant production. The analysis will include the role of market policies, land tenure regulations, incentives and disincentives to producers, and governmental responses to abiotic perturbations.

Synthesis. As it is impossible to manipulate experimentally whole systems, scientific inference can be strengthened in two ways: (a) by providing a sufficiently long project life (at least 5 years) that changing natural and economic forces subject the system to "manipulation;" and (b) by experimentally manipulating sub-components of the system as appropriate (e.g., introducing an improved forage species in marginal cropland) and measuring the outcome on some other component(s) of the system (e.g., increased reproductive performance of sheep/increased revenue to the producer/decreased animal forage demand on degraded grazing land).

Simulation models can be a valuable tool if the system or sub-system of interest is sufficiently well defined and clearly bounded. However, a separate systems analysis component is not proposed as was the case in past SR-CRSP research. Individual scientists might employ different forms of models as appropriate to their needs and particular training, but only as interpretive tools and not as an end in themselves. Major synthesis and interpretation will be by standard practices of scientific inference and deduction.

b. Sites

Several sites will be explored to determine the most suitable based on the selection criteria shown in annex I. The major criteria include the existence of small ruminant production enterprises on fragile lands, the interface of cultivation and small ruminant production, and demonstrated problems with or concern for associated environmental values (e.g., loss of wildlife, de-forestation, land erosion). If resources and priorities permit, as indicated in budget Plan A (Section IV), it may be desirable to consider more than one site that represents agropastoral ecosystems.

Several Sahelian countries, including Mali, Burkina Faso, and Niger, have expressed interest in direct involvement of a SR-CRSP project [annex J]. Major considerations in favor of these countries include: a large dependence on small ruminants; a fragile, drought-prone environment in which to test hypotheses regarding ecosystem function; and the possibility of affiliating

with international research centers. Disadvantages include high costs, poorly developed infrastructures, and a perceived shortage of collaborating institutions and scientists. [See annex J.]

Both Ecuador and Bolivia may meet the specified criteria for a South American location. A project in either of these countries could build on SR-CRSP accomplishments in Peru. The presence of New World camelids and their interaction with sheep increase the appeal of these countries from a development point of view. Both countries have expressed interest in supporting a SR-CRSP project. [See annex J.]

In north Africa, Morocco would be a viable choice for several reasons: the project could build on past SR-CRSP research; a well-developed infrastructure exists and research can be accomplished at a reasonable cost; excellent collaborative relations exist with scientists at the Institute Agronomique et Veterinaire, Hassan II (IAV) and the potential is large for IAV to assume a "graduate institution" role where major outreach to Sahelian countries (e.g., Niger, Mali, Senegal, etc.) could be provided directly by IAV faculty. [See annex J.]

4. Methods

Research on grazing land ecology and livestock production will attempt to define the climate-centered paradigm and its implications for development programs. Whereas data-gathering methods would differ only slightly from those employed in past SR-CRSP grazing projects, the research design and interpretation of the results would be in the light of a new theoretical approach to grazing ecology and management. The data may be used to create radically different grazing systems.

Furthermore, application of the findings would depart greatly from previous CRSP conventions. The information would be used to explore a completely new way of thinking about range-livestock and crop-livestock production systems in marginal semi-arid agropastoral zones. If the new paradigm proves valid, this information will be useful for persons at the highest level of national policy formulation down to those in local extension operations.

The urgent need addressed in this research proposal is for better knowledge and understanding of how agropastoral production systems function and what their ecological, social, and economic constraints really are. The unique role of small ruminants in these systems must be understood--not simply from the standpoint of how, technologically, their specific production might be improved, but also how they are integrated into the whole. There is a need to know how small ruminants may contribute to system persistence and sustained agropastoral production. With such knowledge, appropriate interventions and alternatives can be

developed to address goals for improving the productivity of agropastoral zones in the developing world.

Ecosystem Structure and Processes. Baseline measurements will be made on forage plant community structure (mapping communities, describing them in terms of botanical composition, density, cover, etc.), seasonal forage biomass production, plant growth rates, and rates of herbivory. These measurements will be continued throughout the project to define the dynamic relationships between plant community function and stability and abiotic factors (primarily soils and climate). These data also will be useful in monitoring changes in biological diversity.

Analysis of Livestock Nutrition, Management, Production, and Health. Seasonal diets of all major grazing species will be determined and the nutritional value of these diets assessed. Total nutrient intake by various herd components will be determined in light of nutrient requirements for production.

Herd composition and productivity will be measured for all livestock species. Production measures will include conception rate, birth rate, mortality, birth weight, weaning weight, and animals sold, consumed, and traded, etc. Herd management practices, including disease and parasite control, will be studied.

Analysis of Abiotic Components. Data from existing climatological stations in the region will be analyzed, and additional field stations will be established to measure precipitation, evaporation, and temperature. Soils will be classified broadly and limited mineralogical analyses done. Depending on the locality selected, much of this information already may exist and will be used as appropriate.

Analysis of Ecosystem Changes. Movements both in space and over time of plants, animals, and people will be monitored. Geographic Information Systems (GIS), which employ satellite imagery, offer recent records for assessing how changes in climate affect land-use and native plant communities. This approach provides a way to establish a historical record of the effect of changing weather patterns in terms of large scale plant community response and soil erosion features. In addition to remote sensing for data acquisition on plant communities, "on-ground" methods of surveys and oral histories will be used to determine similar changes for human populations.

Crop-livestock Interaction. Areas cropped and fallowed will be delineated and impacts of cropping on soil stability assessed. Current use of agricultural products and crop by-products in livestock production will be described as well as the contribution to animal diets. Contributions of livestock to agricultural activities as a source of capital and fertilizer will be assessed. The impact that abiotic forces have on production will be noted.

The role of small ruminant production in determining crop production strategies will be assessed. Also, kinds and yields of crops will be quantified. The potentials for establishing forage crops, using both tame and native species (grasses, forbs, and shrubs) will be evaluated. Shifts over time in land areas subjected to cultivation can be ascertained through the GIS approach.

Analysis of Native Animal Populations and Interactions. If wild ungulate species are an important part of the ecosystem, their populations will be inventoried and herd dynamics monitored. Their patterns of land use (habitat selection) will be described and potential competitive interactions with livestock determined on the basis of dietary overlap and habitat preference. Such research will have lower level of resolution than for livestock research. Other native faunal species will be inventoried and monitored in an effort to ascertain changes in biological diversity as affected by small ruminant competition or by climatic change.

Analysis of Social Dynamics and Economics. A census of the study region's human and animal populations will be included in the baseline survey. This census will provide information on land tenure and markets as well as information on individual production strategies. After the initial survey, representative micro-regions and producer families will be selected for detailed studies. The behavior of selected families will be monitored by the entire project, but social scientists will coordinate this activity. Family decision making in the light of family needs and environmental and economic change will be assessed.

Policy Analysis. State policies concerning food security, marketing, land tenure, credit, response to natural disasters and agricultural development have a significant impact on the sustainability of small ruminant production systems. These impacts will be assessed through searches of government documents and interviews with key officials.

Synthesis. The four objectives identified earlier are information-based (as opposed to product-based) goals. Their complete realization can be achieved only when all data have been collected, interpreted and integrated. Major steps toward synthesis can begin immediately, once the project site has been identified. Relevant literature can be reviewed and "state of knowledge" papers prepared such as was done early in current SR-CRSP projects.[23,24] Conceptual models of the system (e.g., Forester diagrams) can be constructed during the initial year and refined as data are accumulated. Provisional assessments on objectives 1 and 2 should be available by year 3, as the first cohort of graduate students (MS-level) complete their projects. Information on how governmental policy impacts system function (objective 1) and how economic constraints and land use policy may lead to land deterioration (objective 2)

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will be available by year 3. Since objective 3 is interpretive, it can best be accomplished after all possible data are in, i.e., in year 5. As information is evaluated and processed, dissemination to relevant audiences can begin. Thus, information processing and dissemination (objective 4) can commence early on, accelerating after 2 to 3 years and continuing through year 5.

5. Time Frame

As the present workplan assumes that these activities will be carried out in a country where SR-CRSP is not presently working, Year 1 of the program will be devoted to site development, the analysis of existing data, and baseline studies. Field research for all disciplines will not begin in earnest until late in year 1 or early in year 2. (See table 6 on page 96).

Ecosystem Structure and Function. Baseline inventory and monitoring studies will be underway in year 2. These studies will continue throughout the life of the project. Three full years of data are anticipated by the end of year 5.

Livestock Production and Nutrition. Sample herds will be identified and sampling strategies will be established during the second year. Three complete years of data (years 3, 4, and 5) are anticipated.

Abiotic Components. Weather stations will be established during the initial year and soil surveys will begin. By the end of year 5, 3 full years of climatological data will have been obtained and soil surveys completed.

Ecosystem Changes. Procedures will be established during the first 1.5 years. Data from an additional 3 years will be collected before the end of year 5.

Animal Interactions. Surveys of the seasonal populations and spatial distribution of wild ungulates will begin in year 2 (if appropriate). Studies of dietary interrelationships among wildlife and livestock will begin in year 3. By the end of year 5 at least 2.5 years of data will be available.

Crop-livestock Interaction. Baseline surveys in years 1 and 2 will identify the kinds of crops produced and the areas devoted to crops and to fallow. Yield determinations will be made through on-farm monitoring in years 3 to 5. Quantity and quality of crop material used by livestock will be evaluated. Agronomic research to improve the contribution of crops to livestock production will begin in year 3. Data from 3 years of trials will be available by the end of Year 5.

Social-economic Sub-system. Social scientists will have two major activities - service and research. The service activity will

assist the other disciplines in monitoring and field research activities. This ongoing activity will begin in year 2 and continue throughout the project. A rapid appraisal of the project area will be initiated late in year 1 and the results analyzed by the beginning of year 2. The initial survey will serve as a guide to selection of micro-regions and farm families for more detailed studies on land and animal ownership, production strategies, marketing approaches and level of knowledge about existing production systems. These studies will be completed by year 3. Beginning in year 3, social scientists will help monitor and evaluate the potential of interventions proposed by other project components.

Policy Studies. During years 1 to 3, the impact of government policies on both the viability and sustainability of small ruminant production will be evaluated. This research should be completed by the end of year 3.

Synthesis. (See discussion under Synthesis, Section 4. Methods.)

The above discussion of time frame and accomplishments assumes for all project activities that site development, establishment of collaborative relationships, and recruitment of graduate students and project personnel will be accomplished largely during year 1.

6. Expected Results Within Time Frame

1990-1992 Identification of work site(s), participants; research of existing data available; development of initial conceptual ecosystem model; identification of producers for detailed socioeconomic studies; analysis of data inputs of sub-system models.

1992-1994 Data outputs for (a) animal management, production, and nutrition; (b) cropping systems and crop-livestock interactions; (c) animal interactions among wild and domestic ungulates; soil and climatological data focused into maps and long-term changes; (d) dynamics of native plant communities; and (e) detailed report of policy analysis complete.

1995 Graduate training complete; methodology described for characterizing and diagnosing agropastoral production systems; scientific and technical papers summarizing animal production, management and nutrition, crop-livestock interactions, plant community structure and dynamics, socioeconomic analysis of agropastoralist system; suggested strategies for sustainability and persistence in marginal and fragile land zones; information processing and dissemination.

Table 6. Chart of planned activities for sustainable agropastoral systems in marginal lands.

```
1990        1991        1992        1993        1994        1995
Oct.                                                        Sept.

 Site Develop
/------------/

/------------Ecosystem Dynamics and Modeling------------------/

             /--Nutrition, Management, Production--/

             /--------------Abiotic Components----------------/


             /--------Ecosystem Change-------/

                        /--------Animal Interactions----------/

             /---------Crop/Livestock Interactions------------/

/-------------------Social-Economic Systems-------------------/

/------------Policy Analysis-----------------/

                                   /----Technology Testing----/

                        /-----Information Processing and-----/
                                     Dissemination
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E. ANIMAL HEALTH MANAGEMENT THROUGH BIOTECHNOLOGY

1. Introduction

a. Background

The broad importance of disease was recognized as one of the major constraints to small ruminant production in the initial design of the SR-CRSP, and animal health research was planned for inclusion in the program at all sites, with particular emphasis in Kenya, Peru, and Brazil. At the onset these projects were oriented primarily towards herd health care and veterinary extension. They surveyed diseases in populations of sheep, goats, and alpaca to determine their prevalence and incidence.

By 1984, all of the projects had a sharp research focus and were directed to more basic studies of infectious disease and development of innovative control methods. Diseases investigated have included caseous lymphadenitis, contagious caprine pleuropneumonia, heartwater, caprine arthritis-encephalitis, ovine pulmonary carcinoma, ovine progressive pneumonia, and neonatal mortality in alpaca. Continued, sharply focused studies are projected to take advantage of recombinant technology in the development of multivalent vaccines and at the same time continue to give support to the overall health needs of small ruminants.

Health problems, such as internal parasites and several other infectious diseases, continue to constrain the improvement of sheep and goat production in areas where these animals are important sources of food and fiber. Therefore, SR-CRSP proposes to continue research to solve the major health problems of these animals. These solutions will build on previous investments and will contribute to a substantial increase in small ruminant production in developing countries throughout the world. Specifically, the proposal is to use the information from SR-CRSP research in Kenya, Peru, and Brazil, the recent general advances in biotechnology, and the ability of SR-CRSP to evaluate health management changes in small ruminant production systems to make and evaluate new vaccines.

The approach is to make (i) a single multivalent vaccine for goats that will protect against several important infectious diseases, and (ii) another single multivalent vaccine for sheep. These vaccines will be designed to protect against the major diseases occurring in the areas where SR-CRSP is working. When developed, the goat vaccine will be evaluated in the dual purpose goat production system in Kenya, and the sheep vaccine will be evaluated in the hair sheep production system in Indonesia. In addition, the animal health scientists will continue to collaborate with other SR-CRSP scientists in the other research components.

The important characteristics of the proposed new vaccines

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include:

They are multivalent and induce protection against more than one disease.

They are delivered by a virus vector that is relatively cheap and easy to produce. In fact, almost all countries of the world have the capability to produce virus vaccines such as the ones proposed.

They are based on recombinant DNA and can be modified to add genes from other infectious agents.

They can be made with virus vectors that are safe for animal use and have no potential for human infection.

They can be lyophilized and stored without a cold-chain.

They can be developed to be given by the oral route instead of by injection.

The new vaccines would be affordable by farmers raising sheep and goats.

The new vaccines can be developed in the proposed time frame.

b. Justification of Proposed Research and Assumptions that Work Can Be Done

There are several advantages for SR-CRSP to continue biotechnology research for animal health management. These advantages include:

SR-CRSP already has funded important preliminary research on contagious caprine pleuropneumonia (CCPP), heartwater, and sheep and goat lentiviruses.

A laboratory for biotechnology research has been equipped in Kenya, a collaborating country.

Collaborating country personnel have been trained at the MS and PhD levels in biotechnology research.

The new goat vaccine can be evaluated in the dual purpose goat production system with collaborating scientists including sociologists and economists.

The new sheep vaccine can be developed and evaluated with the collaborating research team in the hair sheep production system.

SR-CRSP can incorporate biotechnology research by other

scientists into animal health management strategies.

The cost of doing this research is reduced by the previous SR-CRSP investment, access by SR-CRSP scientists to research on cattle diseases, and experience of SR-CRSP scientists in animal disease research.

Development of animal health management through biotechnology will help complete the production systems approach to research on small ruminants.

Another major advantage is that SR-CRSP has collaborating scientists to conduct market studies to determine current systems for supply and distribution of animal health products. This will permit development of a cost/benefit analysis of the proposed vaccines. The technology needed to produce conventional virus vaccines exists in most developing countries. This technology can be used to produce a recombinant vaccine, once the vaccine is constructed and tested. As the mass production of the recombinant vaccine would be relatively inexpensive, its manufacture and distribution should interest the private sector.

Justification of the use of recombinant virus vectors as a way to make multivalent vaccines is based on the published work on vaccinia virus vaccines:

Vaccinia virus recombinants can be made that express the protein coded for by the inserted foreign gene.[25,26,27]

Proteins expressed by recombinant vaccinia viruses have induced protective immune responses to DNA and RNA viruses, protozoa, and bacteria.[28,29]

A single vaccinia virus recombinant containing appropriate genes from three pathogens induced protective immunity against all three pathogens.[29] Also, there is no practical limit to the number of genes that can be inserted and expressed in vaccinia virus.[28,30]

Once a multivalent, recombinant, virus-vectored vaccine is made it can be economically expanded by routine cell culture techniques and stored indefinitely in convenient repositories.

Such a vaccine can be administered easily to goats and sheep.[31]

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 ovine pulmonary carcinoma (OPC) and ovine progressive pneumonia (OPP). Suitable genes from caprine arthritis-encephalitis virus,

enterotoxigenic E. coli, and Haemonchus also are being identified. Other genes will be obtained as they become available, allowing the project also to capitalize on the efforts of other research programs. Certain of the genes may be used in the sheep and goat multivalent vaccines because they induce cross-protective immunity to diseases in both species. The identification of genes and proteins that can be used in rapid diagnostic tests and in health surveys of small ruminant flocks is an important spin-off of such vaccine-related research. These tests can be used to determine which diseases are most important in other sites where SR-CRSP is working.

There is concern about the widespread use of vaccinia virus recombinants because of the possibility of causing disease in people.[32,33,34] Therefore, it seems reasonable to use a virus vector that is restricted at least to ruminants and does not infect people. One candidate is attenuated sheep pox, a Capripox.[35] The restriction of the Capripox virus to ruminants is a significant safety advantage.[36] If a suitable pox virus vector cannot be made, non-pathogenic adenoviruses of sheep and goats will be investigated as possible vectors.[37,38]

The assumption that recombinant virus vaccines are possible is based on the published work on successful recombinant vaccinia vaccines,[28,29] including the protection of cattle against rinderpest.[39] Although other biotechnology research is occurring on vaccines for a cattle virus and two hemoprotozoal diseases, the small ruminant research is well justified because the proposed multivalent vaccines are specific to sheep and goats. Assumptions that the necessary proteins can be identified from small ruminant pathogens that induce a protective immune response and that the genes coding for the proteins can be cloned from the organisms are based on publications by the SR-CRSP animal health investigators based on their work on other organisms.[40,41,42,43]

2. Objectives

To develop a general-purpose Capripox vector for sheep and goat vaccines.

To construct a multivalent, recombinant, virus-vectored vaccine for goats.

To insert CCPP, CAEV, and heartwater genes coding for protective proteins into vaccinia virus.

To test the recombinant, vaccinia virus as a multivalent vaccine for goats.

To isolate a gene coding for a protective protein of Haemonchus contortus.

To insert CCPP, CAEV, heartwater, and H. contortus genes coding for protective proteins into Capripox virus.

To test the recombinant, Capripox virus as a multivalent vaccine for goats.

To construct a multivalent, recombinant, virus-vectored vaccine for sheep.

To test a recombinant, vaccinia virus (CCPP, CAEV, and heartwater) as a multivalent vaccine for sheep.

To clone the env genes of retroviruses causing ovine pulmonary carcinoma (OPC) and ovine progressive pneumonia (OPP).

To clone the gene coding for a protective protein of sheep coccidia.

To insert the heartwater, OPC, OPP, H. contortus and coccidia genes coding for protective proteins into Capripox virus.

To test the recombinant, Capripox virus as a multivalent vaccine for sheep.

To identify economic and social constraints for vaccine delivery systems in collaborating sites.

To describe the existing systems for vaccine production and delivery to small ruminants.

To analyze cost/benefit ratio for new vaccines and determine willingness of farmers to pay for vaccines.

To identify social influences on the use of new vaccines.

3. Project Activities

a. Specific Objectives

Even though multiple objectives are proposed, these objectives will be integrated closely by a project coordinator (one of the principal investigators). Principal investigators will make yearly budgets and workplans to accomplish the four shared objectives. This will reduce costs and enhance productivity.

b. Requirements for Each Activity

To improve animal health management in developing countries, new vaccines must be developed and evaluated. Evaluation is best done using the SR-CRSP production systems approach in collaboration with the various SR-CRSP components. In particular, evaluation of

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the economics of the recombinant vaccines requires an economist, and a sociologist is needed to evaluate acceptability of the vaccines by small ruminant owners. All these and other disciplines are available to SR-CRSP projects, and collaborators are available at the proposed work sites.

c. Sites

The animal health management through biotechnology plan can best be accomplished by having a major collaborating site and transferring the findings to the other SR-CRSP sites. There are several reasons for proposing the continuation of Kenya as a major collaborating site for animal health research:

New vaccines can be tested in collaboration with other SR-CRSP components on the dual purpose goat system.

Most of the diseases that need study occur naturally in Kenya with well-defined epidemiology.

An SR-CRSP equipped laboratory is available to do most of the proposed experiments, allowing project funds to be spent primarily on research.

Personnel trained by SR-CRSP are available to work on the project.

Two U.S. SR-CRSP scientists have considerable animal disease research experience in Kenya.

Research on recombinant vaccinia virus vectors in cattle is ongoing in Kenya in collaboration with one of the investigators, allowing an easy interchange of research results between the projects.

Containment facilities are available for animal experiments with recombinant viruses.

The genes that could be inserted into a virus vector are being identified in Kenya for heartwater, a disease of both sheep and goats, and for CCPP, a major disease of goats that also occurs in sheep. Resulting recombinants could be tested rapidly in Kenya as the challenge and evaluation systems are in place.

SR-CRSP scientists currently are investigating OPC and OPP, two worldwide retrovirus diseases of sheep that occur in Kenya.

4. Methods

As the overall strategy has been presented, only the rationale

for each objective is given below; and the detailed methods are described in annex K.

Objective a. To develop a general-purpose Capripox virus-vector for sheep and goat vaccines.

Capripox virus has been selected because: (1) it provides the DNA-carrying capacity of a pox virus, (2) it has been attenuated for sheep and goats,[36] (3) it replicates only in sheep, goats, and cattle,[35] (4) it is non-pathogenic for people, and (5) it will immunize against both sheep and goat pox by itself.[35] As sheep pox virus is in the same family as vaccinia virus, it is proposed to try using the same plasmid insertion vectors now used for homologous recombination with vaccinia virus. If the homology is insufficient for the existing insertion vectors to function, it will be necessary to make new ones using the published sequence of the thymidine kinase gene of sheep pox virus.[44] As indicated above, if a suitable Capripox virus vector cannot be made, non-pathogenic adenoviruses of sheep and goats will be investigated.[37,38] Methodology to be used is described in annex K.

Objective b. To construct a multivalent, recombinant, virus-vectored vaccine for goats.

i. To insert CCPP, CAEV, and heartwater genes coding for protective proteins into vaccinia virus.

Current SR-CRSP workplans include identification of genes expressing protective proteins of CCPP and heartwater. Since both projects are well advanced, the expectation is that these genes will be available by October 1990. SR-CRSP collaborators, funded by other sources, are expressing the CAEV env gene in vaccinia virus. This work will be completed by the time the construct is needed for this project. These pathogens are important goat diseases, the genes are expected to be available, and recombinant vaccinia viruses can be made for a relatively rapid test of the hypothesis that a multivalent, recombinant, virus-vectored vaccine for goats can be made. The methodology is described in detail in annex K.

ii. To test the recombinant vaccinia virus as a multivalent vaccine for goats. The details of the experimental design to test the vaccination potential of each construct are described in annex K.

iii. To isolate a gene coding for a protective protein of *H. contortus*.

Internal parasites are a major constraint to small ruminant production in most areas of the world and *H. contortus* is the major helminth involved. Current work by SR-CRSP scientists has

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identified a tissue homogenate that induces significant protection against challenge with larvae (Jasmer and McGuire, unpublished). It is hypothesized that a protein can be isolated from the homogenate that will induce protection and that the gene for this protein can be cloned. The identification of the involved protein and the cloning of the coding gene would be done by procedures used by SR-CRSP investigators in other similar studies.[40,41,45,46,47]

iv. To insert CCPP, CAEV, heartwater, and H. contortus genes coding for protective proteins into Capripox virus.

If the insertion vectors with vaccinia virus thymidine kinase as a part of the insertion cassette work with attenuated sheep pox, then the plasmid containing multiple genes (see b.ii. above) can be used here. The only requirement would be to insert the H. contortus gene and verify its expression along with the other three genes. If a new plasmid insertion vector is needed for homologous recombination with the attenuated sheep pox, then the four genes will need to be inserted into the new plasmid (see b.ii. above) and a homologous recombination done to make the multivalent, recombinant, Capripox virus vector.

v. To test the recombinant Capripox virus vector as a multivalent vaccine for goats.

Ten goats are vaccinated two times with the vaccine (VV-CCPP,CAEV,heartwater, H. contortus) and 10 goats vaccinated in the same way with VV. After evaluation of the immune response to all four proteins by western immunoblot, all goats are challenged with all four organisms sequentially. The sequence of challenge would be CCPP, heartwater, H. contortus and finally CAEV.

Objective c. To construct a multivalent, recombinant, virus-vectored vaccine for sheep.

Many sheep pathogens are unique to the species. However, several of the organisms SR-CRSP staff are working on infect both sheep and goats. This allows a test of some of our recombinant vaccines in both sheep and goats. Specifically, heartwater and H. contortus infect both sheep and goats equally while CCPP and CAEV[48] infect both, although they are less severe in sheep. Other diseases, such as OPC and OPP, are restricted to sheep and will require identification and cloning of relevant genes. The most pathogenic sheep coccidia, Eimeria ovinoidalis, may share protective antigens with the major goat coccidia, E. ninakohlyakimovae. The proposal is to start with the sheep coccidia and, when protective antigens are identified, to evaluate their potential to protect goats against goat coccidia.

i. To test a recombinant vaccinia virus (CCPP, CAEV, and heartwater) as a multivalent sheep vaccine.

The vaccinia construct containing genes from CCPP, CAEV, and heartwater from section b.ii. is used to vaccinate sheep. After two doses of 100 million PFU per dose, sera are evaluated for antibodies to each of the proteins and the sheep are sequentially challenged with CCPP, heartwater, and CAEV.

ii. To clone the envelope genes of retroviruses causing ovine pulmonary carcinoma (OPC) and ovine progressive pneumonia (OPP). The cloning procedures are described in annex K.

iii. To clone the gene coding for a protective protein of sheep coccidia.

The strategy in this case is similar to that used in other organisms.[45] Briefly, E. ovinoidalis is grown in culture, oocysts isolated, surface labeled, surface labeled proteins identified and isolated, sheep immunized with isolated surface proteins and challenged with virulent oocysts. Sera from the sheep protected against challenge are used to screen a lambda zap expression library prepared from oocyst DNA.[45] Plaques expressing the protein are evaluated for the size of the DNA insert and the longest insert is evaluated by DNA sequencing to determine the plan for constructing vaccinia insertion plasmids. A vaccinia construct is made as described above and evaluated for its ability to protect sheep against oocyst challenge when compared to sheep vaccinated with VV alone.

iv. To insert the heartwater, OPC, OPP, and coccidia genes coding for protective proteins into Capripox virus.

This aim is accomplished in the same way as described for the genes in b.ii. above. The result is a VV-heartwater,OPC,OPP, coccidia construct.

v. To test the recombinant Capripox virus as a multivalent vaccine for sheep.

Ten sheep are vaccinated with the VV-heartwater, OPC, OPP, coccidia construct and 10 sheep are vaccinated with VV. After a boost, sera are evaluated for response to the relevant proteins and all the sheep are challenged sequentially with heartwater, coccidia oocysts, and then simultaneously with OPC and OPP. The latter two are combined because of their relatively long incubation periods.

Objective d. To identify economic and social constraints for vaccine delivery systems in collaborating sites.

i. To describe the existing systems for vaccine production and delivery to small ruminants.

This objective requires collaboration of economic, sociology, and animal health components to describe the capabilities of collaborating sites (possible locations include Indonesia, West or Southern Africa, or Andean Highlands) to make new vaccines and to define possible limitations. Also, the ability to deliver vaccines to small ruminants through existing systems requires documentation to identify possible constraints

ii. To analyze the cost/benefit ratio of new vaccines.

The general approach for this objective is to collaborate with SR-CRSP economists in an initial evaluation of vaccine production and distribution costs and the actual cost of vaccination for the livestock owner. Finally, the benefit is determined by conducting a large field trial with the vaccines in areas where the diseases included in the vaccines are endemic. The plan is to have vaccinated and non-vaccinated animals, to monitor production and disease parameters in both groups and to calculate the resulting benefits of the vaccines.

iii. To identify social influences that affect the use of new vaccines.

This study is directed by sociologists to define who in the family units are responsible for animal health, how they make their decisions with regard to resource allocation, and what is the acceptability of various types of animal health management practices, including vaccines.

5. Time Frame and Expected Results

1990-91 Determine if vaccinia insertion vectors can be used for Capripox virus.

Insert CCPP, CAEV, and heartwater genes coding for protective proteins into vaccinia virus.

Identify H. contortus protective protein.

Make OPC and OPP cDNA clones.

Identify coccidia oocyst surface antigens.

Describe existing systems for vaccine production and delivery.

Identify 1-2 candidates and initiate training for advanced degrees.

1991-92 Make new insertion vectors for Capripox, if necessary.

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Test recombinant VV-CCPP,CAEV,heartwater vaccine in sheep and goats. This experiment, if successful, will show that the long term goal of the project is attainable.

Clone and sequence gene for protective protein of H. contortus.

Determine 5' sequence of OPC and OPP env gene cDNA clones and construct vaccinia insertion plasmids.

Identify protective protein form coccidia.

Identify social influences that impact on vaccine use and animal health management practices.

Continue training program and identify further candidates.

1992-93 Make Capripox virus insertion vectors and test recombinant attenuated sheep pox as a vaccine using one of the genes available.

Make multivalent, recombinant, Capripox virus vaccine for sheep and goats.

Make and test recombinant vaccine to H. contortus.

Make and test recombinant vaccine to OPC and OPP.

Clone and sequence gene for coccidia protective protein.

Study possible economic and social constraints for vaccine use.

Program 1-2 candidates for advanced training and integrate degree trained personnel into research/testing program.

1993-94 Test multivalent, recombinant, Capripox virus-vectored vaccines in sheep and goats.

Make and test individual recombinant vaccine for coccidia.

Initiate experiments on identifying relevant genes from Brucella ovis and melitensis for use in recombinant vaccines.

Begin cost/benefit analysis for vaccines.

Continue integrating trained personnel into program.

1994-95 Field test sheep and goat vaccines and complete cost/benefit analysis.

Identify other diseases that should be included in vaccines, especially for use in countries with SR-CRSP components.

Complete training and integration of trained personnel into program.

PAGE ONE

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

Indefinite with Life of Project: 5-Year Minimum
From FY 10/90 to FY 10/95
Total U.S. Funding _____ est.
Date Prepared June 30, 1989

Project Title & Number Small Ruminant Collaborative Research Support Program/DAN-1328-G-SS-4093-00

Narrative Summary	Obj. Verifiable Indicators	Means of Verification	Important Assumptions
Program or Sector Goal (the broader objective to which this project contributes): To improve the efficiency and sustainability of small ruminant production in LDCs (Continued)	**Measures of Goal Achievement:** (a) Availability of published information on new knowledge developed. (b) Evidence of improved competence of U.S. and LDC (Continued)	Review by involved agencies and institutions, including USAID, EEP, BD, AC, JCARD, BIFAD, and LDC Institutions. Annual Review by EEP. 3-year reviews by USAID.	**Assumptions for Achieving Goal Targets:** (a) That research undertaken will succeed in providing practical solutions toward removing identified (Continued)
Project Purposes To bring together the resources of U.S. institutions having expertise in the disciplines of small ruminant nutrition, breeding and (Continued)	**Conditions that will Indicate Purpose has been Achieved. End of Project Status:** (a) Viable and functioning collaborative research projects/programs in the U.S. (Continued)	Reports from Mission personnel and host country representatives that report adoption of methods based on SR-CRSP research and testing.	**Assumptions for achieving purpose:** That the Host country extension systems will adopt & promote methods developed through SR-CRSP research to relieve the identified constraints.
Outputs: (a) Packages of validated, improved technological practices developed in specific locations but readily adaptable to other areas. (Continued)	**Magnitude of Outputs:** (a) Manuals, other publications, and presentations at meetings/workshops. (b) Demonstration of working examples of improved (Continued)	Review by EEP and other reviewers of publication lists revised annually as well as lists of workshops, seminars, and trainees achieving various objectives and degrees. (Continued)	**Assumptions for Achieving Outputs:** That those identified as collaborators and trainees will assimilate the technical information and they will (Continued)
Inputs: (a) Grant No. U.S. DAN-1328-G-SS-4093-00 with University of California, Davis. (b) 25% minimum cost-sharing by each participating U.S. (Continued)	**Implementation Target (Type and Quantity):** Extension of grant from 10/1/90 through 9/30/95 as requested by BD, AC, and ME.	Annual reports and periodic evaluation by EEP, USAID, JCARD, and BIFAD to summarize progress made and to plan for the future. Audit of each subgrantee, the ME, and the (Continued)	**Assumptions for providing inputs:** That SR-CRSP will be funded by USAID to carry out the proposed work plans. That overseas collaborating (Continued

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

Indefinite with Life of Project: 5-Year Minimum
From FY 10/90 to FY 10/95
Total U.S. Funding _____ est.
Date Prepared June 30, 1989

Project Title & Number Small Ruminant Collaborative Research Support Program/DAN-1328-G-SS-4093-00

Narrative Summary	Obj. Verifiable Indicators	Means of Verification	Important Assumptions
and U.S. by: expanding the body of knowledge and its application to the solution of specific problems; expanding the level of competence of U.S. and developing country (Continued)	staff by the quantity and quality of newly trained personnel. (c) Evidence of the suitability of management packages and appropriate (Continued)		constraints. (b) That host country personnel trained by SR-CRSP will remain in research and extension jobs related to small ruminants. (Continued)
genetics, economics, sociology, health, and range management with the developing institutions in the LDCs in order to facilitate the development of a base of (Continued)	and LDCs with identifiable personnel. (b) Identifiable personnel under training in the LDCs, U.S., and through in-country programs. (Continued)		
(b) Knowledge and understanding of the interacting forces constraining improved efficiency and development of management practices incorporating the new knowledge (Continued)	management practices using new technology packages. (c) Extension of the knowledge through newly trained people. Several trained at each of the Ph.D., (Continued)	Trainee lists by country of origin and site of training, including thesis and degree. Host country workshops and subsequent proceedings.	apply it to the host country situation. That LDC facilities, staff, and collaborators will be willing to work with SR-CRSP subgrantees in the appropriate (Continued)
institution. (c) Experience and expertise of U.S. and LDC staff to undertake the planned research as specified in the Global Plan. (Continued)		SR-CRSP as a whole. Each subgrantee, the ME, and SR-CRSP as a whole are subject to audit by USAID/W or their designee.	institutions will continue to receive domestic funding and adhere to the terms and conditions of the Memoranda of Understanding with ME. That U.S. institutions and their (Continued)

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

Indefinite with Life of Project: 5-Year Minimum
From FY 10/90 to FY 10/95
Total U.S. Funding _____ est.
Date Prepared June 30, 1989

Project Title & Number Small Ruminant Collaborative Research Support Program/DAN-1328-G-88-4093-00

Narrative Summary	Obj. Verifiable Indicators	Means of Verification	Important Assumptions
scientists to conduct research; developing and testing appropriate technologies designed to improve food and fiber production; improving the (Continued)	technologies to improve small ruminant productivity and sustainability. (d) Comparisons of baseline survey data with improved packages. (Continued)		(c) That the research and training efforts envisioned will improve the competency of LDC and U.S. scientists. (d) That the capacity and capability to increase (Continued)
knowledge and people from which improved management systems and increase efficiency of small ruminants can be achieved.	(c) Research results that demonstrate significant improvement in small ruminant productivity in LDCs and U.S. (d) On-farm demonstrations showing that technological (Continued)		
and techniques. (c) Practical application of knowledge gained and its methods of implementation through publications, consultations, workshops, and trained people.	M.S., and service course levels through U.S. and LDC universities and in-country workshops.		field. That suitable staff and students will be available for training in the relevant disciplines at appropriate institutions.
(d) Students and other collaborators from U.S. and LDC institutions for specific and advanced training.			faculties will continue to retain an active interest in the SR-CRSP and contribute 25% cost sharing.

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

Indefinite with Life of Project: 5-Year Minimum
From FY 10/90 to FY 10/95
Total U.S. Funding _____ est.
Date Prepared June 30, 1989

Project Title & Number Small Ruminant Collaborative Research Support Program/DAN-1328-G-SS-4093-00

Narrative Summary	Obj. Verifiable Indicators	Means of verification	Important Assumptions
small ruminant food and fiber production capabilities of the LDCs; and improving the economic position of the sheep and goat producer.	(e) Sociological studies of original and recent status of smallholder families.		productivity will be grasped by the LDCs.
	packages can be used effectively by indigenous personnel.		

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VI. ANNEXES

A. Cost Proposal: Plan A

B. Cost Proposal: Plan B

C. Cost Proposal: Plan C

D. FAO Sheep and Goat Statistics

E. SR-CRSP Organization and Management

1. Administrative Council, Board of Directors, Technical Committee, and External Evaluation Panel

2. Number of Scientists, Institutions, and Disciplines Involved

3. SR-CRSP Institutions, Major Projects, and Country Sites

4. General Organizational Relationships in SR-CRSP

5. Funds Management

F. Global Plans for Years 1-12

G. Status of Technological Packages

H. Summary of Degree Trained Students, 1980-1988

I. Criteria for Research Site Selection and Maintenance

J. Mission Responses to USAID/W Inquiries

K. Animal Health Management Through Biotechnology (Methods)

L. Literature Cited

ANNEX A

SMALL RUMINANTS CRSP — PLAN A

BUDGETS

Summary-All Programs

ALL AMOUNTS EXPRESSED IN THOUSANDS

FROM USAID

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
Dual Purpose Goat	$400	$300	$200	$0	$0	$900
Prolific Sheep-Moroc.	$60	$50	$40	$0	$0	$150
Hair Sheep*	$650	$750	$825	$970	$982	$4,177
Agropastoral	$470	$550	$650	$700	$764	$3,134
Animal Health	$450	$480	$500	$600	$650	$2,680
Networking	$170	$180	$210	$280	$260	$1,120
Add Site Development			$600	$800	$400	$1,800
Subtotal	$2,200	$2,310	$3,025	$3,350	$3,076	$13,961
Management	$600	$630	$662	$695	$729	$3,316
TOTAL	$2,800	$2,940	$3,687	$4,045	$3,805	$17,277

* Includes funds for Prolific Sheep activities in Indonesia

SMALL RUMINANTS CRSP — Plan A

BUDGETS

Dual Purpose Goat Project

ALL AMOUNTS EXPRESSED IN THOUSANDS

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
Dual Purpose Goats - Breeding						
1. Scientists & Staff	$97	$69	$45	$0	$0	$211
2. Research Costs						
Supplies	$95	$70	$47	$0	$0	$212
Equipment	$8	$6	$4	$0	$0	$18
Travel	$39	$30	$20	$0	$0	$89
Training	$39	$30	$20	$0	$0	$89
Other	$30	$26	$18	$0	$0	$74
Subtotal	$308	$231	$154	$0	$0	$693
Indirect Costs	$92	$69	$46	$0	$0	$207
Subtotal	$400	$300	$200	$0	$0	$900

FN:dualgt.a3

Prepared: 21 June 89 jws

SMALL RUMINANTS CRSP — Plan A

BUDGETS

PROLIFIC SHEEP-MOROCCO

ALL AMOUNTS EXPRESSED IN THOUSANDS

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
Research Costs						
Supplies	$29	$24	$19	$0	$0	$72
Equipment	$0	$0	$0	$0	$0	$0
Travel	$7	$6	$5	$0	$0	$18
Training	$0	$0	$0	$0	$0	$0
Other	$10	$9	$7	$0	$0	$26
Subtotal	$46	$39	$31	$0	$0	$116
Indirect Costs	$14	$11	$9	$0	$0	$34
Total	$60	$50	$40	$0	$0	$150

FN:Prolifbud.a3

Prepared: 21 June 89 jws

SMALL RUMINANTS CRSP

BUDGETS

HAIR SHEEP

PLAN A

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
ALL AMOUNTS EXPRESSED IN THOUSANDS						
1. Scientists & Staff						
U.S. Personnel	$75	$80	$100	$120	$150	$525
H.C. Personnel	$130	$150	$170	$200	$225	$875
Subtotal Personnel	$205	$230	$270	$320	$375	$1,400
2. Research Costs						
Supplies	$84	$100	$150	$196	$185	$715
Equipment	$40	$40	$40	$20	$20	$160
Travel	$40	$55	$65	$80	$45	$285
Training	$35	$70	$154	$175	$175	$609
Site Development	$113	$107	$0	$0	$0	$221
Subtotal	$517	$602	$679	$791	$800	$3,390
Indirect Costs	$133	$148	$146	$179	$182	$787
Total	$650	$750	$825	$970	$982	$4,177

FN:hairbud.a3

Prepared: 22 June 89 jws

SMALL RUMINANTS CRSP PLAN A

BUDGETS

AGROPASTORAL

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
ALL AMOUNTS EXPRESSED IN THOUSANDS						
1. Scientists & Staff						
U.S. Personnel	$50	$55	$90	$115	$100	$410
H.C. Personnel	$100	$110	$135	$150	$175	$670
Subtotal Personnel	$150	$165	$225	$265	$275	$1,080
2. Research Costs						
Supplies	$30	$51	$80	$95	$100	$357
Equipment	$25	$25	$20	$21	$21	$113
Travel	$35	$45	$50	$85	$100	$315
Training	$35	$36	$103	$100	$125	$399
Site Development	$100	$115	$50	$0	$0	$265
Subtotal	$375	$437	$528	$566	$621	$2,529
Indirect Costs	$95	$113	$122	$134	$143	$605
Total	$470	$550	$650	$700	$764	$3,134

FN:AGRObud.a3

Prepared: 21 June 89 jws

SMALL RUMINANTS CRSP PLAN A

BUDGETS

ANIMAL HEALTH

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
	ALL AMOUNTS EXPRESSED IN THOUSANDS					
1. Scientists & Staff	$157	$160	$150	$200	$170	$837
2. Research Costs						
Supplies	$155	$170	$180	$200	$248	$953
Equipment	$6	$7	$5	$6	$5	$29
Travel	$13	$15	$20	$25	$40	$113
Training	$21	$25	$40	$42	$50	$178
Other	$0	$0	$0	$0	$0	$0
Subtotal	$352	$377	$395	$473	$513	$2,110
Indirect Costs	$98	$103	$105	$127	$137	$570
Total	$450	$480	$500	$600	$650	$2,680

FN:Anmlbud.a

Prepared: 14 June 89 jws

SMALL RUMINANTS CRSP — PLAN A

BUDGETS

NETWORKING

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
ALL AMOUNTS EXPRESSED IN THOUSANDS						
1. Secretariat						
Staff	$18	$18	$20	$25	$25	$106
Supplies	$9	$9	$10	$15	$15	$58
Equipment	$15	$7	$2	$5	$15	$44
Communications	$6	$9	$10	$15	$15	$55
Subtotal	$48	$43	$42	$60	$70	$263
2. Regional Workshops	$25	$30	$33	$60	$54	$202
3. Travel						
P.I. Visits	$8	$8	$8	$17	$15	$56
SRSN Coordinators	$8	$9	$9	$20	$20	$66
Subtotal Travel	$16	$17	$17	$37	$35	$122
4. Linkages	$45	$50	$70	$60	$60	$285
Subtotal Netwk/Links	$134	$140	$162	$217	$219	$872
Indirect Costs	$36	$40	$48	$63	$61	$248
Total	$170	$180	$210	$280	$280	$1,120

FN:netwkbud.a3

Prepared: 21 June 89 jws

SMALL RUMINANTS CRSP PLAN A

BUDGETS

Management

	1990/91	1991/92	1992/93	1993/94	1994/95	TOTAL
	ALL AMOUNTS EXPRESSED IN THOUSANDS					
Salaries & Benefits	$185	$194	$204	$214	$225	$1,022
Supplies	$140	$147	$154	$162	$170	$774
Equipment	$5	$5	$6	$6	$6	$28
Travel	$45	$47	$50	$52	$55	$249
Committees	$45	$47	$50	$52	$55	$249
EEP	$43	$45	$47	$50	$52	$238
Subtotal	$463	$486	$510	$536	$563	$2,558
Indirect Costs	$137	$144	$151	$159	$166	$757
TOTAL	$600	$630	$662	$695	$729	$3,316

FN:Adminbud.a3

Prepared:21 JUNE 89

ANNEX B

SMALL RUMINANTS CRSP — PLAN B

BUDGETS

Summary-All Programs

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
	ALL AMOUNTS EXPRESSED IN THOUSANDS					
Dual Purpose Goat	$400	$300	$200	$0	$0	$900
Prolific Sheep-Moroc.	$60	$50	$40	$0	$0	$150
Hair Sheep*	$650	$750	$825	$967	$980	$4,172
Agropastoral	$470	$550	$650	$700	$764	$3,134
Animal Health	$450	$480	$500	$600	$650	$2,680
Networking	$170	$180	$210	$280	$280	$1,120
Subtotal	$2,200	$2,310	$2,425	$2,547	$2,674	$12,156
Management	$600	$630	$662	$695	$729	$3,316
TOTAL	$2,800	$2,940	$3,087	$3,242	$3,403	$15,472

* Includes funds for Prolific Sheep activities in Indonesia

FN:Sumbud.b3
Prepared: 21 June 89 jws

SMALL RUMINANTS CRSP Plan B

BUDGETS

Dual Purpose Goat Project

ALL AMOUNTS EXPRESSED IN THOUSANDS

Dual Purpose Goats - Breeding

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
1. Scientists & Staff	$97	$69	$45	$0	$0	$211
2. Research Costs						
Supplies	$95	$70	$47	$0	$0	$212
Equipment	$8	$6	$4	$0	$0	$18
Travel	$39	$30	$20	$0	$0	$89
Training	$39	$30	$20	$0	$0	$89
Other	$30	$26	$18	$0	$0	$74
Subtotal	$308	$231	$154	$0	$0	$693
Indirect Costs	$92	$69	$46	$0	$0	$207
TOTAL	$400	$300	$200	$0	$0	$900

FN:Dualgt.b3

Prepared: 21 JUNE 89 JWS

SMALL RUMINANTS CRSP PLAN B

BUDGETS

AGROPASTORAL

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
ALL AMOUNTS EXPRESSED IN THOUSANDS						
1. Scientists & Staff						
U.S. Personnel	$50	$55	$90	$115	$100	$410
H.C. Personnel	$100	$110	$135	$150	$175	$670
Subtotal Personnel	$150	$165	$225	$265	$275	$1,080
2. Research Costs						
Supplies	$30	$51	$80	$95	$100	$356
Equipment	$25	$25	$20	$21	$21	$112
Travel	$35	$45	$50	$85	$100	$315
Training	$35	$36	$103	$100	$125	$399
Site Development	$100	$115	$50	$0	$0	$265
Subtotal	$375	$437	$528	$566	$621	$2,527
Indirect Costs	$95	$113	$122	$134	$143	$607
Total	$470	$550	$650	$700	$764	$3,134

FN:AGRObud.b3

Prepared: 21 June 89 jws

SMALL RUMINANTS CRSP PLAN B

BUDGETS

ANIMAL HEALTH

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
	ALL AMOUNTS EXPRESSED IN THOUSANDS					
1. Scientists & Staff	$157	$160	$150	$200	$170	$837
2. Research Costs						
Supplies	$155	$170	$180	$200	$248	$953
Equipment	$6	$6	$5	$6	$5	$28
Travel	$13	$15	$20	$25	$40	$113
Training	$21	$25	$40	$41	$50	$177
Other	$0	$0	$0	$0	$0	$0
Subtotal	$352	$376	$395	$472	$513	$2,108
Indirect Costs	$98	$104	$105	$128	$137	$572
Total	$450	$480	$500	$600	$650	$2,680

FN:Anmlbud.b3

Prepared: 21 June 89 jws

SMALL RUMINANTS CRSP

BUDGETS

PROLIFIC SHEEP-MOROCCO

Plan B

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
	ALL AMOUNTS EXPRESSED IN THOUSANDS					
Research Costs						
Supplies	$29	$24	$19	$0	$0	$72
Equipment	$0	$0	$0	$0	$0	$0
Travel	$7	$6	$5	$0	$0	$18
Training	$0	$0	$0	$0	$0	$0
Other	$10	$9	$7	$0	$0	$26
Subtotal	$46	$39	$31	$0	$0	$116
Indirect Costs	$14	$11	$9	$0	$0	$34
Total Prolific Sheep	$60	$50	$40	$0	$0	$150

FN:Prolifbud.b3

Prepared: 21 JUNE 89 jws

SMALL RUMINANTS CRSP PLAN B

BUDGETS

HAIR SHEEP

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
	ALL AMOUNTS EXPRESSED IN THOUSANDS					
1. Scientists & Staff						
U.S. Personnel	$75	$80	$100	$120	$150	$525
H.C. Personnel	$130	$150	$170	$200	$225	$875
Subtotal Personnel	$205	$230	$270	$320	$375	$1,400
2. Research Costs						
Supplies	$84	$100	$150	$196	$184	$714
Equipment	$40	$40	$40	$20	$20	$160
Travel	$40	$55	$65	$78	$45	$283
Training	$35	$70	$154	$175	$175	$609
Site Development	$113	$107	$0	$0	$0	$220
Subtotal	$517	$602	$679	$789	$799	$3,386
Indirect Costs	$133	$148	$146	$178	$181	$786
Total	$650	$750	$825	$967	$980	$4,172

FN:hairbud.b3

Prepared: 21 June 89 jws

SMALL RUMINANTS CRSP PLAN B

BUDGETS

NETWORKING

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
ALL AMOUNTS EXPRESSED IN THOUSANDS						
1. Secretariat						
Staff	$18	$18	$20	$25	$25	$106
Supplies	$9	$9	$10	$15	$15	$58
Equipment	$15	$7	$2	$5	$15	$44
Communications	$6	$9	$10	$15	$15	$55
Subtotal	$48	$43	$42	$60	$70	$263
2. Regional Workshops	$25	$30	$33	$60	$54	$202
3. Travel						
P.I. Visits	$8	$8	$8	$16	$15	$55
SRSN Coordinators	$8	$9	$9	$20	$20	$66
Subtotal Travel	$16	$17	$17	$36	$35	$121
4. Linkages	$45	$50	$70	$60	$60	$285
Subtotal Netwk/Links	$134	$140	$162	$216	$219	$871
Indirect Costs	$36	$40	$48	$64	$61	$249
Total	$170	$180	$210	$280	$280	$1,120

FN:netwkbud.b3

Prepared: 21 June 89 jws

SMALL RUMINANTS CRSP PLAN B

BUDGETS

Management

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
	ALL AMOUNTS EXPRESSED IN THOUSANDS					
Salaries & Benefits	$185	$194	$204	$214	$225	$1,022
Supplies	$140	$147	$154	$162	$170	$774
Equipment	$5	$5	$6	$6	$6	$28
Travel	$45	$47	$50	$52	$55	$249
Committees	$45	$47	$50	$52	$55	$249
EEP	$43	$45	$47	$50	$52	$238
Subtotal	$463	$486	$510	$536	$563	$2,558
Indirect Costs	$137	$144	$151	$159	$166	$757
TOTAL	$600	$630	$662	$695	$729	$3,316

FN:Adminbud.b3

Prepared:21 JUNE 89 jws

ANNEX C

SMALL RUMINANTS CRSP — Plan C

BUDGETS

Summary-All Programs

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
	ALL AMOUNTS EXPRESSED IN THOUSANDS					
Dual Purpose Goat	$400	$300	$200	$0	$0	$900
Prolific Sheep-Moroc.	$60	$50	$40	$0	$0	$150
Hair Sheep*	$650	$700	$750	$800	$800	$3,700
Agropastoral	$470	$510	$550	$600	$600	$2,730
Animal Health	$450	$470	$490	$520	$520	$2,450
Networking	$170	$170	$170	$280	$280	$1,070
Subtotal	$2,200	$2,200	$2,200	$2,200	$2,200	$11,000
Management	$600	$600	$600	$600	$600	$3,000
TOTAL	$2,800	$2,800	$2,800	$2,800	$2,800	$14,000

* Includes funds for Prolific Sheep activities in Indonesia

FN:Sumbud.C3

Prepared: 21 JUNE 89 jws

SMALL RUMINANTS CRSP Plan C

BUDGETS

Dual Purpose Goat Project

ALL AMOUNTS EXPRESSED IN THOUSANDS

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
Dual Purpose Goats - Breeding						
1. Scientists & Staff	$97	$69	$45	$0	$0	$211
2. Research Costs						
Supplies	$95	$70	$47	$0	$0	$212
Equipment	$8	$6	$4	$0	$0	$18
Travel	$39	$30	$20	$0	$0	$89
Training	$39	$30	$20	$0	$0	$89
Other	$30	$26	$18	$0	$0	$74
Subtotal	$308	$231	$154	$0	$0	$693
Indirect Costs	$92	$69	$46	$0	$0	$207
TOTAL	$400	$300	$200	$0	$0	$900

FN:Dualgt.c3

Prepared: 21 JUNE 89 JWS

SMALL RUMINANTS CRSP Plan C

BUDGETS

PROLIFIC SHEEP-MOROCCO

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
	ALL AMOUNTS EXPRESSED IN THOUSANDS					
Research Costs						
Supplies	$29	$24	$19	$0	$0	$72
Equipment	$0	$0	$0	$0	$0	$0
Travel	$7	$6	$5	$0	$0	$18
Training	$0	$0	$0	$0	$0	$0
Other	$10	$9	$7	$0	$0	$26
Subtotal	$46	$39	$31	$0	$0	$116
Indirect Costs	$14	$11	$9	$0	$0	$34
Total Prolific Sheep	$60	$50	$40	$0	$0	$150

FN:PROLIFBUD.C3

Prepared: 21 JUNE 89 jws

SMALL RUMINANTS CRSP

BUDGETS

HAIR SHEEP

Plan C

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
	ALL AMOUNTS EXPRESSED IN THOUSANDS					
1. Scientists & Staff						
U.S. Personnel	$75	$75	$86	$90	$90	$416
H.C. Personnel	$130	$130	$140	$150	$150	$700
Subtotal Personnel	$205	$205	$226	$240	$240	$1,116
2. Research Costs						
Supplies	$84	$100	$140	$180	$180	$684
Equipment	$40	$40	$40	$20	$20	$160
Travel	$40	$45	$65	$45	$45	$240
Training	$35	$70	$150	$175	$175	$605
Site Development	$113	$104	$0	$0	$0	$217
Subtotal	$517	$564	$621	$660	$660	$3,022
Indirect Costs	$133	$136	$129	$140	$140	$678
Total	$650	$700	$750	$800	$800	$3,700

FN:hairshep.C3

Prepared: 21 JUNE 89 jws

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SMALL RUMINANTS CRSP — Plan C

BUDGETS

AGROPASTORAL

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
ALL AMOUNTS EXPRESSED IN THOUSANDS						
1. Scientists & Staff						
U.S. Personnel	$50	$55	$90	$90	$90	$375
H.C. Personnel	$100	$110	$135	$150	$150	$645
Subtotal Personnel	$150	$165	$225	$240	$240	$1,020
2. Research Costs						
Supplies	$30	$31	$62	$65	$65	$253
Equipment	$25	$25	$20	$20	$20	$110
Travel	$35	$35	$40	$45	$45	$200
Training	$35	$35	$105	$125	$125	$425
Site Development	$100	$115	$0	$0	$0	$215
Subtotal	$375	$406	$452	$495	$495	$2,223
Indirect Costs	$95	$104	$98	$105	$105	$507
Total	$470	$510	$550	$600	$600	$2,730

FN:AGROPAST.C3

Prepared: 21 JUNE 89 jws

SMALL RUMINANTS CRSP

BUDGETS

ANIMAL HEALTH

Plan C

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
ALL AMOUNTS EXPRESSED IN THOUSANDS						
1. Scientists & Staff	$157	$160	$175	$185	$185	$862
2. Research Costs						
Supplies	$155	$165	$168	$175	$175	$838
Equipment	$6	$7	$5	$6	$6	$30
Travel	$13	$12	$12	$15	$15	$67
Training	$21	$25	$24	$27	$27	$124
Other	$0	$0	$0	$0	$0	$0
Subtotal	$352	$369	$384	$408	$408	$1,921
Indirect Costs	$98	$101	$106	$112	$112	$529
Total	$450	$470	$490	$520	$520	$2,450

FN:Anmlhelt.C3

Prepared: 21 JUNE 89 jws

SMALL RUMINANTS CRSP — Plan C

BUDGETS

NETWORKING

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
ALL AMOUNTS EXPRESSED IN THOUSANDS						
1. Secretariat						
Staff	$18	$18	$20	$25	$25	$106
Supplies	$9	$9	$10	$15	$15	$58
Equipment	$15	$7	$2	$15	$15	$54
Communications	$6	$6	$7	$15	$15	$49
Subtotal	$48	$40	$39	$70	$70	$267
2. Regional Workshops	$25	$30	$30	$54	$54	$193
3. Travel						
P.I. Visits	$8	$8	$8	$15	$15	$54
SRSN Coordinators	$8	$9	$9	$20	$20	$66
Subtotal Travel	$16	$17	$17	$35	$35	$120
4. Linkages	$45	$45	$45	$60	$60	$255
Subtotal Netwk/Links	$134	$132	$131	$219	$219	$835
Indirect Costs	$36	$38	$39	$61	$61	$235
Total	$170	$170	$170	$280	$280	$1,070

FN:netwk.C3

Prepared: 21 JUNE 89 jws

SMALL RUMINANTS CRSP — Plan C

BUDGETS

Management

	1990/91	1991/92	1992/93	1993/94	1994/95	1990-95
	ALL AMOUNTS EXPRESSED IN THOUSANDS					
Salaries & Benefits	$185	$190	$195	$200	$207	$977
Supplies	$140	$145	$148	$145	$143	$721
Equipment	$5	$5	$0	$0	$0	$10
Travel	$45	$35	$30	$29	$30	$169
Committees	$45	$46	$46	$45	$39	$221
EEP	$43	$42	$42	$43	$43	$213
Subtotal	$463	$463	$461	$462	$462	$2,311
Indirect Costs	$137	$137	$139	$138	$138	$689
TOTAL	$600	$600	$600	$600	$600	$3,000

FN:Admin.C3

Prepared:21 JUNE 89

ANNEX D

FAO Sheep and Goat Statistics[1]

Numbers of Sheep and Goats
in thousands of head

	Sheep Stocks			Goat Stocks		
	79-81	1986	1987	79-81	1986	1987
World	1,094,427	1,145,690	1,160,422	465,529	472,192	503,165
Developed Countries	512,684	544,528	545,855	24,903	28,991	28,705
Developing Countries	581,757	601,162	614,567	440,652	463,201	474,460
Kenya	5,100	7,100	-	7,761	8,500	-
Morocco	15,228	14,545	15,000	5,773	5,276	5,300
Peru	14,565	13,500*	13,500*	1,983	1,720*	1,720*
Brazil	18,414	18,473*	19,200*	8,420	9,800*	9,800*
Indonesia	4,124	5,193	5,353	8,153	12,289	12,972
U.S.A.	12,670	9,983	7,000*	1,380	1,700	-

*Estimate

Meat and Milk Production
in metric tons

	Sheep				Goats			
	Meat		Milk		Meat		Milk	
	79-81	1986	79-81	1986	79-81	1986	79-81	1986
World	5,711	6,246	8,005	8,618	1,818	2,117	7,241	7,692
Developed Countries	3,337	3,509	3,576	3,734	102	94	1,896	1,977
Developing Countries	2,374	2,736	4,429	4,885	1,445	1,646	5,345	5,714
Kenya	18	26	1	1	20	19	1	1
Morocco	56	47	20	25	18	13	27	35
Peru	21	17	-	-	9	7	19	19
Brazil	29	29	-	-	89	90	23	23
Indonesia	23	25	-	-	44	51	-	-
U.S.A.	143	152	-	-	-	-	-	-

[1]From FAO Production Yearbook, 1986, Vol. 40 and 1987 Monthly Bulletin of Statistics.

ANNEX E.1

SR-CRSP ADMINISTRATIVE COUNCIL

Robert C. Albin	Texas Tech University
Antonio Chavez	INIAA - Peru
Samson Chema	MALD - Kenya
Larbi Firdawcy	IAV-Hassan II-Morocco
James Henson	Washington State University
Charles Lassiter	N. Carolina State University
Arthur Linton	Montana State University
A. G. Marr	University of California, Davis
Carl Menzies	Texas A&M University
Jan Nari	CRIAS-Indonesia
Gordon Niswender	Colorado State University
Ned S. Raun	Winrock International
Paul Rasmussen	Utah State University

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Arthur Linton	Montana State University
A. G. Marr	University of California, Davis
Carl Menzies	Texas A&M University
Ned Raun	Winrock International

TECHNICAL COMMITTEE

Eric Bradford	University of California, Davis
Fred Bryant	Texas Tech. University
Peter Burfening, Chair	Montana State University
James DeMartini	Colorado State University
Henry Fitzhugh	Winrock International
Arturo Florez	INIAA, Peru
Fouad Guessous	Hassan II Univerisity, Morocco
Benny Gunawan	AARD, Indonesia
Hendrick Knipscheer	Winrock International
John Malechek	Utah State University
Travis McGuire	Washington State University
Michael Nolan	University of Missouri
James Oxley, ex officio	Management Entity, UC Davis
Kevin Pond	N. Carolina State University
Jeremy Taylor	Texas A&M University
open	KARI, Kenya

EXTERNAL EVALUATION PANEL

Gordon Campbell, Chair	Cornell University
Saul Fernandez-Baca	Peru
Cornelia Butler Flora	Virginia Polytechnic Institute
Hudson Glimp	USDA/ARS
Gerald Thomas	New Mexico State University

NUMBER OF SCIENTISTS, INSTITUTIONS, AND DISCIPLINES INVOLVED IN THE SR-CRSP

Institutions		Scientists		Disciplines
U.S. Name	Host Country	U.S. Number	Host C.* Number	
Morocco				
Utah State	Institut Agronomique Et Veterinaire-Hassan II (IAV)	2	3	Range Management
N. Carolina State	IAV and National School of Agriculture	4	5	Animal Nutrition
University of Missiouri-Columbia	IAV	2	1	Rural Sociology
University of California	IAV	7	7	Animal Breeding Genetics
Indonesia				
University of Cal., Davis	Balai Penelitian Ternak (BPT)	1	7	Animal Breeding and Genetics
University of Missouri-Columbia	BPT	1	4	Rural Sociology
Winrock Int'l	BPT	1	8	Agricultural Economics
N. Carolina State	BPT, sub BPT, and Rubber Institute	2	11	Animal Nutrition
Brazil				
Utah State	Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA)	2	5	Range Management

ANNEX E.2

Institutions U.S. Name	Host Country	Scientists U.S.	Scientists Host C.*	Disciplines
		Number		
Peru				
Colorado State University	Universidad Nacional Mayor de San Marcos (INVITA)/San Marcos University	5	11	Animal Health
University of Missouri-Colum.	Instituto Nacional de Investigacion Agraria y Agroindustrial (INIAA) Grupo Yanapai	3	4	Rural Sociology
Winrock Int'l	Universidad Nacional Agraria-La Molina (UNA), INIAA, Grupo Yanapai	1	6	Agricultural Economics
Montana State University	INIAA, UNA, Universidad Nacional de Altiplano, Puno (UNTA)	3	5	Animal Breeding and Management
Texas Tech	UNA, IVITA, UNTA, INIAA	7	8	Range Management
Kenya				
Winrock Int'l	Kenya Agricultural Research Institute (KARI)	2	7	Agricultural Economics and Production Systems
Washington St.	Kenya Animal Health Min. of Livestock Develop.	1	5	Animal Health
University of Missouri-Columbia	KARI	1	2	Rural Sociology
Texas A&M	KARI	2	5	Animal Breeding and Systems Analysis

* Includes expatriate resident scientists and collaborating scientists

June, 1989

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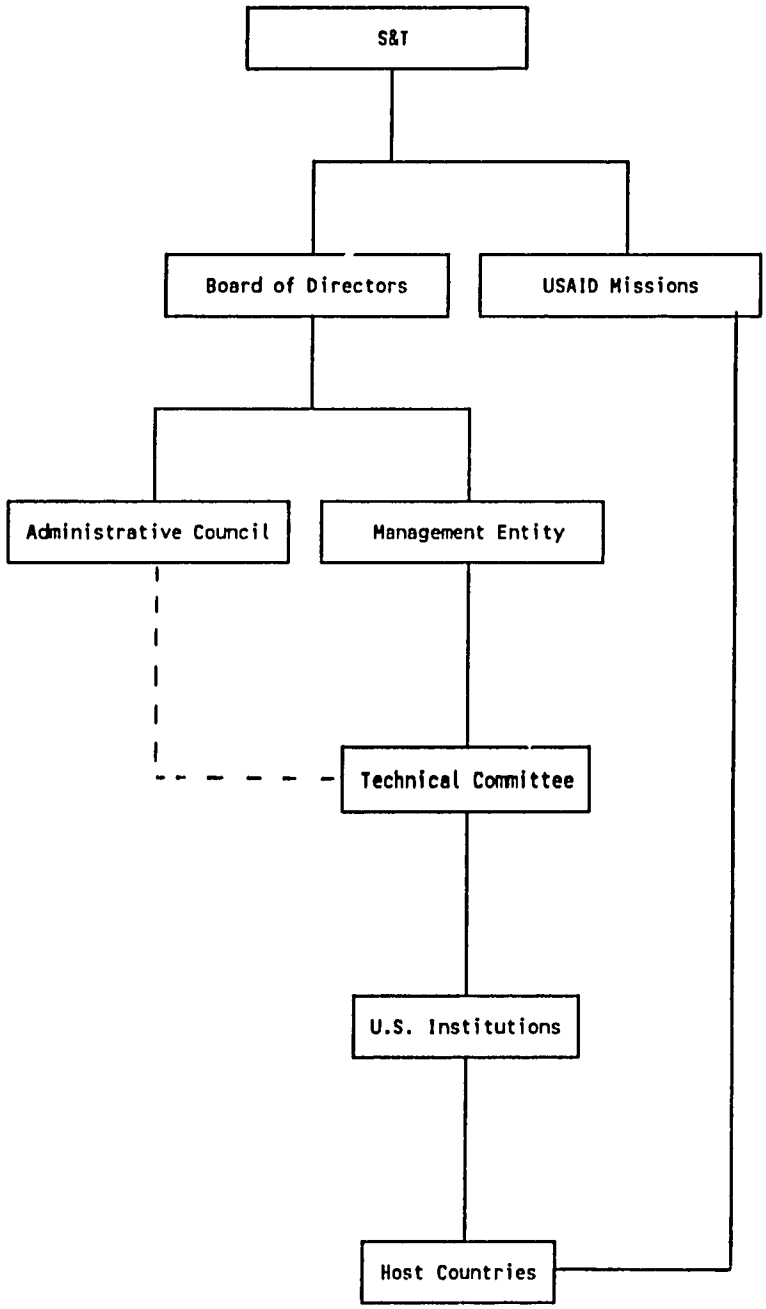
ANNEX E.3

SR-CRSP Institutions, Major Projects, and Country Sites

	Major Projects by Sites						
Institutions	Breeding	Health	Nutrition	Sociology	Economics	Management Systems	Range Management
UCD	Morocco Indonesia						
MSU	Peru						
UMC				Indonesia Morocco Kenya Peru			
NCSU			Indonesia Morocco				
TAMU	Kenya						
Texas Tech							Peru
USU							Morocco Brazil
Winrock Int'l					Indonesia Kenya Peru	Kenya	
CSU		Peru					
WSU		Kenya					

UCD	University of California, Davis
MSU	Montana State University
UMC	University of Missouri, Columbia
NCSU	North Carolina State University
TAMU	Texas A&M University
USU	Utah State University
Winrock Int'l	Winrock International
CSU	Colorado State University
WSU	Washington State University

ANNEX E.4



General Organizational Relationships in SR-CRSP

ANNEX E.5

FUNDS MANAGEMENT

The total funds authorized by USAID are allocated to each of the research programs, host country research and administrative operations, and the Management Entity, including administrative subunits, e.g., Technical Committee, Board, Administrative Council, External Evaluation Panel, Workshops and Conferences, etc. The allocations are based on annual work plans and budgets which are reviewed by the Technical Committee and approved by the Board. Subgrants/subcontracts are issued annually by the ME to the participating institutions. The subgrants/subcontracts include the standard provisions of the grant document issued by USAID as well as the detailed budgets totalling the amount approved by the board for that program and institution.

The subgrant/subcontract institutions are responsible for managing and controlling funds allocated to them in accord with USAID and SR-CRSP regulations. Participating institutions report expenditures periodically, usually monthly, to the ME UCD maintains separate accounts for each institution; the periodic expense reports are recorded in the appropriate expense account in the UCD general ledger. UCD reports total expenditures and commitments to USAID/W quarterly.

Similarly, each host country submits an annual budget for the in-country administrative and research activities that complement the participating institutions' projects. The host country expenses are local currency expenditures. Each site has an administrative person responsible who monitors the local expenditures and submits monthly expenditure reports along with supporting receipts. The host country administrator is responsible for assuring that the expenditure complies with USAID regulations and SR CRSP policies. The host country operates from a cash advance from the ME and the participating institutions. When expenses are reported and accepted by the ME and the participating institution, the reporting host country is reimbursed for the total expenses allowed. Any disallowed expenses are deducted from the amount of the reimbursement to the host country.

Separate bank accounts are maintained for local currency and U.S. dollars at each site. The site administrator submits copies of each bank account to the ME. Each bank account is reconciled monthly.

All expenditures by the ME are subject to the policies and procedures of UCD. The campus accounting office reviews the expenditures and financial transactions; the campus purchasing department processes the purchase requisitions.

Transactions requiring USAID approval, e.g., international

travel, certain equipment items, etc., must be processed through the ME which in turn obtains the necessary approval from USAID/W. Any expenses for items without proper approval are not reimbursed by the ME.

The university's external auditors review the financial records of the SR-CRSP in the annual review of the university's fiscal operations. In addition, fiscal reviews are held when the assistant director visits a host country site.

ANNEX F

Small Ruminant Collaborative Research Support Program

Global Plan for Years 1-12
Initiated in 1979; revised in 1985 and 1987

The guidelines developed in 1979 under Title XII for the Conduct of Collaborative Research Support Program (CRSPs) explicitly states:

"The amelioration of world food, nutrition, and poverty problems will require considerable expansion in a comprehensive body of relevant scientific knowledge" and that "the agricultural research establishment of the American higher education community...has extensive capacity to work effectively on this set of problems...and if progress is to be made...this capacity must be mobilized to work in collaborative fashion with (most importantly) the agricultural research institutions in the developing nations."

The Small Ruminant CRSP was the first attempt to implement this concept. Criteria that we established to construct our program were the following:

- Our work would be <u>collaborative</u> with qualified scientific colleagues in the agricultural research institutions overseas of developing nations. Our research is strictly a partnership with counterparts in every country on every subproject.

- Our work would be <u>research</u> - the best research we could do. Our purpose would be to do research and also teach researchers from the region so that developing countries could be self reliant in problem solving with respect to their livestock industries in the future.

- Our research would provide <u>support</u> for existing priorities in country and for the identification of restraints limiting productivity. We would not initiate new esoteric lines of investigation but fit into the existing perceived priorities as determined by our host country colleagues.

- We would attempt to be <u>diplomatic</u> in our selectivity, including a country from every USAID Bureau - that is Africa, Near East, Latin America, and Asia. We chose the specific countries only when host governments and USAID Missions concurred.

- We would attempt to have a <u>multidisciplinary</u> program at each site very broadly based in systems analysis, nutrition, range,

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management, economics, sociology, breeding, physiology, and health.

- We would attempt to work directly with and for smallholders. This is not easy or usual, but to a large extent it has been our imperative. Much of our research is in smallholdings and remote field stations as well as in basic science on U.S. campuses.

- Finally, we would attempt to be only what we can be, and accomplish only those things that we do best. We cannot be all things to all people and so our focus has been institution building. We have concentrated not only on research (over 1200 papers) and training (over 230 scientists and 600 students and staff trained), but also on establishing efficient, well-equipped offices with trained administrators, so that in the future these developing countries can be self reliant. We have actually brought junior as well as senior administrators to the U.S. so that all levels of communications and research support can be improved overseas not only with the CRSP, but with numerous other bilateral and multilateral programs.

With these criteria as our focus, the SR-CRSP has been allowed to take its course and evolve. Strong evolutionary pressures that have been exerted upon the SR-CRSP include a constant and thorough evaluation by an expert panel (EEP), constant constructive criticism by our host country colleagues, and firm accountability from the Management Entity. As evidence of the evolutionary process, it can be demonstrated that a strong positive correlation exits between EEP reviews and project funding. It can be seen that some subgrants have been terminated or reduced for lack of performance while others have grown. Some have successfully achieved their goals and have withdrawn from the program leaving excellent programs in place as a result of their efforts. We hope that the SR-CRSP will always be dynamic, forced to respond to positive pressures of the type described and also that the numerous checks and balances will guarantee its productivity.

As a result of the "workability" of the SR-CRSP model it has received external support from several agencies. IDRC continued to fund a program initiated by the SR-CRSP and used CRSP infrastructure for the continuation. Funds have come from World Bank, IICA, RMI, and ILCA to support substantial SR-CRSP activities. It is our hope that such financial support can be maintained in coming years.

Issues which USAID, BIFAD, SR-CRSP, and Host Country colleagues must consider are:

- Should the SR-CRSP expand into new countries? If so, which ones and under what type of funding?

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- Should the SR-CRSP pull out of existing countries when they have accomplished an acceptable level of institution building?

- Should the SR-CRSP consider itself to be a Country program or a Global program? Thus, when Mission priorities change - how should the SR-CRSP respond?

- Should the SR-CRSP retain indefinitely the bridges it has built with a network of scientists in a limited number of countries or extend this network to a wider field?

- Should the SR-CRSP respond to the numerous requests for "buy-ins" to its program, and if so, by what mechanisms?

- Should the SR-CRSP promote outreach workshops to other institutions in other countries using our present host country colleagues with their cultural and linguistic skills in the vanguard of such outreach?

For the future, the Management Entity would recommend:

- The present mode of the SR-CRSP should be preserved as a basic "backbone" upon which to expand, change, or modify future programs.

- The present mode of the SR-CRSP should be preserved as a basic "window" for participating LDCs through which they can look to U.S. institutions for help.

- The present mode allows for access to a vast depth of knowledge and expertise in food and agriculture - the greatest repository of which is the U.S. Land Grant Universities. Through the SR-CRSP, not only the Principal Investigators but also their colleagues in the same or even other departments on many campuses can be accessed. By this route, active researchers in mid-career, not normally available, may be used as resources.

- The SR-CRSP must be willing to change for there are other associated groups with different agendas. For example:

  - Ministries and organizations overseas change.
  - USAID Mission priorities change from time to time.
  - U.S. institutions needs and capabilities may change.

As indicated in the subproject's and Management Entity's plans, they will accomplish the following goals during years ten, eleven, and twelve.

1. Continue to improve research administration, data collection, analysis and evaluation in the five primary LDC sites.

2. Improve the small ruminant data base, teaching and research resources and ability to serve the cooperating LDCs and their neighboring countries with similar opportunities.

3. Develop for the smallholder in the humid and arid, tropical and subtropical small ruminant production areas, more efficient adapted breeds and production systems, which include range and forage development, insect and disease control, and feed evaluation and feeding systems.

4. Complete academic training at both under graduate and advanced degree levels for over 250 participants.

5. Through on-the-job training, workshops and seminars, provide nonacademic training to 800 participants.

6. Work toward close collaboration with other donor agencies and scientific groups, particularly in the International Centers.

7. Continue to encourage and develop scientific leadership capabilities among counterpart personnel in the host countries.

8. Continue to study the social and economic incentives that will improve smallholder production of sheep and goats.

9. The SR-CRSP has begun to award funds on the basis of merit in research and implementation of advances made.

During years eight and nine, an in-depth evaluation will be required to determine in detail the programs that will be required to sustain and further improve the capabilities that have been developed both in the LDC and U.S. institutions by the SR-CRSP. Research in small ruminants, as in other industries, is a continuing activity in order to solve new problems and continue to increase production efficiency. Even if all institutions are successful in developing the capability and acquiring the resources to sustain dynamic research and extension institutions, a system for maintaining linkages, establishing staff and data exchanges and continuing to do collaborative research must be established. Institutions working in isolation soon stagnate and lose their dynamism. The establishment of a continuing network is the minimum that must be assured following year nine. With the development research capability, the attention should be focused on outreach programs and farmer education systems. Only then will the investment in good research facilities be returned in increased agricultural production.

ANNEX G

Status of Technological Packages - May 1989

Title	Country	Completion Date
Improving Meat Goat Production in the Semiarid Tropics	Brazil	Published March, 1989
Improving Sheep Production in the Semiarid Tropics	Brazil	Summer, 1989
Sheep Production and Management in a Mediterranean Climate: the Agropastoral Systems of Morocco	Morocco	Summer, 1989
Several modules on specific topics related to production, management, health, and economics	Indonesia	Several modules are completed; 30 scheduled for completion in 1990
Five units on topics related to production, management, health, and economics	Peru	Late 1989
Dual-Purpose Goat Technology for Smallholders in Kenya	Kenya	Validating research-based recommendations under field conditions; all will be compiled into book to be published in late 1989 or early 1990. Subject to future updating

ANNEX H

Summary of Degree Trained Students by Country, Discipline, and Sites 1980-1988

	Sociology		Animal Reprod.		Range Science		Animal Science		Animal Nutrition		Veterinary Sciences		Animal Breeding		Ag Econ		Food Sci Biology Ag Sci Other		Total
	Numbers of Students by Sites and Disciplines																		
Country	U.S.	O.S.[1]	U.S.	O.S.	U.S.	O.S.	U.S.	O.S.	U.S.	O.S.	U.S.	O.S.	U.S.	O.S	U.S.	O.S.	U.S.	O.S.	
Brazil	1	-	2	1	4	1	-	4	1	1	2	1	4	-	-	4	-	-	26
Indonesia	1	1	-	-			2	2	3	8	-	-	1	-	3	2			23
Kenya	3	1	-	-	1	2	10	-	1	-	6	-	4	-	1	1	1		31
Morocco					4	11	-	13	3	11	1	2	3	1	-	1			50
Peru	2	6	3		4	25				1	8	5	1	8	3	9	2	10	91
U.S.A.	5	0	7	0	12	0	12	-	4	-	7	2	8	0	3	0	1		61
Ethiopia					1								2						3
Sudan					1						1								2
Switzerland									1				1						2
Chile													2						2
Mexico					2														2
Mali								2											2
Niger						1		1											2
Nigeria			1																1
Australia											1								1
Ivory Coast													1						1
Venezuela													1						1
Trinidad															1				1
Tanzania							1												1
Israel	1																		1
Panama									1										1
Uruguay													1						1
Columbia															1				1
Holland																	1		1
Comorois								1											1
Guinea								1											1
C. Africa																1			1
Cameroon						1													1
Unknown		1																	1
TOTALS	13	9	13	5	29	41	25	24	14	21	26	10	29	9	12	18	5	10	313

1 Overseas

ANNEX I

CRITERIA FOR RESEARCH SITE SELECTION AND MAINTENANCE

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 an USAID mission supportive of CRSP objectives.

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 willingness to accept the presence of an expatriate site coordinator.

8. The site must have the potential of generating technology of regional applicability.

9. Commitment for collaboration and ability of collaborating personnel to work at the site.

10. Security for program employees.

11. The collaborating host country institution should have an identifiable linkage to the small ruminant producers. A clear example is an extension component, although there are other acceptable mechanisms.

ANNEX J

Responses to AID/W Inquiries of USAID Missions Relative to Future Interest in SR-CRSP.

[Note: Page numbers are in the lower right hand corner.]

Telegram sent to selected USAID Missions explaining the SR-CRSP and asking for an expression of interest in future collaboration..... 1

Responses from USAID Missions..... 6

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INFO PRECEDENCE — INFO ADDRESSES
Also sent to Botswana and Cameroon

SPECIAL HANDLING

ADMINS AID

E.O. 12356: N/A

TAGS:

SUBJECT: SMALL RUMINANT COLLABORATIVE RESEARCH SUPPORT PROGRAM {SR-CRSP} - 936-1328

PASS TO: DENNIS MCCARTHY, ADO, OUAGADOUGOU; ERNIE GIBSON, ADO, NIAMEY; DICK PETERS, ADO, QUITO; DARRELL MCINTYRE, ADO, LA PAZ; TRACY ATWOOD, ADO, BAMAKO.

SUMMARY OF THE SMALL RUMINANT COLLABORATIVE RESEARCH SUPPORT PROGRAM {SR-CRSP}

THE SR-CRSP IS A CENTRALLY FUNDED LONG-TERM RESEARCH PROJECT DESIGNED TO IMPROVE THE PRODUCTION OF SHEEP, GOATS, AND ALPACAS. CURRENTLY THE PROJECT ACTIVITIES ARE LOCATED IN PERU, MOROCCO, KENYA, AND INDONESIA. DUE TO THE SECURITY PROBLEMS IN PERU, THE CRSP CANNOT CONTINUE ITS COLLABORATIVE RESEARCH IN THE FIELD AND WILL BE PHASING OUT NO LATER THAN SEPTEMBER, 1990. THE PROGRAM HAS REACHED A SIGNIFICANT LEVEL OF SUCCESS AND IS CONSIDERING REDUCING ACTIVITIES TWO OTHER COUNTRIES WITH THE INTENTION OF MOVING TO OTHER SITES IN THE SAHEL OR THE ALTIPLANO. SR-CRSP IS FOSTERING REGIONAL

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NETWORKING IN SMALL RUMINANT RESEARCH WITH THE PRIMARY RESEARCH SITES PLAYING IMPORTANT ROLES IN EXTENDING TECHNOLOGIES. WE ARE INTENT ON IDENTIFYING INTERESTED AND APPROPRIATE SECONDARY SITES TO FORM REGIONAL NETWORKS IN EACH ECOLOGICAL ZONE WHERE INTERESTED HOST COUNTRIES CAN KEEP ABREAST OF SCIENTIFIC ADVANCEMENTS AND BE ON THE RECEIVING END OF NEW TECHNOLOGY. THEREFORE, WE ARE SOLICITING THE INTEREST OF SELECT COUNTRIES TO WHICH THE CRSP CAN CONTRIBUTE WITH THE POSSIBILITY OF PHASING IN RESEARCH ACTIVITIES OVER THE NEXT YEAR OR SO. SELECTION OF FUTURE PROGRAM SITE(S) WILL BE MADE BY AID AND SR-CRSP TECHNICAL COMMITTEE WITH MISSION'S INPUT AND POSSIBLE SITE VISITS.

THE U.S. INSTITUTIONS INVOLVED WITH THE SR-CRSP, THEIR COUNTRIES AND ACTIVITIES, ARE:

COLORADO STATE - ANIMAL HEALTH - PERU
MONTANA STATE - BREEDING AND GENETICS - PERU
NORTH CAROLINA STATE - NUTRITION - MOROCCO, INDONESIA
TEXAS A AND M - SYSTEMS ANALYSIS - KENYA
TEXAS TECH - RANGE MANAGEMENT - MOROCCO
WASHINGTON STATE - ANIMAL HEALTH - KENYA
WINROCK INTERNATIONAL - ECONOMICS, GOAT PRODUCTION SYSTEMS - KENYA, INDONESIA, PERU
UTAH STATE - RANGE MANAGEMENT - MOROCCO
UNIVERSITY OF MISSOURI - SOCIOLOGY - PERU, KENYA, INDONESIA

U.S UNIVERSITIES ARE REQUIRED TO CONTRIBUTE A MINIMUM OF 25 PERCENT OF THEIR (NON-FEDERAL) RESOURCES TO THE RESEARCH, SUPPLEMENTING AID CENTRAL FUNDING. DIRECT MISSION SUPPORT IS NOT REQUIRED, BUT MISSIONS ARE ENCOURAGED TO CONTRIBUTE TO HOST COUNTRY ACTIVITIES WHERE THERE IS HOST COUNTRY INTEREST.

FOLLOWING ARE SOME OF THE SIGNIFICANT ACCOMPLISHMENTS OF THE SR-CRSP:

THE SR-CRSP HAS PROVIDED TECHNICAL LEADERSHIP, TECHNICAL FIELD SERVICES, AND COLLABORATIVE RESEARCH AND DEVELOPMENT IN SEVERAL DIFFERENT AREAS AS WELL AS TRAINED SCIENTISTS TO CARRY ON IN THESE ROLES IN THE FUTURE.

SR-CRSP SCIENTISTS HAVE IDENTIFIED THE GENETIC BASIS FOR HIGH REPRODUCTIVE RATES (PROLIFICACY) IN THE SHEEP OF INDONESIA AND MOROCCO. BY CROSSING TWO LOCAL BREEDS IN

MOROCCO, LAMB CROPS CAN BE INCREASED BY NEARLY 150 PERCENT. THIS PRESENTS ADDITIONAL INCOME TO THE PRODUCERS IN TERMS OF MEAT AND FIBER CASH GENERATION.

BY FOLLOWING SR-CRSP DEMONSTRATIONS OF PRODUCTIVE CULLING PROCEDURES, MOROCCAN FARMERS HAVE IMPROVED THE SIZE AND QUALITY OF THEIR FLOCKS. IMPROVING THE METHOD OF MATING MANAGEMENT THROUGH ESTABLISHING MATING SCHEDULES HAS RESULTED IN SOME FARMERS DOUBLING THEIR PRODUCTION OF POOR PRODUCING FLOCKS. IN ADDITION, SR-CRSP RESEARCHERS IDENTIFIED A SELENIUM DEFICIENCY IN MOROCCO WHICH HAS AIDED IN REDUCING THE MORTALITY RATE OF LAMBS.

A HIGHLY SUCCESSFUL OUTREACH PROGRAM IN INDONESIA STARTED BY THE SR-CRSP INVOLVES INDONESIAN SOCIAL SCIENTISTS, ECONOMISTS, AND BIOLOGICAL SCIENTISTS WITH GROUPS OF SMALLHOLDER PRODUCERS. A TOTAL OF 100 FARMERS FORM A NETWORK IN FOLLOWING SR-CRSP METHODS FOR IMPROVED SHEEP PRODUCTION. THE DEMAND IS VERY GREAT FOR SR-CRSP IMPROVED HAIR SHEEP, SO MUCH SO THAT NOT ENOUGH SHEEP CAN BE PRODUCED FOR THE FARMERS THAT WANT THEM. ONE FARMER REPORTEDLY PURCHASED SR-CRSP SHEEP WITH MONEY HE HAD SAVED TO FIX HIS HOUSE NOTING THAT THE SHEEP WOULD BRING HIM GREATER PROFIT IN THE FUTURE.

THE RESEARCH OF SR-CRSP SCIENTISTS IN SHEEP REPRODUCTION HAS BEEN COMPILED, EDITED, AND PUBLISHED IN A BOOK ENTITLED, QUOTE GENETICS OF REPRODUCTION IN SHEEP UNQUOTE. THE BOOK IS NOW USED WORLDWIDE AS A TEXT AND REFERENCE BY ANIMAL SCIENTISTS.

IN THE ANDEAN HIGHLANDS OF PERU, SR-CRSP SCIENTISTS HAVE DEVELOPED GRAZING STRATEGIES FOR LLAMAS, SHEEP, AND ALPACAS THAT REDUCES ENVIRONMENTAL DEGRADATION AND PROVIDES MORE FORAGE ON A CONTINUAL BASIS FOR ALL SPECIES.

HEAVIER BIRTH WEIGHTS OF LAMBS, HENCE GREATER SURVIVAL RATES, ARE THE RESULT OF GENETIC IMPROVEMENTS DEVELOPED BY SR-CRSP SCIENTISTS IN PERU. WITH MORE LAMBS SURVIVING, FLOCK SIZE INCREASES RESULTING IN POTENTIALLY GREATER INCOME GENERATION FOR THE FARMERS.

A SCIENTIST TRAINED UNDER THE SR-CRSP IN PERU IS NOW THE DEAN OF VETERINARY SCIENCE AT THE NATIONAL VETERINARY INSTITUTE.

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SR-CRSP RESEARCHERS HAVE DEVELOPED A GRAZING SCHEME FOR SHEEP UNDER RUBBER TREES IN SUMATRA WHICH HAS REDUCED WEED INFESTATION AS WELL AS THE USE AND COST OF HERBICIDES BY 50 PERCENT, A CONSIDERABLE SAVINGS FOR DIVERSIFIED SMALLHOLDER PRODUCERS. RESEARCH IS NOW UNDERWAY TO USE PROCESSED RUBBER SEEDS, A LONG WASTED SOURCE OF ENERGY, AS A SUPPLEMENT FOR THE SHEEP.

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. THE GOAL HAS INCLUDED MAKING HOST COUNTRY RESEARCH PROGRAMS SELF-SUSTAINING. TO THIS END, TRAINING SCIENTISTS HAS BEEN EXTENSIVE. APPROXIMATELY 300 RESEARCHERS HAVE BEEN TRAINED OVER A PERIOD OF NINE YEARS, 80 PERCENT OF THEM OBTAINING ADVANCED DEGREES. THESE TRAINEES REPRESENT A VALUABLE SCIENTIFIC RESOURCE NOW AVAILABLE TO CONTINUE AND TO EXPAND THE SCOPE OF INTERNATIONAL SMALL RUMINANT RESEARCH. SIMULTANEOUSLY, THE SR-CRSP IMPLEMENTS A PROGRAM OF NON-DEGREE TECHNICAL TRAINING. IN THE PAST EIGHT YEARS, THE PROJECT SUPPORTED OR SPONSORED ABOUT 23 TRAINING SESSIONS IN WHICH APPROXIMATELY 1,000 HOST COUNTRY INDIVIDUALS PARTICIPATED. PARTICIPANTS AT THESE SESSIONS HAVE INCLUDED FARMERS, TECHNICIANS, EXTENSION WORKERS, PROJECT PERSONNEL AND HOST GOVERNMENT ADMINISTRATORS.

AT THE PRESENT TIME THE SR-CRSP IS PLANNING FUTURE RESEARCH ACTIVITIES AND HAS DEVELOPED A TEN-YEAR PLAN WHICH DESCRIBES THE PROJECT'S FUTURE THRUSTS. WHILE THE PLAN IS STILL EVOLVING, THREE AREAS OF RESEARCH HAVE BEEN IDENTIFIED AS IMPORTANT AND PROMISING. THESE ARE BREEDING AND GENETICS, GRAZING MANAGEMENT IN SEMI-ARID/ ARID AREAS OR THE ALTIPLANO, AND THE DEVELOPMENT OF A MULTIVALENT, VIRUS VECTORED VACCINE FOR SHEEP AND GOATS. CONTINUATION OF RESEARCH IN NUTRITION, THE GENETICS OF PROLIFICACY IN SHEEP, AND DEVELOPMENT OF DUAL PURPOSE GOATS COMPLETES THE STRATEGY. IN ORDER TO IDENTIFY AND SELECT OTHER SITES TO WHICH THE SR-CRSP CAN CONTRIBUTE AND CONTINUE TO BUILD UPON ITS TEN YEARS OF COLLABORATIVE RESEARCH EXPERIENCE, INTERESTED MISSIONS SHOULD PROVIDE AS MUCH DETAIL AS POSSIBLE IN ANSWER TO THE FOLLOWING QUESTIONS.

1. IS THE MISSION INTERESTED IN SR-CRSP ACTIVITIES?

2. HOW DOES THE SR-CRSP FIT INTO THE MISSION'S

LONG-TERM PLANS FOR AGRICULTURAL DEVELOPMENT?

3. WOULD THE MISSION SUPPORT SR-CRSP ACTIVITIES? NOTE: NO MISSION FUNDING IS REQUIRED. ADMINISTRATIVE SUPPORT WOULD BE LIMITED TO OBTAINING TRAVEL CLEARANCES FOR ANNUAL VISITS BY PRINCIPAL INVESTIGATORS. NO OTHER ADMINISTRATIVE SUPPORT IS REQUIRED.

4. IS THE HOST COUNTRY (HC) INTERESTED IN THE SR-CRSP?

5. HOW DOES THE SR-CRSP FIT INTO HC LONG-TERM AGRICULTURAL RESEARCH AND DEVELOPMENT?

6. DOES THE COUNTRY 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?

7. WHAT WOULD BE THE LEVEL OF EXPENSE IN STARTING THE SR-CRSP AND CONDUCTING RESEARCH IN THE HOST COUNTRY? (COSTS TO CONSIDER INCLUDE HOUSE RENTAL, VEHICLE INSURANCE, IMPORT DUTIES, TRANSPORTATION WITHIN COUNTRY, MED-EVAC INSURANCE, ETC.)

8. WOULD THE HC BE PREPARED TO INVEST IN THE PROGRAM?

9. WHAT IS THE DEGREE OF ISOLATION FOR SCIENTISTS IN THE FIELD?

10. WILL THE HC AGREE TO PERMIT RESEARCH ON SMALL RUMINANTS BY U.S. STUDENTS?

11. WILL THE HC BE WILLING TO ACCEPT THE PRESENCE OF AN EXPATRIATE SITE COORDINATOR IF NECESSARY? (NOT ALL PROGRAM SITES REQUIRE EXPAT RESIDENT).

12. WOULD THE HC COLLABORATING INSTITUTION HAVE AN IDENTIFIABLE LINKAGE TO SMALL RUMINANT PRODUCERS? A CLEAR EXAMPLE IS AN EXTENSION COMPONENT, ALTHOUGH THERE ARE OTHER ACCEPTABLE MECHANISMS.

13. PLEASE RESPOND NO LATER THAN APRIL 1, 1989. CABLE TO ST/AGR/AP, JOYCE TURK.

THANK YOU FOR YOUR COOPERATION. YY

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AID/W FOR S1/AGR/AP, JOYCE TURK AND AFR/TR/ARRD, LANCE JEPSON

E.O. 12356: N/A
TAGS:
SUBJECT: SMALL RUMINANT COLLABORATIVE RESEARCH SUPPORT PROGRAM (SR-CRSP) 936-5328

REF: STATE 087670

A. SUMMARY: USAID/NIGER AND GON EXTREMELY PLEASED TO BE CONSIDERED FOR SUBJECT PROGRAM. GIVEN IMPORTANCE OF LIVESTOCK AND PARTICULARLY SMALL-RUMINANTS TO ECONOMY AND SUSTAINED PRODUCTIVITY OF NATURAL RESOURCES, BELIEVE NIGER, WITH ITS CENTRAL LOCATION/LINKAGE TO OTHER SAHELIAN COUNTRIES AND INTERNATIONAL RESEARCH CENTERS WOULD BE AN EXCELLENT CHOICE FOR PROGRAM PARTICIPATION AND SITE FOR SR-CRSP COORDINATION.

B. IN THE CONTEXT OF QUESTIONS POSED IN REFTEL (ITEMS 1-13), WE PROVIDE THE FOLLOWING RESPONSE/INFORMATION:

1. MISSION IS EXTREMELY INTERESTED IN SR-CRSP PAST AND PLANNED ACTIVITIES, AND EXPRESSED OUR INTEREST IN PARTICIPATING IN SUBJECT PROGRAM AS EARLY AS 1984. SINCE THEN, THE MISSION HAS FINANCED THROUGH A BILATERAL PROJECT, RESEARCH ON A BIVALENT THERMO-RESISTANT VACCINE AGAINST TWO VIRAL DISEASES (SMALL RUMINANT PEST AND SHEEP POX) OF MAJOR IMPORTANCE TO SMALL RUMINANT PRODUCTION IN NIGER. ALTHOUGH THE BILATERAL PROJECT HAS ENDED, WORK IN THIS AREA CONTINUES BY THE GON THROUGH USAID/NIGER AGRICULTURAL SECTOR DEVELOPMENT GRANT (ASDG) LOCAL CURRENCY FUNDS. IN ADDITION THE MISSION'S MAJOR AGRICULTURAL TECHNICAL ASSISTANCE PROJECT, NIGER APPLIED AGRICULTURAL RESEARCH (NAAR) INCLUDES A SMALL RUMINANT ACTIVITY. THIS ACTIVITY, "UTILIZATION OF AGRICULTURAL BY-PRODUCTS AS FEED FOR SMALL RUMINANTS", IS BEING CARRIED OUT BY ALABAMA A AND M, UNIVERSITY, WITH FUNDING THROUGH A RESEARCH AND UNIVERSITY RELATIONS (BUREAU FOR S&T) GRANT. ALABAMA A AND M, ALONG WITH WINROCK INTERNATIONAL, IS A SUB-CONTRACTOR TO THE PRIMARY CONTRACTOR (PURDUE UNIVERSITY) FOR THE NAAR PROJECT. MOREOVER, TEXAS A AND M, THROUGH THE TROPSOILS CRSP, IS AN IMPORTANT ELEMENT OF THE NAAR PROJECT. BOTH WINROCK

INTERNATIONAL AND TEXAS A AND M ARE U.S. INSTITUTIONS INVOLVED WITH THE SR-CRSP, AND ALABAMA A AND M IS CARRYING OUT A SR-CRSP RELATED ACTIVITY. ALL OF THESE INSTITUTIONS AND THEIR ACTIVITIES ARE INTEGRAL ELEMENTS OF NAAR. THE SR-CRSP COULD BUILD UPON AND BRING A CERTAIN SYNERGY TO THIS EFFORT.

2. USAID/NIGER'S LONG-TERM AGRICULTURAL DEVELOPMENT PLANS EMPHASIZE RESEARCH AND EXPERIMENTATION, WITH AN INTEGRATED POLICY AND TECHNICAL STRATEGY. AS ALLUDED TO ABOVE, THE SR-CRSP WOULD FIT WELL INTO THE MISSION'S PRESENT PORTFOLIO AND INTO OUR PLANNED LONG-TERM PROGRAM. USAID/NIGER IS NOW DESIGNING A NATURAL RESOURCES MANAGEMENT COMPONENT TO THE ASDG. ELEMENTS OF THIS COMPONENT WILL INCLUDE STRATEGIES FOR REDUCING ENVIRONMENTAL DEGRADATION, PASTURE AND RANGELAND MANAGEMENT, CROP RESIDUE UTILIZATION, ETC. THESE TECHNICAL INTERVENTIONS WILL BE SUPPORTED BY APPROPRIATE POLICY MEASURES.

3. AS INDICATED ABOVE, THE MISSION WILL SUPPORT SR-CRSP ACTIVITIES. PLEASE NOTE THAT THREE OTHER CRSPS, TROPSOILS, INTSORMIL, AND THE PEANUT CRSP, HAVE ACTIVE PROGRAMS IN NIGER.

4. AGAIN, AS INDICATED ABOVE, THE GON IS EXTREMELY INTERESTED IN THE SR-CRSP. BOTH THE MINISTRY OF AGRICULTURE AND ENVIRONMENT, AND THE MINISTRY OF ANIMAL AND WATER RESOURCES HAVE EXPRESSED GREAT INTEREST IN THE SR-CRSP. IF NIGER IS SELECTED AS THE SECONDARY/COORDINATOR SITE, THE SR-CRSP WOULD BE EXECUTED THROUGH THE NATIONAL AGRICULTURAL RESEARCH INSTITUTE, THE INSTITUT NATIONAL DE RECHERCHES AGRONOMIQUES DU NIGER (INRAN).

5. INRAN IS THE PRINCIPAL INSTITUTION FOR CROP AND LIVESTOCK RESEARCH IN NIGER. IN THE LIVESTOCK SECTOR, THE FOCUS IS ON IMPROVEMENT OF SMALL RUMINANT PRODUCTION, VACCINE DEVELOPMENT, BREEDING AND GENETICS, RANGE MANAGEMENT AND NUTRITION AND INCREASING THE SMALL RUMINANT STOCK STAGE OF THE NATIONAL LIVESTOCK HERD. THE SR-CRSP WOULD FIT EXTREMELY WELL INTO THE GON'S LONG-TERM STRATEGY FOR AGRICULTURAL RESEARCH AND DEVELOPMENT. TRAINED MANPOWER IS THE MOST LIMITING FACTOR FACING BOTH RESEARCH AND EXTENSION. THERE IS THEREFORE AN URGENT NEED TO BUILD A CRITICAL MASS OF SCIENTISTS AND TECHNICIANS TO ADDRESS SR DEVELOPMENT REQUIREMENTS.

6. IN ADDITION TO INRAN, THE CENTRAL VETERINARY LABORATORY (LABOCELI), THE UNIVERSITY OF NIAMEY, AND THE NATIONAL MID-LEVEL TECHNICAL TRAINING CENTER (IPDR) ARE ALL CAPABLE OF PROVIDING SCIENTIFIC COUNTERPARTS AND/OR STUDENTS FOR TRAINING. THE INSTITUTE THE MISSION FEELS WOULD BE MOST APPROPRIATE TO ATTACH A SR-CRSP INITIATIVE TO IS INRAN. THIS WOULD NOT PRECLUDE COLLABORATIVE EFFORTS WITH OTHER RELEVANT GON INSTITUTIONS. IN FACT, SUCH COLLABORATIVE EFFORTS WOULD BE ESSENTIAL TO A SR-CRSP INITIATIVE.

7. HOUSING COSTS (RENT AND UTILITIES), VEHICLE AND MED-EVAC INSURANCE WOULD COST APPROXIMATELY $34,000 PER YEAR. IMPORT DUTIES WOULD BE WAIVED

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FOR RESEARCH RELATED EQUIPMENT AND FOR COORDINATOR'S PERSONAL EFFECTS, INCLUDING PERSONAL VEHICLE.

8. MISSION IS CONFIDENT THE GON IS PREPARED TO INVEST IN THE PROGRAM BY SECURING SUPPORT FROM THE ASDG AND POSSIBLE LIMITED SUPPORT FROM THE NAAR PROJECT. OTHER GON CONTRIBUTIONS WOULD BE "IN KIND", SUCH AS PERSONNEL, BUILDINGS, LABORATORY FACILITIES, INFRASTRUCTURE (CORRALS, SCALES, ETC.) AND ANIMALS.

9. SCIENTISTS COMING TO NIGER WILL NEED TO BE FAIRLY SELF CONTAINED AS FAR AS THEIR SPECIALITY IS CONCERNED. HOWEVER, THERE ARE SEVERAL IARCS, USAID PROJECTS (WITH TITLE XII INSTITUTION CONTRACTS), AND OTHER INTERNATIONAL DONOR PROGRAMS WITH AGRICULTURAL SCIENTISTS IN-COUNTRY. OUTSIDE OF NIAMEY, THERE IS LITTLE OR NO ACCESS TO PROFESSIONAL JOURNALS OR PUBLICATIONS. THE PHONE SYSTEM IS RELIABLE, AND THE ROAD SYSTEM IS GOOD.

10. US GRADUATE STUDENTS SCHEDULED TO CONDUCT RESEARCH WOULD BE WELCOMED IN NIGER.

11. THE GON WOULD WELCOME THE PRESENCE OF AN EXPATRIATE SITE COORDINATOR IF DEEMED APPROPRIATE.

12. MOST COUNTRY'S PRESENT LINKAGE TO SR PRODUCERS IS THROUGH PRODUCER DEMANDS TO LABOCEL, FOR VACCINES, AS WELL AS TO LIVESTOCK SERVICE FIELD OFFICES FOR THE IDENTIFICATION OF DISEASE PROBLEMS. CUMBIFF

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FOR JOYCE TURK, ST/AGR/AP; INFO AFR/TR/ANR/FS, CHARLES MORGAN

E.O. 12356: N/A
SUBJECT: SMALL RUMINANT COLLABORATIVE RESEARCH SUPPORT PROGRAM (SR-CRSP), 936-1328

REF: STATE 87679

1. MISSION HAS FOLLOWING RESPONSE TO REFTEL.

A) MISSION VERY INTERESTED IN SR-CRSP ACTIVITIES.

B) MISSION LONG TERM PLANS FOR AGRICULTURE DEVELOPMENT INCLUDE LONG TERM INVOLVEMENT IN MALI LIVESTOCK SECTOR. MISSION HAS BEEN ASSOCIATED WITH THIS IMPORTANT ECONOMIC SECTOR FOR PAST 15 YEARS AND CURRENT MISSION LIVESTOCK PROJECT CALLS FOR AN ADDITIONAL 15 YEAR INVOLVEMENT. DURING CURRENT MISSION PROJECT SMALL RUMINANT ACTIVITIES HAVE BEEN RECOGNIZED AS ESSENTIAL PART OF COUNTRY'S LIVESTOCK PROGRAM AND VARIOUS STUDIES ARE UNDERWAY IN THIS AREA. AMONG CURRENT STUDIES ARE: (1) ON-STATION FEEDING TRIALS TO EVALUATE DIFFERENT LEVELS AND TYPES OF FEED SUPPLEMENTS, INCLUDING NATURAL HAY AND LEGUME FORAGES FOR MEAT PRODUCTION. THE TRIALS WILL FOCUS ON SHEEP AND WILL EXAMINE THE RELATION OF AGE AND THE DURATION OF FEEDING ON THE COST-EFFECTIVE UTILIZATION OF SUPPLEMENTS; (2) ON-FARM MONITORING OF SMALL RUMINANT FATTENING ACTIVITIES TO DETERMINE THE COST-EFFECTIVENESS OF SUCH PRACTICES UNDER PRODUCER CONDITIONS AND (3) ACTIVITIES TO ASSESS THE IMPACT OF PREVENTIVE ANIMAL HEALTH MEASURES ON PRODUCTIVITY WITH OBJECTIVES BEING THE VERIFICATION OF PRELIMINARY RESULTS OBTAINED ON THE IMPACT OF VACCINATIONS AND ANTHELMINTIC TREATMENTS, AND TO IDENTIFY AN EFFECTIVE PROTOCOL FOR THE TREATMENT OF INTERNAL PARASITES. THESE STUDIES ARE BEING CONDUCTED IN SEMI-ARID ECOLOGICAL ZONES.

C) THE MISSION WOULD SUPPORT SR-CRSP ACTIVITIES THROUGH THE LIVESTOCK SECTOR PROJECT. MISSION HAS SUCCESSFUL COOPERATION WITH AND SUPPORT TO INSORMIL-CRSP WHICH IS CLOSELY LINKED WITH OUR SEMI-ARID CROP RESEARCH PROJECT IMPLEMENTED BY ICRISAT. WE WOULD USE THE SAME APPROACH WITH THE SR-CRSP INTEGRATING THE RESEARCH ACTIVITIES INTO THE LIVESTOCK SECTOR PROJECT. IN ADDITION SELECTION OF RESEARCH ACTIVITIES WOULD BE COORDINATED WITH ILCA? FYI ILCA HAS BEGUN TO ESTABLISH AN AFRICAN SMALL RUMINANT NETWORK. THIS NETWORK SHOULD DEFINE AND PRIORITIZE RESEARCH NEEDS WITHIN THE MEMBER STATES NATIONAL AGRICULTURE RESEARCH SYSTEMS.

D) REFTEL HAS BEEN TRANSLATED AND PASSED, UNOFFICIALLY, TO GRM OFFICIALS, WHO HAVE EXPRESSED KEEN INTEREST IN SR-CRSP. IN PAST MEETINGS NOTED TO MISSION LIVESTOCK

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PROJECT THE MINISTER OF ENVIRONMENT AND LIVESTOCK HAS MADE A POINT TO PERSONALLY INQUIRE ABOUT SMALL RUMINANT ACTIVITIES.

E) THE GRM HAS DEMONSTRATED THEIR LONG TERM COMMITMENT TO SMALL RUMINANT RESEARCH AND DEVELOPMENT BY THE? INVOLVEMENT OF GOVERNMENT RESEARCH UNIT IN SMALL RUMINANTS (B. ABOVE). THE GRM ALSO RECOGNIZES THAT SMALL RUMINANTS ARE IMPORTANT ECONOMIC PRODUCERS FOR WOMEN, THUS THEY HAVE ANZIK"???
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F) CURRENTLY THE GRM THROUGH THE NATIONAL ZOOLOGIC, WATER AND FOREST RESEARCH INSTITUTE IS THE PRINCIPAL RESEARCH ORGANISATION INVOLVED WITH MISSION LIVESTOCK PROJECT. IT ALONG WITH THE NATIONAL VETERINARY LABORATORY ARE STAFFED WITH WELL-QUALIFIED SCIENTIST IN ANIMAL HEALTH AND PRODUCTION FIELDS. STUDENT TRAINING IN ANIMAL HEALTH AND PRODUCTION IS AN ON-GOING ACTIVITY OF OUR CURRENT PROJECT (APPPOXIMATELY 28 STUDENTS HAVE RECEIVED LONG TERM TRAINING LEADING TO UNIVERSITY DEGREES IN THE U.S.), AND THE POTENTIAL FOR FUTURE TRAINING IS GOOD.

G) A ROUGH ESTIMATE OF EXPENSE, EXCLUSIVE OF SALARY, WOULD BE 140,000 DOLLARS/YR. PURCHASE OF VEHICLES WOULD ADD TO THIS.

H) GRM INVESTMENT WOULD BE LIMITED TO SUPPLY OF PERSONNEL. THEY WOULD PROVIDE INDIRECT SUPPORT THROUGH WAIVER OF CUSTOM DUTIES FOR IMPORT OF PROJECT EQUIPMENT.

I) ISOLATION FOR SCIENTIST WOULD DEPEND ENTIRELY ON LOCATION OF RESEARCH ACTIVITIES. NATIONAL RESEARCH QUARTERS ARE IN THE CAPITOL OF BAMAKO. THE PRIMARY

SEMI-ARID RESEARCH STATION IS APPROXIMATELY A 4 HOUR DRIVE FROM BAMAKO ON A GOOD ROAD. A STUDY IS BEING DONE TO OPEN A SECOND SEMI-ARID RESEARCH STATION IN THE EXTREME WESTERN PORTION OF MALI, APPROXIMATELY 12 HOURS BY TRAIN FROM BAMAKO.

J) IN PAST RESEARCH ACTIVITIES, IN OTHER FIELDS, GRM OFFICIALS HAVE NOT BEEN PLEASED WITH HAVING U.S. STUDENTS CONDUCT RESEARCH. HOWEVER, THIS WAS DUE PRIMARILY TO U.S. STUDENTS BEING PASSED OFF AS EXPERTS WHO COULD ASSIST MALIAN SCIENTISTS STUDENT RESEARCH COULD PROBABLY BE ARRANGED, BUT PRIMARY BENEFICIARY OF RESEARCH WILL HAVE TO BE HOST COUNTRY.
K) THE GRM WILL MOST LIKELY ACCEPT AN EXPATRIATE SITE COORDINATOR PROVIDED THE UNDERSTANDING IS REACHED THAT ANY TECHNICAL ASSISTANCE IS FOR THE BENEFIT AND MEETS THE NEEDS OF THE HOST COUNTRY OFFICIALS, AND THAT THE TECHNICAL ASSISTANCE IS NOT THERE TO DO ITS OWN THING.

L) CURRENT RESEARCH PROGRAM INVOLVING SMALL RUMINANTS INVOLVES ON-FARM MONITORING ACTIVITIES, AND THE MISSION LIVESTOCK PROJECT INCLUDES ACTIVITIES TO EFFECTIVELY LINK RESEARCH AND EXTENSION EFFORTS.

2. MISSION WOULD WELCOME FIELD VISIT BY SR-CRSP PERSONNEL TO OBTAIN AN ON THE GROUND ASSESSMENT OF MALI'S POTENTIAL IN THIS AREA THE MISSION WILL, IN FY 90 BEGIN PID AND PP ACTIONS FOR LONG-TERM CONTINUATION OF LIVESTOCK SECTOR PROGRAM AND INVOLVEMENT OF A TITLE XII INSTITUTION IN THIS CONTINUATION IS (6)
THE POTENTIAL IN MALI OF (6)
FORWARD TO (8) TOWARD THIS POSSIBILITY.
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TO SECSTATE WASHDC PRIORITY 8803

UNCLAS OUAGADOUGOU 01575 BURKINA FASO

AIDAO

FOR ST/AGR/AP; JOYCE TURK

E.O. 12356: N/A
SUBJECT: BURKINA/INTEREST IN SR-CRSP ACTIVITIES

REF: STATE 087878/01

1. MISSION AND GOB RESPONSES TO QUESTIONS POSED IN REFTEL FOLLOW:

(A) QUESTION NO.1. BOTH USAID/BURKINA AND THE GOB ARE INTERESTED IN SR-CRSP ACTIVITIES BEING STARTED IN BURKINA. MISSION AND THE UNIVERSITY OF OUAGADOUGOU HAVE HAD EXTENSIVE EXPERIENCE WITH CRSP ACTIVITIES IN BURKINA FOR MANY YEARS. NUMEROUS PEANUT CRSP ACTIVITIES (PATHOLOGY, ENTOMOLOGY, AND FOOD TECHNOLOGY) HAVE BEEN OPERATING IN BURKINA SINCE 1984. PEANUT CRSP LEAD INSTITUTION COLLABORATORS, FROM THE UNIVERSITY OF GEORGIA, ARE WELL KNOWN AND RESPECTED BY THE MISSION AS WELL AS THEIR BURKINABE COUNTERPARTS. MISSION OFFICE OF AGRICULTURE HAS BEEN INTIMATELY INVOLVED IN ASSISTING AND TRACKING THE PROGRESS/OUTPUTS OF THESE ACTIVITIES SINCE THEIR INCEPTION IN BURKINA. RESULTS TO DATE ARE CONSIDERED BY THIS MISSION TO BE EXTREMELY SUCCESSFUL IN TERMS OF BUILDING INDIGENOUS RESEARCH CAPABILITY IN BURKINA AS WELL AS THE QUALITY AND RESULTS OF RESEARCH BEING CARRIED OUT UNDER THESE PROGRAMS. MISSION WOULD LOOK FORWARD TO ASSISTING IN FURTHER ACTIVITIES OF THIS KIND IN BURKINA.

(B) QUESTION NO.2. SR-CRSP ACTIVITIES FIT WELL WITHIN THE MISSIONS PRESENT AND FUTURE LONG-TERM PLANS FOR AGRICULTURAL DEVELOPMENT IN BURKINA. THROUGH THE USAID FUNDED AGRICULTURAL HUMAN RESOURCES DEVELOPMENT (AGHRD) PROJECT NO. 686-0221, WHICH BEGAN IN 1978, USAID HAS DEVELOPED THE UNIVERSITY OF OUAGADOUGOU'S SCHOOL OF AGRICULTURE INTO A WELL RESPECTED AND VIABLE AGRICULTURE SCHOOL IN THE SAHEL. THE MAJOR OBJECTIVE OF THE PROJECT WAS TO REORIENT AGRICULTURAL TRAINING FROM PURELY THEORETICAL TO A U.S. PATTERNED PRACTICAL TRAINING WITH EMPHASIS ON APPLIED RESEARCH AND EXTENSION. THE PROJECT HAS TRAINED 18 PARTICIPANTS TO THE MASTERS DEGREE LEVEL IN THE U.S., 10 PHDS (AMONG WHICH 4 ANIMAL SCIENTISTS) AND HAS FUNDED VEHICLES, LABORATORY EQUIPMENT FACILITIES AND CONSTRUCTION OF A RESEARCH FARM FACILITY, COMPLETE WITH ANIMAL RESEARCH CAPABILITY, LOCATED 25 KMS EAST OF OUAGADOUGOU.

- THE MISSIONS NEW START IN FY 1988, THE AGRICULTURAL RESEARCH AND TRAINING SUPPORT (ARTS) PROJECT NO. 686-0278, IS AIMED AT DEVELOPING A FARMING SYSTEMS RESEARCH CAPABILITY WITHIN THE BURKINA NATIONAL INSTITUTE FOR AGRICULTURAL RESEARCH (INERA). INERA IS

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UNDER THE SAME MINISTRY AS THE UNIVERSITY OF OUAGADOUGOU, I.E., THE MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH. AMONG INERA'S FIVE RESEARCH DIVISIONS WORKING JOINTLY WITH THE FARMING SYSTEMS RESEARCH DIVISION IS AN ANIMAL PRODUCTION RESEARCH DIVISION. ONE OF THE MAJOR OBJECTIVES OF THE PROJECT IS TO FOSTER THE ALREADY EXISTING, YET LIMITED DUE TO FUNDING CONSTRAINTS, COLLABORATIVE RESEARCH ACTIVITIES BETWEEN INERA AND THE UNIVERSITY'S AGRICULTURE SCHOOL IN PRACTICAL APPLIED RESEARCH ACTIVITIES WITH SMALL RURAL FARMERS. THE UNIVERSITY OF OUAGADOUGOU CURRENTLY PLACES MASTERS DEGREE STUDENTS WITH INERA RESEARCH PROGRAMS FOR THESES WORK.

(C) QUESTION NO.3. MISSION ADMINISTRATIVE SUPPORT TO PRESENT CRSP ACTIVITIES IN BURKINA HAS POSED NO PROBLEMS FOR THE MISSION. MISSION WOULD GLADLY PROVIDE SIMILAR ADMINISTRATIVE SUPPORT TO THE SR-CRSP ACTIVITIES.

(D) QUESTION NO.4. BURKINA'S INTEREST IN THE SR-CRSP IS KEEN. DR. AIME NIANOGO, RECENTLY RETURNED USAID PARTICIPANT FROM THE UNIVERSITY OF GEORGIA WITH A DOCTORAL DEGREE IN RUMINANT NUTRITION (WITH A 4.0 GPA), IS PRESENTLY ONE OF THE UNIVERSITY FACULTY MEMBERS IN CHARGE OF ANIMAL SCIENCE. DR. NIANOGO RECENTLY CONTACTED (LETTER DATED 12/14/88) DR. J.W. OXLEY SR-CRSP PROGRAM DIRECTOR, UNIVERSITY OF CALIFORNIA, DAVIS, REGARDING UNIVERSITY OF OUAGADOUGOU INTEREST IN PARTICIPATION IN THE SR-CRSP PROGRAM. MISSION POUCHING COPY TO AID/W OF DR. NIANOGO'S LETTER THIS DATE.

(E) QUESTION NO.5. BURKINA'S LONG-TERM AGRICULTURAL DEVELOPMENT PLAN INCLUDES MAJOR EMPHASIS ON SMALL FARMING DEVELOPMENT OF WHICH, SMALL RUMINANT BREEDING IS AN IMPORTANT COMPONANT.

(F) QUESTION NO.6. THE UNIVERSITY'S SCHOOL OF AGRICULTURE IS AN IDEAL LOCAL INSTITUTION CAPABLE OF PROVIDING WELL QUALIFIED SCIENTIFIC COUNTERPARTS SUCH AS DR. AIME NIANOGO, AMONG OTHERS. IN ADDITION, IT WOULD BE IDEALLY SUITED AS A SOURCE OF STUDENTS FOR TRAINING UNDER THE PROGRAM. (NOTE ANSWER TO QUESTION NO. 2 ABOVE).

(G) QUESTION NO.7. START-UP EXPENSES WOULD BE MINIMAL AS EXTENSIVE ADEQUATE INFRASTRUCTURE FOR ANIMAL RESEARCH IS ALREADY IN PLACE AT THE UNIVERSITY OF OUAGADOUGOU SCHOOL OF AGRICULTURE RESEARCH FARM. EXPENSES ASSOCIATED WITH A LONG-TERM EXPATRIATE RESEARCHER (IF ASSISNED) WOULD BE THE SAME AS THROUGHOUT WEST AFRICA. HOUSING RENTAL AND UTILITIES AVERAGE 15-20 THOUSAND DOLLARS PER YEAR.

(H) QUESTION NO.8. IN DISCUSSIONS WITH DR. NIANOGO IN REPARING THIS CABLE IT IS CLEAR THAT THE UNIVERSITY WOULD BE WILLING TO INVEST IN THE PROGRAM WITHIN THE LIMITS OF ITS VERY LIMITED BUDGET. SOME OF THE IMMEDIATE IN KIND INVESTMENTS THAT THE UNIVERSITY COULD CONTRIBUTE TO THE PROGRAM ARE THE RESEARCH FACILITIES ALREADY IN PLACE AT THE UNIVERSITY RESEARCH FARM, EXISTING HERD OF SHEEP AND GOATS, LABORATORY TECHNICIANS, WATER, ELECTRICITY, AND AN ANNUAL RESEARCH ALLOTMENT FROM THE NATIONAL BUDGET FOR UNIVERSITY FACULTY MEMBERS ENGAGED IN RESEARCH.

(I) QUESTION NO.9. ISOLATION OF SCIENTISTS WOULD BE MINIMAL AS THE UNIVERSITY RESEARCH FARM IS ONLY 25 KMS

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FROM THE CAPITAL CITY, OUAGADOUGOU. IT IS WELL INTEGRETED IN THE UNIVERSITY RESEARCH STRUCTURE AND THERE IS EASY ACCESS TO THE FACILITIES AND STAFF OF INERA. BURKINA IS CENTRALLY LOCATED IN THE SAHEL WITH EASY ACCESS TO AND FROM THE U.S. AND NEIGHBORING COUNTRIES BY AIR AS WELL AS EASY ROAD ACCESS ON PAVED ROADS BETWEEN NEIGHBORING COUNTRIES (MALI, NIGER, TOGO, BENIN, GHANA, COTE D'IVOIRE). INTERNAL TRANSPORT WITHIN COUNTRY IS GOOD.

(J) QUESTION NO.10. BURKINA WOULD BE WILLING TO PERMIT RESEARCH ON SMALL RUMINANTS BY U.S. STUDENTS.

(K) QUESTION NO.11. BURKINA WOULD BE WILLING TO ACCEPT THE PRESENCE OF AN EXPATRIATE SITE COORDINATOR IF NECESSARY. HOWEVER MISSION IS CONFIDENT THAT DR. NIAMOGO IS QUITE CAPABLE OF SERVING IN THIS CAPACITY. THREE OTHER UNIVERSITY RESEARCHERS PROGRAMMED FOR PHD TRAINING, HOLD A MASTERS DEGREE IN ANIMAL SCIENCE (ONE IN RUMINANT NUTRITION) AND WILL CONTRIBUTE TO THE PROGRAM SUCCESS.

(L) QUESTION NO.12. IDENTIFIABLE LINKAGE TO SMALL RUMINANT PRODUCERS WOULD BE THE EXISTING UNIVERSITY OF OUAGADOUGOU/INERA COLLABORATIVE RESEARCH EFFORTS WHICH HAVE LINKAGES WITH THE MINISTRY OF AGRICULTURE AND LIVESTOCK AND ITS EXTENSION PROGRAMS.

2. OUAGADOUGOU IS THE HEADQUARTERS FOR CILSS, SAFGRAD AND THE WEST AFRICAN FARMING SYSTEMS NETWORK. BURKINA THUS PROVIDES RESEARCHERS WITH A WIDE BASE FOR CONTACT WITH SCIENTISTS FROM A VARIETY OF AGRICULTURE RELATED DISCIPLINES AND PROGRAMS. USAID/BURKINA ENCOURAGES THE SELECTION OF BURKINA AS THE SR-CRSP EPI-CENTER IN THE SAHEL. SWINN

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TO SECSTATE WASHDC 3261

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ADM AID

E.O. 12356: N/A
SUBJECT: TRIENNIAL REVIEW FOR THE SMALL RUMINANT CRSP

REF: STATE 23582

1. SUMMARY: FROM A DEVELOPMENT PERSPECTIVE FOR USAID, THE SR-CRSP HAS BEEN A COMPLIMENTARY ACTIVITY TO USAID'S FOCUS ON INSTITUTIONAL DEVELOPMENT OF THE AGRONOMIC INSTITUTE. FROM THE INSTITUTE'S PERSPECTIVE, IT IS HIGHLY VALUED AS A FINANCIAL RESOURCE AND A COLLABORATIVE MECHANISM LINKING SELECTED SCIENTISTS FROM THE INSTITUTE WITH U.S. SCIENTISTS. FROM THE BROADER PERSPECTIVE OF THE MINISTRY OF AGRICULTURE, THE SR-CRSP DOES NOT APPEAR TO HAVE HAD A SIGNIFICANT IMPACT ON THE NATIONAL PROGRAM LEVEL.

2. PRIOR TO 1981, RESEARCH ON SMALL RUMINANTS AT THE AGRONOMIC INSTITUTE WAS MUCH LESS ACTIVE THAN IT IS NOW. DURING SEVEN YEARS OF IMPLEMENTATION, THE SR-CRSP PROGRAM HAS ALLOWED THE INSTITUTE TO STRENGTHEN A TEAM OF MORE THAN 25 SCIENTISTS AT THE INSTITUTE WHO WORK TOGETHER ON SEVERAL ASPECTS OF SHEEP PRODUCTION: NUTRITION, RANGE, GENETIC, REPRODUCTION, SOCIOLOGY, PARASITOLOGY. ALSO, ABOUT 25 MOROCCAN STUDENTS WERE TRAINED UNDER THIS PROGRAM WHO ARE NOW WORKING WITHIN THE MINISTRY OF AGRICULTURE AND ITS EXTENSION SERVICES, PARASTATAL COMPANIES, AND IN THE PRIVATE SECTOR. IN ADDITION, A NUMBER OF OTHER AFRICAN STUDENTS FROM SAHELIAN COUNTRIES WERE TRAINED UNDER THE SR-CRSP AT THE INSTITUTE. THERE IS NO DOUBT THAT THE PROJECT HAS HAD IMPACTS ON THE RESEARCH CAPABILITY ACTIVITIES AT THE INSTITUTE. HOWEVER, THIS IMPACT COULD HAVE BEEN BROADENED IF STRONGER LINKAGES WITH OTHER MOROCCAN RESEARCH INSTITUTIONS, SUCH AS THE INSTITUTE NATIONAL DE LA RECHERCHE AGRONOMIQUE (INRA) AND THE MINISTRY OF AGRICULTURE'S SHEEP PRODUCTION UNIT AND EXTENSION SERVICES, WERE DEVELOPED. AS A CONSEQUENCE, IT IS NOT APPARENT THAT THE SR-CRSP PROJECT HAD AN IMPACT ON GOVERNMENT OF MOROCCO PROGRAMS AND POLICY REGARDING SHEEP PRODUCTION AT THE NATIONAL LEVEL.

3. ESTABLISHING FIELD RESEARCH PROGRAMS IN TABLA AND THE MIDDLE ATLAS HAVE NECESSITATED CONSIDERABLE INVESTMENT IN TIME AND MONEY. HOWEVER, THESE TWO COMPONENTS ARE NOW GENERATING IMPORTANT DATA FOR SHEEP PRODUCTION IMPROVEMENT THAT SHOULD BE OF INTEREST TO MINISTRY OF AGRICULTURE. FOR EXAMPLE, A TECHNOLOGICAL PACKAGE HAS BEEN DEVELOPED DURING THE LAST TWO YEARS AND, AS WE UNDERSTAND, WILL BE PUBLISHED NEXT MONTH.

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4. THE SR-CRSP HAS HELPED THE INSTITUTE TO ORGANIZE NATIONAL AND REGIONAL SEMINARS ON A MORE FREQUENT BASIS WHICH HELPS TO DISSEMINATE TECHNOLOGY WITHIN MOROCCO, THE MAGHREB, AND SUBSAHARAN AFRICAN COUNTRIES WITH SIMILAR ECOLOGICAL CONDITIONS. NEVERTHELESS, THE DIFFUSION OF RESEARCH RESULTS HAS NOT HAD ANY VISIBLE INFLUENCE ON OTHER MOROCCAN INSTITUTIONS INVOLVED WITH SMALL RUMINANTS.

5. THE INSTITUTE STRONGEST ARGUMENT FOR THE SR-CRSP IS THEIR BELIEF THAT THE COLLABORATIVE MODE OF THE SR-CRSP IS AN EFFECTIVE WAY TO ESTABLISH DURABLE AND COLLABORATIVE LINKAGES BETWEEN U.S. UNIVERSITIES AND LESS DEVELOPED COUNTRY UNIVERSITIES. ALTHOUGH THIS MAY BE TRUE, USAID IS OF THE VIEW THAT COLLABORATION SHOULD MEAN BROADER INVOLVEMENT WITH OTHER GOM INSTITUTES AND PROGRAMS, INCLUDING THE MINISTRY OF AGRICULTURE, THE LATTER WHO MAKE POLICY DECISIONS AFFECTING FINANCIAL LEVELS AND PLANNING COUNTRY-WIDE PROGRAMS PRIORITIES. IN THIS REGARD, THE SR-CRSP HAS HAD LITTLE INPUT INTO THE MINISTRY OF AGRICULTURE PROGRAMS DIRECTLY.

6. THE MISSION HAS NO INTENTION TO CONTINUE SUPPORTING THE SR-CRSP THROUGH OUR BILATERAL PROJECT WITH THE AGRONOMIC INSTITUTE. EXCEPT FOR COMPLETING THE LONG TERM TRAINING, ALL OTHER ACTIVITIES UNDER THE MISSION BILATERAL PROJECT WILL TERMINATE BY APRIL 1990. THUS, THE FUTURE OF THE SR-CRSP IN MOROCCO DEPENDS ON AT LEAST TWO ESSENTIAL FACTORS. FIRST, THE SR-CRSP WOULD NEED TO DEMONSTRATE A RELEVANT DEVELOPMENT PERSPECTIVE THAT INTEGRATES WITH THE USAID PROGRAM IF IT IS TO BE CONSISTENT WITH THE USAID MOROCCO CDSS. SECOND, ALL FUNDING FOR THE SR-CRSP WOULD NEED TO COME FROM SOURCES OTHER THAN USAID MOROCCO BILATERAL FUNDS. USSERT

MISSION SUPPORT MINNESOTA PROJECT

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ADM AID

FOR S AND T/AGR

E.O. 12356: N/A
SUBJECT: ANNUAL REVIEW OF THE SR-CRSP PROGRAM IN
- MOROCCO

1. SUMMARY: THE RECENT ANNUAL REVIEW OF THE SR-CRSP PROGRAM IN MOROCCO HELD AT THE AGRONOMIC INSTITUTE HIGHLIGHTED RESEARCH ACHIEVEMENTS, PROGRESS IN COLLABORATION, AND CONCERNS RELATIVE TO FUTURE FUNDING. DEMONSTRATED ACHIEVEMENTS IN RESEARCH, AND CONTINUING EFFORTS BY PARTICIPATING CRSP-SCIENTISTS TO COLLABORATE WITH OTHER INSTITUTIONS IN MOROCCO INVOLVED IN SMALL RUMINANT PRODUCTION SYSTEMS ARE PROVIDING A BROADER BASE FOR RELEVANT TECHNOLOGY TRANSFER EFFORTS. THE QUESTION OF FUTURE FUNDING FOR THE SR-CRSP IS OBVIOUSLY OF CONCERN. END SUMMARY.

2. ACHIEVEMENTS IN RESEARCH ARE DETAILED IN REPORTS AVAILABLE WITH THE MANAGEMENT ENTITY AND ARE NOT REPORTED HERE. IN SHORT, A NUMBER OF SIGNIFICANT RESEARCH ACHIEVEMENTS HAVE COME FORTH FROM THE SR-CRSP PROGRAM AND MANY ARE READY FOR GREATER TECHNOLOGY TRANSFER EFFORTS. THE MOROCCAN SCIENTISTS HAVE INCREASINGLY INVOLVED FARMERS AND HERDERS AS WELL AS LIVESTOCK ASSOCIATIONS IN THEIR RESEARCH FRAMEWORK OVER THE YEARS AND THIS HAS PROVIDED A GOOD BASE FOR PROBLEM IDENTIFICATION AND SOLUTION. IN ADDITION, MOROCCAN SCIENTISTS HAVE TAKEN MEASURES TO BROADEN THEIR BASE OF COLLABORATION WITHIN MOROCCO THEREBY ALLEVIATING MANY OF THE PREVIOUS CONCERNS RAISED BY USAID RELATIVE TO CONSISTENCY OF SR-CRSP PRIORITIES AND MINISTRY OF AGRICULTURE PRIORITIES. USAID CONTINUES TO BELIEVE THAT THE SR-CRSP PROGRAM PRIORITIES IN MOROCCO SHOULD BE ESTABLISHED IN CLOSE COLLABORATION AND CONSULTATION WITH THE MINISTRY OF AGRICULTURE AND USAID AND WHICH RELATE TO COUNTRY DEVELOPEMENT PRIORITIES AND STRATEGIES.

3. USAID BELIEVES THE SR-CRSP HAS PROVIDED SIGNIFICANT AND USEFUL RESEARCH UP TO THIS POINT THAT IS RELEVANT TO MOROCCO. CLEARLY, ONE OF THE STRENGTHS OF THE PROGRAM IN MOROCCO IS THE QUALITY OF MOROCCAN RESEARCHERS. FUTURE BENEFITS COMING FROM THE SR-CRSP PROGRAM WILL INCREASINGLY DEPEND ON HOW WELL RESEARCH RESULTS, WHICH ARE NOW APPARENT, CAN BE TRANSLATED INTO TECHNOLOGICAL INTERVENTIONS THAT MAKES AN IMPACT.

4. USAID WILL NOT BE ABLE TO CONTINUE THE PARTIAL FUNDING ARRANGEMENT OF THE SR-CRSP THROUGH THE BILATERAL AGRONOMIC INSTITUTE PROJECT AS FUNDING UNDER THE BILATERAL PROJECT FOR ALL ACTIVITIES OTHER THAN TRAINING WILL BE TERMINATED BY APRIL 30, 1990.
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BOLIVIA

AIDAC

FOR JOYCE TUHN, ST/AGR/AP

L.O. 12356:N/A
SUBJECT: SMALL RUMINANT COLLABORATIVE RESEARCH SUPPORT PROGRAM (SR-CRSP) - 936-1328

REF: STATE 087670/01

1. USAID/BOLIVIA IS EXTREMELY INTERESTED IN PARTICIPATING IN THE SMALL RUMINANT-COLLABORATIVE RESEARCH SUPPORT PROGRAM (SR-CRSP) 936-1328.

2. MISSION AGRICULTURAL DEVELOPMENT STRATEGY HIGHLIGHTS AGRICULTURAL AND LIVESTOCK DEVELOPMENT IN THE HIGHLANDS (ALTIPLANO). IN ADDITION, THE PRIVATE AGRICULTURE ORGANIZATIONS PROJECT IS CURRENTLY WORKING WITH THE LLAMA AND ALPACA GROWERS ASSOCIATION ON INSTITUTIONAL STRENGTHENING AND FIBER MARKETING. WE BELIEVE THAT THE CRSP WOULD BE EXTREMELY IMPORTANT TO OUR CONTINUING EFFORT TO DEVELOP THIS SECTOR, AND TO ASSIST BOLIVIA TO INCREASE WOOL PRODUCTION FOR EXPORT AND LOCAL INDUSTRY USES.

3. MISSION WOULD BE ABLE TO COORDINATE AND PROVIDE SUPPORT FOR TRAVEL CLEARANCES FOR ANNUAL VISITS BY IDV AND PRINCIPAL INVESTIGATIONS AND MAKE LOCAL CURRENCY AVAILABLE FROM OUR PL-480 PROGRAM TO PARTIALLY OFFSET LOCAL COSTS OR EXPAND IN-COUNTRY PROGRAM. EXACT AMOUNTS WOULD BE SUBJECT TO AID AND GOB NEGOTIATIONS AND CRSP REQUIREMENTS.

4. HOST COUNTRY AUTHORITIES HAVE INDICATED THEIR INTEREST IN THE SR-CRSP.

5. THE PRIVATE SECTOR MAY PROVIDE MIDDLE LEVEL COUNTERPARTS IN VARIOUS DISCIPLINES AS THE PUBLIC SECTOR DOES NOT CURRENTLY HAVE HIGHLY QUALIFIED PROFESSIONALS. THE UNIVERSITY OF COCHABAMBA COULD PROVIDE STUDENTS FOR TRAINING.

7. THE COST WILL BE APPROXIMATELY:

- HOUSE RENTAL $1,000/MONTH
- VEHICLE INSURANCE 600/YEAR
- IMPORT DUTIES MISSION IS EXEMPT OF TAXES

- IN-COUNTRY TRANSPORTATION IS POSSIBLE, BY PLANE OR BY ROADS (REQUIRES FOUR WHEEL DRIVE VEHICLES).

8. THE DIRECT GOB FINANCIAL CONTRIBUTION WOULD BE SOMEWHAT LIMITED DUE TO INSUFFICIENT RESOURCES TO INVEST ON THIS TYPE OF ACTIVITY. HOWEVER, WE BELIEVE

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THESE COULD BE COMPLEMENTED WITH RESOURCES FROM PL-480 PROGRAM.

9. IT WILL DEPEND ON THE SCIENTISTS' ABILITY TO COMMUNICATE IN SPANISH. FIELD FACILITIES ARE VERY BASIC, RADIO COMMUNICATION COVERS NEARLY THE ENTIRE COUNTRY, ROADS ARE RELATIVELY GOOD ALL YEAR AROUND.

10. AND 11. YES

12. YES, THERE IS A INSTITUTE CALLED INFOL (WOOL PROMOTION INSTITUTE) WHICH DEPENDS ON THE MINISTRY OF CAMPESINO AFFAIRS AND AGRICULTURE. GREENLEE

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SMALL RUMINANT CRSP

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BURKINA FASO

HC contacted SR-CRSP Program Director Dec. 13, 1988 to express interest in program activities -- Program Director responded Feb. 7, 1989

USAID/Ouga very interested in CRSP -- Mission Director strongly supports

University of Ouga interested -- has facilities and personnel (level of assistant profs all trained in U.S. or U.K.)

Asst. Professor of Animal Science, ruminant nutritionist, Nianogo went to Mission and requested support to do small ruminant research -- just finished Ph.D. at U. Ga. -- considered one of best grad students they ever had -- is in charge of livestock research at the Univ

Peanut CRSP also in BF -- opportunity to collaborate X-CRSP

Ag. Research and Training Project (FSR) just approved in Mission -- BF Director of project is an animal scientist (but wants animal traction)

CRSP fits well with Mission's program and strategy

AID sponsored U. of Ouga over 8 years -- lots of $ into research facility -- Univ. set up to do good job in research

Dutch built ruminant nutrition lab -- it is totally brand new -- as good as anything TAMU has

ADO asked is there anything they can do to get to the top of our list? (AID/W response was to answer questionnaire with as much detail as possible and indicate how Mission can add source of funding with local currency or $)

CAMEROON

Might be interested -- nothing going on in livestock presently due to deliberate decision to cut out livestock when Mission reduced program a few years ago

1988 -- Mission began discussions with Min. Livestock -- Agr. Prod. and Policy Project includes work with statistics in Min. Livestock

mostly large animals in northwest region of country

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Director (Jay Johnson) has no real objection to centrally funded activities in country as long as program establishes linkages and working relations with appropriate Cameroonians -- 2/3 health program that way now so some principle would apply to SR-CRSP

Director of Livestock Research group is one of more dynamic individuals -- eager to be a collaborator

ADO can't speak to how well organized Cameroonians would be -- he doesn't have much information (S&T sent him questionnaire 2/28/89)

NIGER

Mission completed livestock program 12/88 -- no medium or long term plans for including livestock in program "at the moment" but does not mean SR-CRSP may be of interest

If CRSP looking for funding support from Mission -- problem

How much funding could Mission depend on from CRSP? ***

Wants more information on buy-in possibilities

Cannot say if HC can play complementary role

Dr. Soumana (corresponded with Oxley) always looking for opportunity to enlarge research programs and primarily looking for more equipment and visibility

INRAN/Mission already collaborating with Alabama A&M to do research on small ruminants -- plans and arrangements already made -- Alabama A&M rep due out to Niger March 1988 to initiate research

CAMEROON

In past Mission had livestock project generally with IRZ (veterinary research) -- Director is very good technically and good adminstrator (trained at U. Ky.)

IRZ does creditible research

Unfortunately Director was clever enough to take advantage of project for his own use (research, not extension) -- Mission takes part of blame for

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HC shifting attention to small stock (rabbits poultry) and small ruminants -- has own sense of where it will be going -- plans are compatible with SR-CRSP
However, IRZ has short history -- no big, well-established research program in small ruminants -- but has good capability in vet science

CRSP-IRZ linkages would have to be worked out

Mission encourages Bureaus to go ahead and develop own projects -- Mission will not interfere and second-guess decisions

Won't offer a lot of resources

livestock won't factor very prominently in CDSS --govt's financial research and local support drastically down -- any changes Mission makes will be to increase local costs

Economic policy reform project to be Mission's focus in short-term

In longer term, ADO suspects Mission will diversify program to include small ruminants (long term = 3 years)

local cost support areas will be problem in designing CRSP activities

HC will pay salaries, but their local budget doesn't cover more than that (cereals project covers per diem and travel costs for HCNs)

HC has labs, some equipment (maybe not complete, needs repair) -- CRSP would have to look closely at that -- assume they don't have much that is useable (including computers)

research expensive (must pay per diems, travel, house rental) -- Mission spends more than $160,000/yr/expat -- includes other costs such as medievac insurance -- no reliable medical care available

in general, living conditions at locations where research would be done (Bimenda, Angamadre, Yaounde) not too bad -- nice houses, social life -- should be attractive to scientists for finite period of time

HC welcomes collaborators -- relationship is quite profesional

However, HC wants to be in control, have own way of doing things, "determined" -- quite insistent on their point of view, cannot be intimidated

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However -- they are not far advanced in the field, CRSP would be starting on ground floor -- may not be compatible with CRSP strategy

All things considered -- good opportunity to work there, good cooperation -- Cameroonians maybe flexible or may have a policy statement (well thought out) which may not fit CRSP program design

BOTSWANA

At one time wanted CRSP -- abruptly told to "stay away" (5 yrs. ago)

pointed out major problems with Gladson as AA/AFR

6 months ago interest resurrected -- Mission sent cable to express their interest

In 3 weeks Pres of Kansas State going to Botswana to discuss future of university's involvement in the MIAC project (Ag. Tech. Improvement Project)

ADO asked for cable to be sent specifically to Mission (not generic cable) -- include (1) would SR-CRSP be a program that could be tied into MIAC project, and (2) would be a possible follow-on to Mission discussions with Pres. of K State and MIAC officials

1 916-0751 - 7513 Jockley

BOLIVIA

Darrell McIntyre ADO as of Feb. 1989

-- **advocate** for CRSP in Bolivia
-- very **timely**
-- **Mission is supporting marketing fiber** -- haven't done anything on production
-- focus is obviously on high value of altiplano products
-- **Mission could make sure to get government research station behind project**
-- **big Title III @ $29 m/year** -- could use for local costs, i.e., purchase of animals and equipment
-- **could offer good amount of local currency funding to cover support costs**
-- **CRSP is complementary to Mission's ag sector strategy**
-- Bolivia starting out with primitive base -- **desperately needs CRSP activities**
-- **Mission's program has no way of responding to production needs**
-- **can attach people to associations of producers** -- pay private sector salaries thereby keeping available human resources in country

ECUADOR

Dick Peters, ADO

-- very interested
-- have sheep project with Utah State -- deal with imported breeds, management of flocks, and some work with pastures
-- CRSP would fit in very nicely
-- ongoing project linked to local project in private sector therefore 2-pronged base -- MOA and private sector
-- interesting working relationship
-- project going to extend for 2 more years
-- already doing a lot with production -- further along than Bolivia

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ANNEX K

Animal Health Management Through Biotechnology

This annex relates to section V. E. and includes descriptions of methods and references related to that section.

Detailed description of methodology:

Objective a. To develop a general-purpose Capripox virus-vector for sheep and goat vaccines.

To determine if existing plasmid insertion vectors, such as pSC11, have the potential for homologous recombination with attenuated sheep pox virus, a fragment of the thymidine kinase gene is excised from isolated pSC11 DNA with restriction endonucleases selected based on the known gene sequence.[27,41] The fragment is labeled by nick translation with ^{32}P labeled dCTP, and the labeled fragment hybridized to sheep pox DNA in a Southern transfer experiment.[41]

If hybridization occurs, homologous recombination is accomplished with pSC11 and attenuated sheep pox and recombinant viruses selected for inactivation of the thymidine kinase gene and for expression of the @-galactosidase gene, which is in the insertion package of pSC11.[45,49] If hybridization does not occur, the published Capripox thymidine kinase gene sequence[44] is examined for the presence of pox virus promoter and transcriptional initiation sites, and when those sites are identified, a new insertion vector is constructed for use with sheep pox virus.[26,50]

Objective b. To construct a multi-valent, recombinant, virus-vectored vaccine for goats.

i) To insert CCPP, CAEV, and beartnator genes coding for protective proteins into vaccinia virus.

The easiest way to make and test the first multivalent vaccine is to insert the appropriate coding sequence from each pathogen into the SmaI site of different pSC11 plasmids.[49] The structure of each plasmid construct is verified by restriction endonuclease mapping and hybridization and nucleotide sequence.[51] Homologous recombinations are done individually between each new plasmid construct and wild type vaccinia virus.[49] Recombinant vaccinia viruses are selected on TK-cells in the presence of BUdR and for the expression of the @-galactosidase gene from the pSC11 insertion cassette.[43] @-galactosidase expression is measured by conversion of 5-bromo-4-chloro-3-indolyl-B-D-galactopyranoside (Xgal) to a blue color which results in blue plaques.[49] In each case, blue plaques are selected, plaque purified three times, and the

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recombinant viral DNA evaluated by both restriction endonucleases and DNA hybridization.[45,49] Finally, the recombinant viruses are evaluated for production of their respective proteins by immunblot assays,[42,45] expanded, and the plaque forming units (PFU) determined.

ii) To test the recombinant vaccinia virus as a multivalent vaccine for goats.

To test the vaccination potential of each construct, 5 goats are vaccinated with VV-CCPP, 5 with VV-CAEV, 5 with VV-heartwater and 15 with VV. The vaccinations contain 100 million PFU and are repeated once. The antibody responses of the goats are evaluated against their respective antigens by western immunoblot.[46] The vaccinated goats along with 5 controls (VV) are challenged with the homologous virulent organism and evaluated for protection as previously described.[47,52] If the recombinant vaccinia viruses induce a protective immune response, they are tried in combination as a multivalent vaccine. Ten goats are vaccinated with a mixture of equal amounts of VV-CCPP, VV-CAEV, and VV-heartwater and 10 goats with VV. Following boosting, the protective immune responses are evaluated by sequential challenge with all three organisms. The order of challenge is CCPP, heartwater and then CAEV. If this type of multivalent, recombinant, vaccinia virus-vectored vaccine works, the next step is to put all three coding sequences into one recombinant vaccinia virus. This can be done using described techniques[30] or by inserting all three genes into a plasmid, such as pSC11, with the vaccinia promoter (7.5) and transcription sites between each gene. Both DNA and protein expression of the multiple, recombinant, vaccinia virus are evaluated as described for the individual recombinants. The vaccination potential of the VV-CCPP,CAEV,heartwater construct is evaluated by sequential challenge in the same way as for the mixture of recombinant viruses.

<u>Objective c</u>. To construct a multivalent, recombinant, virus-vectored vaccine for sheep).

i) Methodologies are described under objective b.

ii) To clone the envelope genes of retroviruses causing ovine pulmonary procedures.

The envelope gene of retroviruses codes for the major surface glycoprotein and for a transmembrane glycoprotein. Most of the protective immune responses that have been demonstrated against members of this virus family are directed to these two glycoproteins. These viruses have a single strand positive sense RNA genome that has a 3' poly A sequence. The strategy is to isolate viral RNA, make cDNA copies with reverse transcriptase primed with oligo dT. A library of the cDNA is made by cloning

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into pUC19. Plasmid transformed E. coli are selected for ampicillin resistance and screened for the longest cDNA insert. A 5' sequence of the cDNA is generated to determine the start site of protein and to plan a way to construct vaccinia insertion plasmids. Before using either of the retrovirus genes in multivalent constructs, they are evaluated separately by making individual constructs. Each gene is inserted into the SmaI site of pSC11, used for homologous recombination with wild type vaccinia virus, recombinants selected and evaluated as described above, and used to immunize sheep. Five sheep are immunized with each construct along with 10 VV immunized sheep. Immunized and control sheep are challenged as previously described,[6] tested for antibody formation by western blot and evaluated for protection.

ANNEX L

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