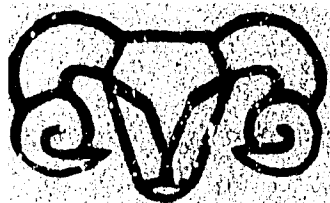


**Small Ruminant
Collaborative Research
Support Program
Annual Report for
Peru
Program Year Seven
1985-1986**



Small Ruminant CRSP
University of California
Davis, CA 95688

**THE SMALL RUMINANT
COLLABORATIVE RESEARCH SUPPORT PROGRAM
(SR-CRSP)
ANNUAL REPORT FOR PERU
PROGRAM YEAR SEVEN
1985-1986**

Edited and Compiled by the Management Entity

**SMALL RUMINANT
COLLABORATIVE RESEARCH SUPPORT PROGRAM
ANNUAL REPORT
PERU 1985-1986***

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*Similar reports for Brazil, Indonesia, Kenya, and Morocco as well as a summary report of the full program are available from the Small Ruminant CRSP Management Entity, University of California, Davis, CA 95616.

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SMALL RUMINANT CRSP

IN PERU 1985/86

ANNUAL REPORT

INTRODUCTION

Implemented in 1979, the SR-CRSP in Peru has dedicated itself to seeking ways to improve range livestock production. Research has focused on livestock diseases, genetic improvement, reproduction and fertility, range management, improved forages, and social and economic constraints. While technological packages do not apply to every single producer in the Andean zone above 3,800 m, the findings do have far-reaching implications in **Bolivia, Ecuador, Colombia, Chile and Argentina.**

Most of Peru's 15 million sheep and 3 million camelids derive most, if not all of their nutrition from two primary sources--range vegetation and improved forages. Furthermore, degradation of these resources is occurring at an accelerating rate. Research efforts indicate stocking rates of sheep should never exceed three to four sheep/ha on the very best native pasture. Since most of the Andes rangeland is in poor to fair condition, stocking rate norms should probably be 0.5 to one sheep/ha to sustain long-term animal production until the range recovers. Greatest protein stress for sheep occurs from June through November and protein supplementation should be considered during this time. Potential energy deficiencies could occur during gestation (October-November) and the first eight weeks of lactation (December-January). Alpacas are under nutritional stress as they enter the last trimester of gestation (August-October). Mixed-species grazing of native range with sheep and cattle or sheep and camelids is encouraged. Greatest economic use of improved pastures occurs when these pastures are used in a yearly production system which includes fattening, flushing, hay harvest, maturation of young females, and supplementation of native range during stress periods. To be sure, improved irrigated pastures should rarely be used as feed for a few elite animals at specific times of the year.

The fertility level of the sheep industry in Peru, and the Andean region itself, is low. Reproductive physiologists working in Peru have studied such factors as the environmental influence on semen characteristics, the effect of rams upon the incidence of ewe ovulation, hormone therapy, hormonal control, postpartum intervals, and incidence and rate of ovulation. Low fertility rates of alpaca also has received attention, but much work still needs to be done. Some of the findings for sheep demonstrate that (1) Corriedale and Criollo breeds produce usable semen throughout the year (2) implants of progesterone plus exposure to rams affects ovulations in females, (3) low levels of fertility are due primarily to fertilization failure and/or embryo fetal losses, (4) progesterone and pregnant mare serum gonadotrophin (PMSG) can induce estrous and a moderate level of PMSG can increase ovulation and lambing rates, (5) Criollo sheep have a higher potential than Corriedale or Junin sheep for intensive breeding programs, and (6) introducing prolific genotypes can increase ovulating performance of indigenous ewes.

Genetic improvement of Criollo sheep through introduction of superior breeds or other indigenous breeds appears to have some application in the Andean region. Crossbreeding of Criollos to improve growth rate and wool production (Targhee breed) or reproduction and maternal ability (Finnish breed) has enhanced these desirable traits. However, adaptability of progeny must be insured before embarking on Criollo crossbreeding programs. Currently used indigenous breeds, Criollo, Corriedale, and Junin, also may have potential for improvement of desirable traits through classification and selection of sires. Certainly, a classification system based on growth rate and fleece weight are superior to the selection system currently being used in the Andean Zone. Screening rams for mating ability is an area fertile for application in the high Andes.

Above 3,800 m in the Andes, sheep production is constrained by two viral respiratory diseases, sheep pulmonary adenomatosis and ovine progressive pneumonia. Because there currently are no effective methods for their control, research is focused on the cause, pathogenesis, transmission, and diagnosis of these diseases. Recently acquired ability to experimentally induce both diseases in neonatal lambs will allow progress in achieving these objectives. Emphasis also has been placed on causes of reproductive failure in sheep such as chlamydiosis, leptospirosis, and ram epididymitis. Control strategies for these diseases are in developmental stages. Perinatal mortality in camelids, particularly the economically important alpaca, is a constraint to their production. Researchers have targeted enteritis caused by Clostridium perfringens, and enteropathogenic E. coli for intensive study. Currently, improved methods of detection and a potential vaccine have been developed for C. perfringens.

While biological information is important, its application hinges on an understanding of the social and economic constraints of the potential benefactors. For example, low-cost alternatives for parasite control must become available before privately owned animals will be systematically treated. Through research findings of rural sociologists, the profound role of women in day-to-day management of flocks suggests extension activities should include, if not focus on, participation of women in Andean communities. Further, governmental extension efforts to distribute technology, animals with improved traits, or vaccine/medicines should consider that both reciprocal and al partir sharing occurs. The latter, where one person provides animals and another provide labor, results in division of offspring. Thus, all who share labor, animals, or products must be targets of extension efforts. Extension specialists should also understand that technology which requires more management time, expertise and capital may not be well received. The ultimate value of animals to peasants is that they require a minimum of attention and little capital. Extensionists should never overlook the relative importance of cropping vs herding.

Not unlike other peoples of the world, decisions are made based on a multitude of factors. One of those factors is economic profitability. Research has encompassed wide-ranging topics like 1) economic analysis of the use of native pastures and improved forages, 2) labor allocation in mixed herding/farming systems and 3) a detailed analysis of cooperative sector units. Research has documented that using improved forages as the only forage base for alpaca or sheep production system yielded internal rates of return (IRR) of 13.3% and 14.9%, respectively. These IRR values are too low to be

profitable in most Andean production systems. However, improved pastures were found to be profitable if used as a supplement to the forage base of native rangeland. Although continuous, yearlong grazing (CG) and rotational grazing (RG) had about the same net value (\$32.40/ha/yr for CG vs \$34.12/ha/yr for RG), RG is recommended for optimum health of the range resource. Rotationally grazing mixed-species (cattle and sheep) resulted in a net value of \$59.20/ha/yr. It appears that inability to absorb the labor force within social cooperatives may create unprofitable situations. As the number of beneficiaries increases, resources available for reinvestment decreases. Thus, the level of capitalization needed for the development of the enterprise was lacking. Also, it was determined that the profitability of any new practices must not only be evaluated against profitability of current farm enterprises, but also against the earnings cooperative members derive from off-farm employment.

The Small Ruminant Collaborative Research Support Program has matured to the point where research results are applicable to many similar range livestock production systems throughout the Andean chain, mostly above 3,800 m. The United States Agency for International Development should be applauded for their timely contribution to developing nations in this region the world.

TRAINING-SR-CRSP SPONSORED STUDENTS IN DEGREE PROGRAMS IN US.

<u>NAME</u>	<u>DEGREE</u>	<u>PROGRAM</u>	<u>TRAINING DATES</u>	<u>NATIVE COUNTRY</u>
CAL POLY				
Adegoke, Adewald	MS Reproduction	Cal Poly	9/81 - 6/84	Nigeria
Drobnis, Erma ¹	MS Animal Science	Cal Poly	4/79 - 8/81	US
Garcia, Laura ¹	MS Animal Science	Cal Poly	4/81 - 4/83	US
Kooyman, David ¹	MS Animal Science	Cal Poly	8/82 - 6/84	US
Krown, Kevin	MS Reproduction	Cal Poly	9/82 - 6/86	US
Mandari, Godfrey ⁴	MS Animal Science	Cal Poly	8/80 - 8/82	Tanzania
Vivanco, H. William	MS Reproduction	Cal Poly	9/81 - 6/83	Peru
COLORADO STATE UNIVERSITY				
Ali Musa, Osheik ¹	PhD Pathology	Colorado	9/83 - 12/84	Sudan
Arnold, K. ¹	MS Clinical Sciences	Colorado	6/82 - 6/83	Australia
Ellis, John DVM ¹²	PhD Pathology	Colorado	8/80 - 7/83	US
Garmendia, Antonio ¹	PhD Vet. Immunology	CSU/WSU	9/82 - 9/85	Peru
Hoffman, L. ¹	PhD Biochemistry	Colorado	9/83 - 6/87	US
Lairmore, M.D. ¹	PhD Pathology	Colorado	9/83 - 6/87	US
Nelson, Dennis ⁸	PhD Comp. Pathology	Colorado	7/83 - 7/84	US
Nieves, R. ¹	MS Microbiology	Colorado	1/85 - 12/86	US
Ramirez, Antonio	PhD Microbiology	Colorado	6/82 - 12/86	Peru
Rivera, Linda ¹¹	Virology/Serology	Colorado	2/84 - 2/85	Peru
Rosadio, Raul	PhD Vet Pathology	Colorado	9/83 - 12/87	Peru
UNIVERSITY OF MISSOURI				
Abunadba, Martha	MS Rural Sociology	Missouri	9/87 - 8/88	Peru
Bilinsky, Paula ¹²	MS Rural Sociology	Missouri	9/82 - 12/85	US
Estofanero, Manuel ⁹	MS Rural Sociology	Missouri	1/87 - 12/88	Peru
Fernandez, Maria ⁹	MA Rural Social Devel.	Missouri	9/84 - 9/85	Peru
Fernandez, Maria ⁹	PhD Development Studies	Missouri	10/85 - 9/88	Peru
Jimenez, Lidia	MS Rural Sociology	Missouri	9/81 - 1/85	Peru
Jamtgaard, Keith ¹²	MS Rural Sociology	Missouri	1/79 - 12/82	US

PERU

<u>NAME</u>	<u>DEGREE</u>	<u>PROGRAM</u>	<u>TRAINING DATES</u>	<u>NATIVE COUNTRY</u>
UNIVERSITY OF MISSOURI (cont.)				
McCorkle, Constance ^{5,12}	PhD Anthropology	Missouri	2/80 - 12/82	US
Perevolotsky, Avi ^{7,12}	PhD Anthropology	Missouri	8/81 - 9/83	Israel
MONTANA STATE UNIVERSITY				
Chavez, Juan F. ¹	PhD Biology	Montana	3/83 - 8/86	Peru
Huapaya, Gladys	Animal Breeding	Montana	4/85 - 7/85	Peru
Tulley, Druska	MS Repro Phys & An Sci	Montana	9/79 - 8/81	US
TEXAS A&M UNIVERSITY/SYSTEMS				
Coronado, Luis	MS Animal Breeding	Texas A&M/Systems	2/81 - 12/83	Peru
TEXAS TECH UNIVERSITY				
Aguirre-Terrazas, Lucrecia	MS Range Science	Texas Tech	12/83 - 12/85	Peru
Bojorquez, Custodio	MS Range Science	Texas Tech	1/84 - 12/86	Peru
Carey, Jim	MS Animal Science	Texas Tech	8/82 - 8/84	US
Farfan, Ramiro ³	MS Range Management	Texas Tech	9/80 - 12/82	Peru
Fierro-Garcia, Carlos	PhD Range Science	Texas Tech	1/82 - 5/85	Mexico/Peru
Antonio Pereira ¹				
Nolte, M. Enrique ⁶	PhD Agronomy	Ohio St./Texas Tech	8/81 - 11/84	Peru
Pitts, John	MS Range Science	Texas Tech	1/82 - 12/83	US
Reiner, Richard ¹²	PhD Range Science	Texas Tech	6/82 - 5/85	US
San Martin, Felipe	PhD Range Science	Texas Tech	1/84 - 10/87	Peru
Soltero, Segio	MS Range Management	Texas Tech	1/85 - 12/86	Mexico
Villena, Francis ¹	MS Range Management	Texas Tech	12/85 - 10/87	Peru
Wilcox, Brad ¹²	MS Range Management	Texas Tech	1/80 - 12/82	US
UTAH STATE UNIVERSITY/RANGE				
Flores, Enrique ³	MS Range Management	Utah/Range	9/80 - 12/83	Peru
Flores, Enrique ¹	PhD Range Management	Utah/Range	4/85 - 3/88	Peru

PERU

<u>NAME</u>	<u>DEGREE</u>	<u>PROGRAM</u>	<u>TRAINING DATES</u>	<u>NATIVE COUNTRY</u>
UTAH STATE UNIVERSITY/REPRODUCTION				
Bravo, Walter	MS Reproduction	Utah/Reproduction	3/84 - 6/86	Peru
Novoa, Cesar	PhD Repro. Physiology	Utah/Reproduction	1/81 - 9/84	Peru
Villalta, Pedro	MS Reproduction	Utah/Reproduction	9/84 - 6/86	Peru
Vivanco, H. William	PhD Reproduction	Utah Reproduction	12/86 - 12/88	Peru
WINROCK INTERNATIONAL/ECONOMICS				
Castilla, Domingo Martinez ²	MS Production Economics	Winrock/Economics	1/81 - 12/82	Peru
Castilla, Domingo Martinez ²	PhD Agr. Economics	Winrock/Economics	8/86 - 8/89	Peru
Jaramillo, Mauricio	MS Ag. Econ.	Winrock/Economics	6/84 - 5/85	Peru
Swindale, Anne ^{10,12}	MS Rural Sociology	Winrock/Economics	1/84 - 12/84	US
Valdivia, Corinne ²	MS Agricultural Policy	Winrock/Economics	1/81 - 12/83	Peru
Valdivia, Corinne ²	MS Agr. Economics	Winrock/Economics	8/86 - 8/89	Peru

- - - -
- 1 Partial support
 - 2 Training at the University of Missouri
 - 3 Partially supported by LASPAU
 - 4 Partially supported by USDA
 - 5 Attended Stanford University; thesis research supported by University of Missouri
 - 6 Final support by Texas Tech
 - 7 Attended University of California, Davis; thesis research supported by University of Missouri
 - 8 Studies discontinued student will not complete the program.
 - 9 Attending University of Reading, UK
 - 10 Attended Tufts University
 - 11 Attended one year of training, S. Dakota State University, SR-CRSP supported travel and per diem
 - 12 Research conducted in Peru

PERU

TRAINING OF OVERSEAS DEGREE CANDIDATES OVERSEAS WITH CRSP SUPPORT

STUDENT	PROGRAM/INSTITUTION	SUPPORT	DATES	NATIVE COUNTRY
COLORADO STATE UNIVERSITY				
Cavieri, A. ²	BS Univ. Richardo Palma	Colorado	11/84 - 12/85	Peru
Puchuri, J. ³	DVM San Marcos Univ.	Colorado	6/84 - 6/85	Peru
Solano, J. ²	DMV San Marcos Univ.	Colorado	6/84 - 6/85	Peru
Soto, Alberto	MS Animal Health San Marcos University, Lima	Colorado	4/82 - 8/82	Peru
UNIVERSITY OF MISSOURI				
Aguirre, Lucrecia ¹	Licenciatura-BA University of Cuzco	Missouri	9/81 - 9/82	Peru
Caldas, Willi ¹	BA Nat. Agrarian University, Lima	Missouri	9/81 - 9/82	Peru
Cruz, Etelmira ²	BS Anthropology Univ. of San Agustin (Arequipa)	Missouri	8/83 - 7/84	Peru
Cutipa, Flore ²	BS Anthropology Univ. of San Agustin (Arequipa)	Missouri	8/83 - 7/84	Peru
Escalante, Victor ¹	Licenciatura University of Cuzco	Missouri	9/81 - 9/82	Peru
Gonzalez, Cristobal ²	BS Anthropology Univ. of San Agustin (Arequipa)	Missouri	8/83 - 7/84	Peru
Mamani, Lolo ²	BS Anthropology Univ. of San Agustin (Arequipa)	Missouri	8/83 - 7/84	Peru

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STUDENT	PROGRAM/INSTITUTION	SUPPORT	DATES	NATIVE COUNTRY
UNIVERSITY OF MISSOURI (cont.)				
Meneses, Norma ²	BA Linqusitics San Marcos Univ.	Missouri	5/85 - 5/86	Peru
Rojas, Corina ²	BS Anthropology Univ. of San Agustin (Arequipa)	Missouri	8/83 - 7/84	Peru
Vega, Pilar ²	BS Anthropology Univ. of San Agustin (Arequipa)	Missouri	8/83 - 7/84	Peru
MONTANA STATE UNIVERSITY				
Bueno S., Juan	MS Animal Breeding Nat. Agrarian University, Lima	Montana	7/81 - indefinite	Peru
Cabrera, Prospero	MS Animal Breeding Nat. Agrarian University, Lima	Montana	3/80 - 1/86	Peru
Chavez, Diana	Ing. Zootechista Nat. Agrarian University, Lima	Montana	7/81 - 7/85	Peru
Garay, Gladys	Ing. Zootechista Nat. Agrarian University, Lima	Montana	3/82 - 3/85	Peru
Garay, Gladys	MS Animal Breeding Nat. Agrairan University, Lima	Montana	3/85 - indefinite	Peru
Grados, Alfredo	Ing. Zootechista Nat. Agrairan University, Lima	Montana	3/82 - 3/84	Peru
Grados, Alfredo	MS Animal Breeding Univ. Nacional Agraria, La Molina	Montana	4/84 - indefinite	Peru
Huayhua, Juan	MS Animal Breeding Univ. Nacional Agraria, La Molina	Montana	9/84 - indefinite	Peru

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STUDENT	PROGRAM/INSTITUTION	SUPPORT	DATES	NATIVE COUNTRY
MONTANA STATE UNIVERSITY (cont.)				
Huapaya, Gladys	MS - Animal Breeding Nat. Agrarian University, Lima	Montana	3/80 - 4/85	Peru
Lopez, Manual	Ing. Zootechista Nat. Agrarian University, Lima	Montana	3/83/ - 9/86	Peru
Lopez, Victor	Ing. Zootechista Nat. Agrarian University, Lima	Montana	Completed 1981	Peru
Maurique, Juan	Ing. Zootechista Centro Nat. Univ. Huancayo	Montana	3/82 - 3/84	Peru
Montesinos, Maria E.	Medco Veterinario y Zootechista	Montana	11/81 - 12/83	Peru
Quevedo, Pillar	Ing. Zootechista Nat. Agrarian University, Lima	Montana	3/84 - 3/86	Peru
Rodriquez, Humberto	MS Animal Breeding Nat. Agrarian University, Lima	Montana	3/80 - 4/81	Peru
Rogue, Juan	MS Animal Breeding Nat. Agrarian University, Lima	Montana	7/81 - indefinite	Peru
Santos, Maximiano	Ing. Zootechista Centro Nat. Univ. Huancayo	Montana	3/82 - 3/85	Peru
Torres, Raul G.	Ing. Zootechista Univ. Nacional Central Peru Huancay, Peru	Montana	1982-84	Peru
Urchupaico, Ide	Ing. Zootechista Univ. Nacional Central Peru Huancay, Peru	Montana	19082-84	Peru

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STUDENT	PROGRAM/INSTITUTION	SUPPORT	DATES	NATIVE COUNTRY
TEXAS TECH UNIVERSITY				
Acata, S. Ortega	MS Range Science UNA, La Molina	Texas Tech	1/84 - 12/85	Peru
Alcarraz, R. Roque	MS Range Science UNA, La Molina	Texas Tech	1/84 - 12/85	Peru
Aries, C. J.	MS Range Science UNA, La Molina	Texas Tech	12/81 - 12/83	Peru
Atamara, Ponce	MS Range Management UNTA, Puno	Texas Tech	1/86 - 10/87	Peru
Bueno, Luiz Juan	Ing. Agr. Nat. Agrarian University, Lima	Texas Tech	1/80 - 12/82	Peru
Gamarra, Jorge ⁴	Ing. Agr Nat. Agrarian University, Lima	Texas Tech	9/82 - 12/84	Peru
Garcia, H.	MS Range Science U.N. Pedro Ruiz Gallo, Lambayeque	Texas Tech	1/82 - 12/82	Peru
Garcia, J. Chafloque	MS Range Science U.N. Pedro Ruiz Gallo, Lambayeque	Texas Tech	1/82 - 12/82	Peru
Gonzalez, E.	MS Range Science UNA, La Molina	Texas Tech	9/83 - 5/85	Peru
Gutierrez, Carlos	DVM San Marcos University, Lima	Texas Tech	1/80 - 5/83	Peru
Huisa, Timoteo	MS Range Ingeniero CUSCO University	Texas Tech	1/84 - 8/85	Peru
Larez, Ivan	Ing. Agr. Nat. Agrarian University, Lima	Texas Tech	6/80 - 12/82	Peru

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STUDENT	PROGRAM/INSTITUTION	SUPPORT	DATES	NATIVE COUNTRY
TEXAS TECH UNIVERSITY (cont.)				
Oscanoa, Luis	MS Range Science UNA, La Molina, Lima	Texas Tech	6/84 - 12/85	Peru
Peralta, A.P. Silva	MS Range Science U.N. Pedro Ruiz Gallo, Lambayeque	Texas Tech	1/84 - 5/86	Peru
Ponce, Gonzalez A.	MS Range Science UNTA, Puno	Texas Tech	1/84 - 5/86	Peru
Rios, Maria	DVM San Marcos University, Lima	Texas Tech/ Colorado	6/80 - 6/81 2/82 - 7/82	Peru
Rodriquez, Neljie	MS Range Science UNA, La Molina, Lima	Texas Tech	6/82 - 5/84	Peru
Soto, L. Bueno	MS Range Science UNA, La Molina	Texas Tech	1/82 - 5/84	Peru
Soto, V.	MS Range Science U.N. Pedro Ruiz Gallo, Lambayeque	Texas Tech	1/82 - 12/82	Peru
Urbano, J. Rueda	MS Range Science UNA, La Molina	Texas Tech	1/84 - 12/85	Peru
Vasquez, Nelly	Ing. Agr. Nat. Agrarian University, Lima	Texas Tech	6/80 - 8/83	Peru
Villa, R. Velarde	MS Range Science UNTA, Puno	Texas Tech	1/84 - 5/86	Peru
UTAH STATE UNIVERSITY/REPRODUCTION				
Alarcon, Victor	MS Reproduction UNA, La Molina, Lima	Utah/Reproduction	1/85 - 12/86	Peru
Alarcon, Virgilio	BS Reproduction UNTA, Puno	Utah/Reproduction	1/85 - 12/86	Peru

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STUDENT	PROGRAM/INSTITUTION	SUPPORT	DATES	NATIVE COUNTRY
UTAH STATE UNIVERSITY/REPRODUCTION (cont.)				
Pinares, Cesar	BS UNA, Lima	Utah/Reproduction	85 - 86	Peru
Pinares, Cesar	MS UNA - La Molina, Lima	Utah Reproduction	86 - 87	Peru
Salazar, Eler	BS Reproduction UNC, Huancayo	Utah/Reproduction	9/83 - 6/84	Peru
WINROCK INTERNATIONAL/ECONOMICS				
Cruces, Martha	Ing. Agr. - Ag. Economics Nat. Agrarian University, Lima	Winrock/Economics	11/80 - 12/83	Peru
Diaz, Roxana	Ing. Agr. - Ag. Economics Nat. Agrarian University Lima	Winrock/Economics	11/80 - 9/82	Peru
Llerena, Gorki	Licenciatura Econ. and Marketing Nat. Agrarian University, Lima	Winrock/Economics	11/80 - 1/82	Peru
Machuca, Juan	Ing. Agr. - Ag. Economics Nat. Agrarian University, Lima	Winrock/Economics	9/80 - 9/81	Peru
Millones, Luiz ²	Licenciatura National Agrarian Univ., Lima	Winrock/Economics	12/81 - 1/83	Peru
Ruiton, Jesus	Ing. Agr. - Ag. Economics Nat. Agrarian University, Lima	Winrock/Economics	1/80 - 9/82	Peru
Valer, Charo	MS Depart. of Econ. & Planning Nat. Agrarian University, Lima	Winrock/Econ	1/84 - 1/85	Peru
Velarde, Ruben	Licenciatura Ag. Economics Nat. Agrarian University, Lima	Winrock/Economics	1/80 - 12/83	Peru
Barrera, Mercedes ²	BS Ag. Econ. Nat. Agrarian Univ. (La Molina)	MSU/Win. Econ.	10/84 - 9/85	Peru

1 - - - - -

1 Support for thesis research only

2 Partial support

PERU

.SR-CRSP SPONSORED SHORTCOURSES

COURSE	NUMBER OF PARTICIPANTS	SPONSORED BY	WHERE HELD	DATES
Management of Reproduction	26	Utah/Cal Poly Reproduction	Lima, Peru	3/81 (5 days)
Animal Breeding	65	Montana	Lima, Peru	11/81 (5 days)
Training on Pathology & Immunology Lab	5	Colorado	Lima, Peru	2/82 (2 weeks)
Management & Improvement of Natural Pastures	117	Texas Tech	Lima, Peru	8/82 (4 days)
Range Shortcourse for Professional Agriculturalists in the Southern Sierra		Texas Tech	Puno, Peru	4/83
Systems Analysis of Peruvian Sheep Production	4	TAMU Systems	Peru	(4 days)

SR-CRSP SPONSORED INFORMAL TRAINING

Subject Matter	No. Participants	Trainer	Project	Location	Dates
Animal Management and Data Collection	12-15 students per year	M. Carpio & B. Quijandria	Montana Animal Breeding	Peru	1981-1985
Training In Veterinary Laboratory Techniques	5-25 Peruvian veterinarians and animal health technicians	J. DeMartini & Colorado colleagues	Colorado Animal Health	Lima La Raya Sais Tupac Amaru	1981 1982 1982 1983
Computer analysis training	Gladys Huapaya	R. Blackwell P. Burfening	Montana	Montana	4/28/85-7/3/85

INDIVIDUAL TRAINING INCLUDING PARTIAL SUPPORT TO ATTEND PROFESSIONAL MEETINGS ^{*a}

Name	Training	Project	Dates
V. Alarcon Victor Lacssa Cesar Pinares H. Cardenas V. Alarcon Ada Ribas Plata Adelaid Prado	Trainees in Reproduction in Peru	USU Reproduction	- - - - -
D. Huaman	New approaches to isolation and characterization of bacterial toxins at CSU	CSU Animal Health	July 1980 (4 weeks)
E. Caletti	New research planning at CSU and Nat'l. Dis. Center, Ames Iowa in field of cell-associated virus isolation and cell culture	CSU Animal Health	1980
E. Ameghino	Ford Animal Veterinary Medicine Meetings and new methodology at UCD, WSU and CSU	CSU Animal Health	March/April 1983
W. Vivanco	Radioimmunoassay Techniques, International Atomic Energy Agency supported training in Peru and Vienna	Utah Reproduction	1983-1984
F. Villena R. Higaona	Tropical Forages Course at CATIE, Costa Rica (Kellogg Foundation sponsored)	Peru Goat Project	4 weeks
T. Cordero M. Callacna	Goat Production in the Tropics (Kellogg Foundation and AID/ROCAP sponsored)	Peru Goat Project	- - - - -

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^{*a} See also publication section for papers presented by SR-CRSP participants at meetings.

Name	Training	Project	Dates
A. Florez	Intn'l. Society for Range Mgt. Meetings at Calgary, Canada and Albuquerque, N. Mex.	Texas Tech Range Mgt.	1982-1983
R. Farfan	IV Intn'l Meeting on South American Camelids, Punta Arenas, Chile	Texas Tech Range Mgt.	Nov. 1981
T. Cordero B. Quijandria	Methodology of Livestock Systems Research (Sponsored by IDRC) Pucallpa, Peru	Peru Goat Project	Jan. 1982
T. Cordero B. Quijandria	Methodology of Livestock Systems Research (Sponsored by IDRC) CATIE, Costa Rica	Peru Goat Project	Feb. 1983
Danilon, Jose	Short Term Traineeship at CNPC	North Carolina	???
P-16 J. Camacho	II International short course on Sheep production. APPA, Huancayo, Peru	Utah Reproduction	Nov. 12-16, 1985
V. Alarcon H. Cardenas V. Llaossa C. Novoa C. Pinares J. Sumar W. Vivanco	V International Convention on South American Camelids, Cusco, Peru,	Utah Reproduction	1985
V. Alarcon J. Camacho H. Cardenas V. Llaossa C. Novoa C. Pinares J. Sumar W. Vivanco	VIII Anual meeting of the Peruvian Association of Animal Production, Huancayo, Peru.	Utah Reproduction	1985

Name	Training	Project	Dates
W. Bravo P. Villalta	ASAS Annual Meeting, University of Georgia, Athens, GA	Utah Reproduction	1985
C. Novoa	VIII National Congress on Veterinary Sciences Lima, Peru	Utah Reproduction	1985
Maximo Gamarra Manuel Carpio	Third International Congress on Genetics Applied to Livestock, Lincoln, Nebraska	Montana	7/5-24/86
R. Farfan J. Astorga N. Gutierrez	ALPA Meetings	Winrock/Economics	4/27/86-
Julio Sumar	Symposium on use of Nuclear Techniques in Studies of Animal Production and Health in Different Environments, Vienna, Austria	Management Entity	3/5-23/86

SR-CRSP
ANNUAL REPORT
1985-86

- I. Project Title:** Evaluation and Genetic Improvement of Small Ruminants in Extensive Management Systems
- II. Host Country:** Peru
- III. Principal Investigator:** Peter J. Burfening
- IV. Personnel:** Co-Workers:
B. Quijandria, Former Director General, INIPA
M. Carpio, Vice Rector for Administration, UNA
R. Alancastre, Animal Scientist, UNTA
J. Sumar, Physiologist and Research Station Coordinator IVITA, La Raya
M. Gamarra, Manager SAIS Tupac Amaru and IVITA
R. Blackwell, Animal Breeding and Genetics, MSU

V. Introductory

In Peru, there are two basic sheep populations: The improved stock (typically the Corriedale and the Junin) and the native or Criollo. The former are relatively productive, mostly in the hands of large enterprises and generally under better management. The latter make up 75-80 percent of the sheep population of Peru and are generally low in productivity, mostly in the hands of limited resource formers and under poorer management. Genetic improvement of sheep in Peru should emphasize two primary approaches. The first includes further improvement and expansion of the better stock to use as a source of genetic material for upgrading the Criolla. This step will eventually raise the genetic potential of all sheep. The second is to improve the Criolla by direct selection within that population. Adaptation to the rigorous Andean environment is considered to be an important consideration. Importation of additional genetic material for use in the highlands should be done conservatively and experimentally, at least until the matter of adaptation and suitability for Peruvian conditions and markets is determined.

Both meat and wool production are important in Peru. Meat is currently considered to be about double in economic importance compared to wool. Primary component traits for efficient meat production from sheep include growth rate, mature size, reproductive rate and survival. In order to enhance the production efficiency of the genetic resource breeding methods need to emphasize selection for these component traits. Traits of little or no economic or biological significance need to be relegated to a low priority or be ignored all together in the breeding program.

The same general approach to genetic improvement of the alpaca is probably warranted. However, less is known about this species as regards genetic and breeding parameters. Also, the economic importance of meat versus fiber may differ. The determination of these parameters is considered an important research priority in alpaca breeding, as is methodology to apply the information acquired from research.

The breeding project is attempting to address these broad concepts through the application of quantitative genetic principles. Greater emphasis is given to sheep than to alpaca because of the relative economic importance of the two species.

Continuing effort will involve data collection, animal selection, making the prescribed mating, data analysis and publication. Data management will continue using the computer at UNA, and specific research studies will be undertaken by students and faculty in Peru as sufficient and suitable data become available from the projects. Due to limitations on computer capacity at UNA, computer tapes of the data files will be transferred to MSU for more comprehensive studies.

Therefore, the objectives of the animal breeding project are:

1. Performance testing, selection and progeny testing:
 - a. Implement and demonstrate sheep performance test programs that will provide objective data for selection of breeding animals on the basis of growth and wool production.
 - b. Conduct progeny tests of sufficient magnitude to enable accurate estimates of ram breeding values for daughter productivity (maternal performance).
 - c. Generate data necessary for the estimation of population parameters (heritabilities, genetic correlations, correlated responses, etc.) and related research in animal breeding.
2. Breed of Sire Comparisons.
 - a. Objectives: Evaluate the genetic differences among local breeds and certain imported breeds for production of meat and wool.
3. Alpaca Breeding.
 - a. Determine direct selection response for staple length and growth rate.
 - b. Determine correlated responses in other economically important traits.
 - c. Obtain estimates of population parameters needed to develop effective breeding and selection procedures.

VI. Research Accomplishments

Crossbreeding. Purebred Targhee (T) and 1/2 Finnish Landrace 1/2 Targhee (F) rams were exported from Montana to Peru to evaluate the influence of a white faced breed that is good in growth rate and fleece production (T) and a breed that is known for high reproductive rate (F) on productivity and maternal ability (reproductive rate and growth rate) when crossed to improved breeds in Peru. Although the results are still incomplete and not thoroughly analyzed, no difference was observed in the reproductive rate of Junin ewes when mated to these breeds of rams. Further, no difference was observed in the growth rate or fleece production of the F-1 lambs when compared to Junin ewes. However, the data is now just becoming available on the productivity of the F-1 females that were retained for breeding. All F-1 ewes and contemporary Junin ewes were mated in a diallel design as shown in Table 1. Also, Criollo ewes that were purchased for this evaluation were included in the experiment.

TABLE 1. DESIGN OF MATING AND NUMBER OF F-1 EWES OF AT SAIS TUPAC AMARU

Breed of Ewe (F-1)	Breed of Ram			
	Junin	1/2T	1/4F	C
Junin	38	35	23	--
1/2T	30	34	27	--
1/4F	28	27	26	--
Criollo (C)	55	65	59	51

The rams were progeny of the original imported sires and were contemporary with the ewes. The results for percent ewes lambing are shown in Table 2. It would appear from these data, the mating involving the Targhee ewes or rams appear to be lower in reproductive rate than the other breeds. It may well be that the Targhees are not well adapted to tough condition of the Andes. Conversely the Criollo had the highest reproductive rate and heterosis estimated for percent ewes lambing from the Junin and Criollo ewes and F-1 crosses was 8.5%. The reproductive rate in the 1/4 Finn ewes was no better than the Junin ewes and at least at this point in time. The twinning rate is not any greater than the Junin ewes, but further evaluation is necessary.

TABLE 2. NUMBER AND PERCENT OF EWES LAMBING FOR THE F-1 EWES AT SAIS TUPAC AMARU

Breed of Ewe	Breed of Sire				TOTAL
	J	1/2T	1/4F	C	
J	28/38(73)	28/35(80)	16/23(69)	--	72/96(75)
1/2T	18/30(60)	22/34(64)	20/27(74)	--	60/91(66)
1/4F	20/38(71)	17/27(62)	21/26(80)	--	58/81(72)
C	46/55(83)	50/65(76)	50/59(84)	41/51(80)	187/230(81)
Total	112/151(74)	117/161(72)	107/135(79)	--	377/498(76)

The birth weights of the progeny of the various crosses is presented in Table 3. The results indicate that the birth weights of the lamb born to straight Criollo ewes are lighter than the other breeds of ewes and the three other "straight" breeds were all lighter than the crosses. Heterosis estimated for the Criollo crosses averaged 21%. Note in Table 3 that almost all of the crosses involving Criollo ewes were heavier than any of the other crosses. Heterosis was also estimated for the crosses of J, 1/2T and 1/4F and averaged 9% with the highest level of heterosis obtained in the JxF reciprocal crosses which are probably the most different in terms of parental genotype of the breeds evaluated.

TABLE 3. BIRTH WEIGHTS (kg) OF PROGENY OF MATINGS INVOLVING F-1 EWES AND RAMS

Breed of Ewe	BREED OF RAM			
	J	1/2T	1/4F	C
J	3.11	3.46	3.57	--
1/2T	3.24	3.15	3.38	--
1/4F	3.26	3.26	3.09	--
C	3.52	3.63	3.44	2.69

The results on survival to weaning, weaning weight, subsequent growth rate and fleece productivity are not yet available, but the results will be analyzed as soon as they are available.

Selection. The results of the progeny test project are currently being collected and analyzed. The complete set of data through weaning will be shipped to MSU for analysis as soon as it is verified at UNA. In general, at SAIS Tupac Amaru, large differences in growth rate and fleece production have been observed between progeny of various sire groups, while at UNTA where 5-8 sires have been used through AI and the 2 to 3 sires with the "best" progeny records have been retained and reused based on their progeny test, small and non-significant differences between sire groups generally have been observed. At both locations, a random bred control population has been established so that genetic progress through selection can and will be evaluated.

Data on scrotal circumference and mating activity has been collected on rams at 16 to 18 months of age in the progeny test project at SAIS Tupac Amaru. The mean scrotal circumference of the rams was 31.1±2.9 cm and the phenotypic correlations with birth weight, weaning weight, body weight at first and second shearing, fleece weight at first and second shearing and staple length at first and second shearing were .06, .24, .30, .44, .07, .16, .09 and .03 respectively. Large differences have also been observed in the mating activity of rams in the pastures. Ten pastures were used and one ram was placed in each pasture for 3 to 4 days with marking harnesses. At the end of the three day period, the rams were removed from the pastures and replaced with another set of 10 rams at the same time all ewes marked by the ram were removed and their identification was recorded. In 1984, the 451 rams used mated an average of 77 ewes with a range of 19 to 109 ewes per ram. At the present time, the data are being analyzed to determine factors that affect mating ability, its' relationship to scrotal circumference and sire-son correlations will be used to estimate heritability of these traits.

The data used in this study were obtained from SAIS Tupac Amaru. At SAIS Tupac Amaru, the classification system developed and present in table 4 is very complicated particularly for rams. Once the rams reach 16 months of age, they are classified on a yearly basis. For the purposes of analysis, the classification scores were numbered from 6 to 17 with 6 being the highest class and 17 the lowest class.

TABLE 4. MEANS FOR VARIOUS TRAITS BY CLASSIFICATION SCORE

Classification score	Numerical score	No.	Trait			
			Body wt (kg)	Fleece wt (kg)	Staple length (cm)	Spinning count
Super ⁺⁺	6	840	71.4	4.1	11.1	57.8
Super ^{+1/2}	7	1336	70.2	4.1	11.1	57.8
Super ⁺	8	1101	65.3	3.9	10.8	57.8
Super ⁺	9	867	63.4	3.9	10.8	57.9
A ⁺	10	507	67.6	3.6	9.9	60.3
A	11	656	66.0	3.8	10.9	57.8
A ⁻	12	601	61.0	3.8	40.9	59.8
B (special)	13	10	59.5	3.7	11.2	57.6
B ⁻	14	10	60.0	3.6	9.3	59.2
Rechazdos (culled) ^a	15	187	59.4	3.6	10.6	58.3
Venta (sale) ^a	16	307	70.2	4.5	11.4	54.6
Camal (colored) ^a	17	46	68.6	3.3	11.8	57.1

^aRechazdos are rams culled for various reasons; Venta are higher quality rams that are offered for sale to other breeders and camal are rams with colored fiber.

To determine if genetic differences existed between different classes of sheep at SAIS Tupac Amaru ewes (Class B) were mated to different classes of rams and growth rate and fleece production of their progeny was evaluated. Rams were selected from 3 groups of Junin sheep at SAIS Tupac Amaru by the management of the SAIS. The classes were Super, A and Twin. The rams from classes Super and A were classified on the basis of body weight, fleece weight and visual appraisal. The twin group is a flock of sheep that was put together by selecting ewes that had given birth to twins from the SAIS's total ewe flock and then rams are selected on the basis of their dam's reproductive performance with no selection for classification score.

Eighteen to 20 rams from each class were mated to approximately 350 per sire group of ram for each of 2 years to produce progeny. The ewes used were from a common source of class B mature ewes. The ewes were assigned at random to sire classification group and mass mating occurred in May and June and lasted for 54 days. Lambing occurred in November and December. At lambing, each lamb was weighed and identified. The lambs were weaned and their bodyweight was obtained. At this time, almost all males were removed from the flock of progeny. Three months later (8 months of age), the lambs were

weighed and shorn and body weight and fleece weight data were collected. All data were analyzed by SAS.

The means for various growth and fleece traits classification score are shown in table 4. It should be noted that there is a fairly linear decrease in both body weight and fleece weight as classification score increases and no real change in staple length or spinning count.

The phenotypic correlation among factors affecting classification score are shown in table 5. The highest correlations were with body weight and spinning count while fleece weight and staple length were not related to classification score. In view of the means in table 4 for each classification score, it is interesting to note that spinning count has a high correlation with score even though there appears to be no trend for that trait in the class means. The standard partial regression coefficient of ram classification on each of the other factors were $-.27$, $.06$, $.01$ and $-.20$ for body weight, fleece weight, staple length and spinning count respectively.

TABLE 5. CORRELATIONS AMONG VARIOUS TRAITS STUDIED AND RAM CLASSIFICATION SCORE

Trait	Classification Score (Y_1)	Body Wt (X_1)	Fleece Wt (X_2)	Staple length (X_3)	Spinning count (X_4)
Y_1	1.00 ^a	$-.18$	$-.04$	$-.00$	$-.18$
X_1	$-.50$	1.00	$.69$	$.45$	$-.19$
X_2	$-.09$	$-.05$	1.00	$.54$	$-.33$
X_3	$-.05$	$.13$	$.38$	1.00	$-.34$
X_4	$-.21$	$-.04$	$-.39$	$-.44$	1.00

^aSimple correlations above main diagonal; within ram correlations below main diagonal.

The within ram correlations are shown in table 5 and as with the overall phenotypic correlations, body weight and spinning count have the highest correlation with classification score. The within ram repeatibilities were $.40$, $.00$, $.08$, $.50$ and $.00$ for classification score, body weight, staple length, spinning count and fleece weight respectively. There were 3.12 records per ram.

These results of the mating experiment indicate that there is no difference in reproductive rate of groups of ewes exposed to the three classes of rams. The mean percentage of ewes lambing ranged from 80.9 for the super to 77.2 for rams from the twin class (table 6). The mean number of lambs weaned per 100 ewes exposed for breeding ranged from 71.4 to 69.4 (table 6) and were not significantly different. These results are probably to be expected since the classification system primarily takes into account growth rate and fleece weight. Further, no difference existed in reproductive rate between ewes mated to rams from the twin flock and those mated to rams from the other 2 classes. However, selection for reproductive rate generally has not been shown to have a direct effect on ewe fertility when mated to unselected ewes.

TABLE 6. EFFECT OF CLASS OF RAM ON REPRODUCTIVE RATE WHEN MATED TO A COMMON GROUP OF EWES

Trait	Class of ram			
	Super	A	Twin	Overall
No. of ewes exposed	716	717	717	2150
No. of ewes lambing (%)	579 (80.9)	568 (79.2)	554 (77.2)	1701 (79.1)
No. of ewes with twins	5	10	3	18
No. of lambs weaned (%)	511 (88.2)	510 (89.8)	498 (89.9)	1519 (89.3)
Lambs weaned/ewe exposed x100	71.4	71.1	69.4	70.6

Growth rate and fleece production of the progeny from the 3 classes of rams are shown in table 7. Lambs sired by rams from the super class were heavier at birth than lambs sired by the other 2 classes. No other significant differences were observed for any of the other traits studied between class of ram. There was no significant difference between classes of rams in weight at weaning or weight at 8 months of age. The mean weight at weaning was 22.9 kg and was affected by year of birth, age of lamb and body weight of the ewe, but was not affected by classes of ram. Body weight, at 8 months of age (first shearing), was affected by year of birth and age of lamb, but again was not affected by classes of ram.

TABLE 7. EFFECT OF CLASS OF RAM ON GROWTH RATE OF PROGENY WHEN MATED TO COMMON GROUP OF EWES

Trait	Class of Ram			
	Super	A	Twin	Overall
Birth wt (kg)				
n	537	538	533	1608
X	3.8 ₋ .02 ^a	3.7 ₊ .02 ^b	3.6 ₊ .03 ^b	3.7
Weaning wt (kg)				
n	408	430	433	1271
Age of weaning (days)	153 ₊ .40	153 ₊ .42	153 ₊ .45	153.
X	22.9 ₊ .19	22.8 ₊ .18	22.9 ₊ .19	22.9
Body wt and fleece wt at first shearing (kg)				
n	198	207	200	605
Age at shearing (days)	241 ₊ .49	240 ₊ .50	240 ₊ .57	240
X body wt	26.3 ₊ .24	26.2 ₊ .22	26.0 ₊ .26	26.2
X fleece wt	1.42 ₊ .02	1.41 ₊ .02	1.39 ₊ .02	1.41
Body wt and fleece wt at second shearing (kg)				
n	83	99	83	265
Age at shearing (days)	478	479	479	479
X body wt	36.8 ₊ .4	37.1 ₊ .4	36.4 ₊ .4	36.8
X fleece wt	1.82 ₊ .03 ^{ab}	1.88 ₊ .03 ^a	1.77 ₊ .03 ^b	1.82

a, b Means with different superscripts within the same row were significantly different.

At 16 months of age, there was no difference in body weight among progeny sired by the three classes of rams. However, there was a significant difference ($P < .05$) in fleece weight among progeny sired by the 3 classes of ram. The differences observed do not relate to the rank of superiority assigned by classifiers at the SAIS. The progeny from the class A rams had heavier fleeces than the twin class, but they were not different from the super class and progeny of rams from the super class were not different from progeny sired by rams from the twin class.

It is very apparent, from these data, that there is no important genetic differences among the classes of rams evaluated in this study. Preliminary results also indicate that there is no difference in daughters reproductive performance or maternal performance.

Complete life-time productive data of 295 Rambouillet, 335 Targhee and 173 Columbia ewes raised from 1960-1976 at the Red Bluff Experimental Ranch of Montana State University were analyzed. Twenty three traits which involved the life-time ewe productive performances were studied. These traits were the average total of lambs born (ATLB), average total lambs weaned (ATLW), average total weight weaned (ATWW), average total of fleece (ATF) and the efficiency index (weight of lamb produced at weaning/ewes adult weight). The remaining traits were the parameters (mature weight), K (maturation rate) derived from Brody (1945) non-linear model of growth and the growth statistics Absolute Growth Rate (AGR), Relative Growth Rate (RGR) and Absolute Maturing Rating (AMR) calculated each for five growth periods: birth to weaning (1), weaning to 12 mo (2), yearling to 18 mo (3), birth to yearling (A) and birth to 18 mo (%), using Fitzhugh and Taylor (1971) free-equation model.

Differences were observed among breeds ($P < .01$) for the productive traits and the growth parameters A and K. Targhee tended to be superior for EI and all the productive traits except ATFP. Columbia tended to be the poorest but had the highest ATFP and a similar A to the Targhee. In general, Rambouillets presented performance was between the other two breeds except for A, having the smallest mature size. Grouping of the ewes according to their age they left the flock (5 or 6 years) were analyzed also for the pooled information of the three breeds observing that the ewes remaining in the flock longer (6 yrs) had the highest performances for the productive traits (and EI) were similar to the others for A, but grew slower (lowest K value).

Analysis of the results of genetic parameters for the 23 variables studied for each breed is in progress. The most important fixed effects from the model used for this analysis were year of birth and type of birth-rearing. Ewes born as twins and reared as singles or twins showed a lower average mature weight (A), lower maturing rates, but had the highest efficiency ($P < .01$). Genetic parameters still are to be estimated.

VII. Significance of Findings

These results indicate that crossing either improved indigenous breeds of sheep or imported breeds of sheep can greatly improve the productivity of the Criollo sheep. However, much of the difference may be due to heterosis and if this is the case, then as subsequent generations are top crossed to the improved breeds the amount of heterosis will be diminished. Further, caution needs to be used before a program of crossing the Criollo ewes with improved

rams is embarked upon to be sure that the adaptability of the crosses is good enough for the environmental conditions.

Selection based on objective measures such as growth rate and fleece weight appear to be superior compared to the selection system currently used in most of the large improved sheep enterprises in Peru. Although the phenotypic differences between classification scores of rams appear to be large, little or no difference is observed in their progeny's performance. However, large differences are observed between sire groups selected for objective measurements such as growth rate.

The results also indicate that large differences exist in rams abilities to mate large numbers of ewes and that significant improvement in the use of rams could be made by screening rams for mating ability and then allowing them to mate more ewes.

Growth rate and the shape of the animals growth curve to maturity appears to be related to subsequent production. High producing ewes had a growth curve that reached maturity at a slower rate than did lower producing ewes. This is probably the result of increased productivity occurring at the expense of growth of the ewe.

VIII. Future Direction

The major emphasis of the research program in the next year will be directed toward the analysis and publication of the research results. Continued evaluation of selection systems that are manageable in Andian region will be emphasized. At the Chiquibambilla, a selection program will be initiated with a flock of Criollo sheep that will evaluate what type of progress can be expected within this breed. This is important since many small communities could practice selection based on some objective measurement where they do not have the resources or the desire to purchase rams from improved flocks. More emphasis and thought will be given to incorporate breeding systems into the community flocks and the impact that these practices will have on the small holders production. A study with approximately 3000 ewes at two locations is being conducted to evaluate the "ram effect" on reproductive performance in the ewe. One half of the ewes at each location were exposed to vasectomized rams 14 days prior to the start of breeding. The data will be summarized next year.

IX. Funding

Subgrant amount 144,000

Matching 57,083

PERU

Breeding - Montana State University

Theses--(SR-CRSP)

PhD

Chavez, Juan Francisco. 1986. Genetic Analysis of Growth and Its Relationship with Lifetime Production in Rambouillet, Targhee and Columbia Ewes Under Range Conditions of Montana. Montana State University, Bozeman.

Montana-Breeding

M. S.

Cabrera Prospero C. 1986. Determinacion de la Curva de Crecimiento para Peso Vivo y Longitud de Mecha en Ovinos Corriedale y Junin por Corriedale hasta los 16 Meses de Edad. Universidad Nacional Agraria-La Molina.

Montana-Breeding

Huapaya, Gladys M. 1985. Estimacion de Parametros Geneticos y Fenotipicos para Peso Vivo, Peso Vellon y Longitud Mecha en Ovinos Junin, Corriedale y Progenie Junin x Corriedale. Universidad Nacional Agraria-La Molina.

Montana-Breeding

Rodriguez, H. L. 1981. Parametros Geneticos y Fenotipicos en Ovinos.

Universidad Nacional Agraria, La Molina, Peru.

Montana-Breeding

B. S. (to obtain the Title of Ingeniero Zootecnista)

Grados, Alfredo B. 1984. Estudio del Peso Vivo y Peso Vellon en la Progenie de Tres Grupos de Carneros en la Raza Junin. Universidad Nacional Agraria, La Molina.

Montana-Breeding

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Montana-Breeding

Manrique, Juan C. 1984. Analisis de Diametro, Longitud, Peso de Vellon en Borreguillas y Carnerillos Procedentes de Diferentes Cruzas. Universidad Nacional del Centro del Peru, Huancayo.

Montana-Breeding

Garay, Gladys L. 1985. Efecto de la Edad y Numero de Esquilas Sobre el Peso Vivo, Peso Vellon, Longitud de Mecha y Finura en el Ovino Junin. Universidad Nacional Agraria, La Molina.

Montana-Breeding

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Montana-Breeding

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Montana-Breeding

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Theses-(Supporting)

M. S.

Lewis, R. D. 1984. Comparison of Finnish Landrace Crossbred Ewes with Columbia, Rambouillet and Targhee on Western Range. Montana State University, Bozeman. **Montana-Breeding**

Tulley, D. 1982. Libido and Scrotal Circumference of Rams as Affected by Season of the Year, Altered Photoperiod and Ram Lambs of Different Breeds and Selection Lines. Montana State University, Bozeman. **Montana-Breeding**

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Oral Presentations (SR-CRSP)

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SR-CRSP

ANNUAL REPORT

1985-86

- I. Project Title:** Economic Analysis of Small Ruminant Production and Marketing Systems
- II. Host Country:** Peru
- III. Principal Investigator:** Hendrik C. Knipscheer
- IV. Personnel:** Co-Workers:
N. Gutierrez
D. Martinez
C. Valdivia
A. Cruz
F. Gutierrez
E. Garcia
J. Flores
M. Fernandez
M. Jaramillo
- V. Project Goals**
1. Provide a well-trained group of professional agricultural economists with the analytical skills, research experience, and professional motivation to contribute to the conduct of multidisciplinary research on small ruminants and their producers.
 2. Provide an improved data base for guiding research and providing policy guidelines for improving small ruminant productivity and farmer incomes.
 3. Strengthen the overall research capacity of selected host country research institutions by providing leadership in conducting interdisciplinary research, conducting training programs, and publishing research results.
 4. Publication and dissemination of research results representing a wide variety of research and which will contribute to a better understanding within the scientific community of small ruminants and their place in selected rural economies of developing countries.
- VI. Objectives**
1. Complete first phase of collaborative research on economic analysis of pasture/forage research results.
 2. Complete two thesis projects by local students, one dealing with profitability of goat production in Northern Peru and the second dealing with labor allocation in highland mixed farming communities.

- dealing with labor allocation in highland mixed farming communities.
3. Initiate analysis of community project baseline survey data and performance monitoring surveys.
 4. Complete second phase on economic analysis of cooperative sector units.

VII. Research Accomplishments

Major progress was made in the areas of economics of pasture/forage utilization in the high altitude rangelands, and evaluation of small ruminant productivity in cooperative sector units. Continuing progress, albeit at a lower level, was made in the Northern Goat project and the Central Sierra Community project, primarily through thesis projects conducted by local students. In addition, an earlier baseline study of two alpaca producing communities was completed.

- a. Economics of pasture/forage utilization. A Winrock International Research Associate worked in collaboration with the Range Management project of Texas Tech and the National Agrarian University to conduct an analysis of the economic and financial viability of applying some of the experimental results of the above project on commercial range/pasturelands in the Peruvian highlands.
- b. Discounted cash flows (CF) were used to estimate net present value (NPV) or internal rate of return (IRR). Analyses were examined from the financial viewpoint of the investor and from the economic viewpoint of society as a whole. Sensitivity analyses were used to evaluate needed incentives for investors to adopt various interventions. At least 25% financial IRR for the producer was assumed to represent minimum payoff needed for a farmer to adopt an intervention.
- c. Using improved forages as the base for an alpaca production system yielded a financial IRR of 13.3%, a return too low to be considered by alpaca producers in the Andes. In order to be profitable, the following examples are illustrative of changes that would have to take place: 1) increase alpaca stocking rates from 20 to 35 alpacas/ha, 2) increase birth and survival rates from 60% to 85%, 3) sell alpaca fiber at \$11.00/kg instead of \$7.00/kg, 4) reduce pasture investment to 25% of the current estimate, 5) reduce pasture operating expenses to 60% of the current estimate, or 6) obtain an 85% increase in the price for mature tuis.
- d. Based upon our criteria for minimum rate of return required, the use of improved forages as the base for sheep production was also unattractive given a 14.9% financial IRR. Examples of interventions needed to raise the financial IRR to the required 25% include: 1) increase stocking rates from 30 ewes/ha to 49 ewes/ha, 2) increase birth and survival rates from 80% to over 100%, 3) sell wool for \$1.71/kg instead of \$0.60/kg, 4) reduce pasture investment to 25% of the current estimate, 5) reduce pasture operating costs to 67% of the current estimate, or 6) obtain a 50% increase in the price/kg of mutton.

- e. Improved pastures were profitable if used as a supplement (rather than the primary source of nutrition) to the vast areas of native range. These supplementation practices might include 1) restricted grazing of improved pastures, 2) harvest of hay from improved pastures during the rainy season to be fed in the dry season, 3) flushing at breeding and late gestation, 4) fattening lambs and tuis during the rainy season, 5) grazing female alpacas on improved pasture during the dry season, and 6) using improved pastures to induce earlier sexual maturation of alpaca female tuis to produce one extra offspring in the producing life of a female.
- f. Mixed alpaca/sheep production systems also appear promising. These include 1) raising alpaca female tuis to one year of age on improved pasture plus cutting hay from improved pastures in the rainy season to be fed to ewes in late gestation -- 55% financial IRR, 2) raising alpaca female tuis to one year on improved pasture plus fattening wethers on improved pastures during the rainy season -- 85% financial IRR, or 3) a combination of raising alpaca female tuis to one year and dry season grazing ewes on improved pasture after weaning plus fattening wethers on improved pasture in the rainy season -- 90% financial IRR.
- g. Under "range-only" production systems without improved pastures, rotational grazing under herding at 3 ewes/ha yielded about the same net value (\$32.40/ha/yr) as continuous yearlong grazing (\$34.12/ha/yr). Because rotational grazing is best for the health of the range resource, this practice is recommended. Under native range in good condition, rotationally grazing 4 ewes/ha/yr yielded a net return of \$53.40/ha/yr. Complimentary grazing of cattle with sheep yielded \$59.20/ha/yr. Rotational grazing of fertilized range with cattle and sheep yielded the best return of \$100/ha/yr.
- h. Evaluation of factors constraining sheep production in cooperative sector units. Two sets of studies were completed in the first project, Corinne Valdivia completed her comparative studies of capital accumulation in two different cooperative sector units. Although both of these large units were cooperatives, their institutional arrangements regarding decision making and sharing of resources were quite different. One unit was Agrarian Production Cooperative El Diezmo Palcan while the other was the Agrarian Social Interest Society Ramon Castilla. An important factor related to the long-term viability of these units showed that there was no process of identification in SAIS Ramon Castilla. The table below summarizes the findings for both the SAIS and the CAP with respect to the variables analyzed.

Summary of the results of CAP Palcan and SAIS Ramon Castilla

Variable	CAP Palcan	SAIS Ramon Castilla
Income generation		
Workers	+	+
Members	+	-
Capital accumulation	+	-
Participation		
All levels	-	-
Partial	+	-
Identification	+	-

Source: Valdivia (1983).

+ = contributes to.

- = detracts from.

- i. Pasture carrying capacity did not increase in the case of Palcan, and decreased in the case of SAIS Ramon Castilla. Both cooperatives reached stable levels in terms of their production and were able to invest capital in the production units. Their rates of labor absorption and technology development were similar. Both developed colonies in the jungle to help solve the problem of labor absorption.
- j. The main difference is that the SAIS were found on already developed haciendas while CAP Palcan started from zero. The members of CAP Palcan stressed capitalization and labor absorption as their main objectives, and with the resources available were able to absorb all the labor force. Profits were reinvested and partial participation was essential to CAP Palcan's development.
- k. The population pressure that existed since the formation of SAIS Ramon Castilla and the social goals to be accomplished were the main obstacles to its development. Although both had the same rate of labor absorption, CAP Palcan was able to absorb 100% of the beneficiaries and SAIS Ramon Castilla only reached 30% of the service cooperative's members, with decreasing real profits and no work through the development division in the peasant communities.
- l. While each family that benefited from CAP Palcan had 327 sheep, each family that benefited from SAIS Ramon Castilla had 45.6 sheep, taking into account only the members of the service cooperative. With more beneficiaries the SAIS had more pressure upon resources available for reinvestment and it did not achieve levels of capitalization that allowed for the development of the enterprise nor for its members, and least of all for the region. The relationship between the number of families benefited through the Agrarian Reform, in both the case of the CAP and the case of the SAIS, and the amount of resources and technology available, were the key issues in determining relationships between members and forms of production.

- m. Northern Peru Goat project. A La Molina student, Rosario Valer, completed her "Licenciatura" thesis on a research project which evaluated the economic returns from goat production in the arid areas of Northern Peru. This work is now being summarized as a SR-CRSP working paper.
- n. Central Sierra Community project. Another La Molina student, Mercedes Barrera, completed her "Licenciatura" thesis based on a study of labor allocation by peasant families. Her work indicated that labor constraints are a severe problem encountered by researchers who wish to introduce technologies requiring more intensive management practices. This would include more intensive crop husbandry as well as more intensive management of sheep. This work is also being summarized as a SR-CRSP Working Paper. A final thesis project was conducted in a collaborative project between Tufts University, the Interamerican Foundation, and the SR-CRSP with INIPA-Huancayo as the coordinating body. Anne Swindale, a graduate student at Tufts, carried out the study which focused on several levels of resources available for agricultural production in the Montaro Valley Area -- the community, the family, and individual household members. The survey found that in both the lower and higher zones of the valley, mixed farming systems predominated with agriculture relatively more important in the lower zones with livestock raising increasing to importance with altitude. Off-farm work was also very important and the profitability of any new practices needs to be evaluated against not only the profitability of current farm enterprises but also against earning from off-farm casual employment.
- o. Alpaca producers survey. Domingo Martinez summarized data from a survey conducted in 1980 in two Huancavelica Department alpaca producing communities -- Santa Barbara and Orccobamba. The major survey results are as follows. The number of animals owned per capita in these communities is similar to that found in a nearby sheep production cooperative. The ratio did not vary over different levels of stocking rate and family living conditions. The welfare level of Orccobamba comuneros is clearly below that of Santa Barbara; however, herd sizes in the former community are larger due to the absence of alternative sources of income. Orccobamba livestock herds have a higher proportion of other (i.e., non-alpaca) species, probably as a strategy for avoiding risk. The distribution of wealth, measured by alpaca herd size, is more variable in Santa Barbara. The herd composition, based upon age, sex, and fiber-color ratios, suggests higher levels of technical efficiency in Orccobamba. Fiber marketing in Orccobamba is more dependent upon middlemen linked to the large export firms.

VIII. Fundings

Grant No. DAN/1328-G-55-4093-00	\$289,529
Matching Contribution from 1985-86 Subgrant	96,510

PERU

Economics - Winrock International

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SR-CRSP

ANNUAL REPORT

1985-86

- I. **Project Title:** An Investigation of Small Ruminant Health Problems
- II. **Host Country:** Peru
- III. **Principal Investigator:** James C. DeMartini
- IV. **Personnel:**
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V. Introductory

The long range goal for the Animal Health Project in Peru is to decrease disease-related losses of food and fiber products of sheep, goats and alpaca by:

1. Determining the causes and prevalence of major infectious and noninfectious disease in small holder production units as well as large cooperatives.
2. Developing control or prevention strategies for chronic respiratory disease of sheep based on increased knowledge of the cause, lesions, diagnosis, and transmission of the specific entities that comprise this complex.
3. Developing control or prevention strategies for neonatal enteritis in alpaca based on increased knowledge of the cause, pathogenesis, diagnosis, and transmission of microbial agents involved.
4. Evaluating the role of infectious agents in losses due to infertility in sheep and developing control strategies for the responsible entities.
5. Providing advanced training for veterinarians interested in disease investigation.
6. Promoting the exchange of ideas between U.S. and Peruvian scientists.
7. Enhancing the dissemination of research findings to Peruvian officials and lay personnel concerned with disease control in small ruminants and camelids.

The Animal Health Project is a collaborative research and training program involving faculty and staff of Colorado State University and IVITA (San Marcos University). The general objectives listed above are being approached by increasing the knowledge base regarding disease problems that constrain livestock production in Peru and conducting research designed to provide solutions for control of diseases for which current knowledge is inadequate. Since 70% of sheep, goats and alpaca in Peru are held by small farmers, it is imperative that the work undertaken and research results are applicable to disease control in these units of livestock production.

Research underway in Peru involves several components. First, serological surveys and other sampling and survey techniques are being applied to learn more about disease prevalence in small farmer flocks and cooperative enterprises. This work is usually conducted by IVITA personnel with assistance from CSU faculty and often with reagents imported from the U.S. More reliance is placed on IVITA research personnel than on long-term U.S. residents to accomplish this work. Second, in-depth investigations on particular disease problems, such as chronic pneumonia of sheep, are conducted collaboratively with CSU and IVITA personnel participants. Samples for study are often collected by CSU scientists during short term visits to Peru. These are processed and analyzed at IVITA, the International Potato Center (CIP) in Lima, or Colorado State University or other U.S. institutions. Third,

experiments to test disease control strategies for selected problems are being employed in target communities or cooperative enterprises in Peru. Fourth, summaries of research findings are being prepared for use by extension personnel or others involved in livestock disease control in Peru. Finally, interchange of ideas and technological training is being facilitated through short courses, seminars, and other training sessions conducted in Peru by CSU and IVITA personnel.

Training opportunities in the U.S. have emphasized the Ph.D. degree for Peruvian veterinarians, although year long and shorter periods of training in diagnostic techniques also have been provided. Drs. Rosadio and Ramirez are soon expected to complete requirements for the Ph.D degree at CSU in pathology and microbiology, respectively. The problems selected for Ph.D. dissertation research have always been directly related to important livestock diseases in Peru and are thus well integrated in the ongoing supporting research activities at Colorado State University. Some support is also provided at CSU for ancillary research activities as well.

VI. Research Accomplishments

a. Chronic Viral Respiratory Diseases of Sheep.

In Peru, sheep production is constrained by two viral respiratory diseases of adult sheep, sheep pulmonary adenomatosis (SPA) and ovine progressive pneumonia (OPP). While both diseases are found in the U.S. and Peru, SPA is most important as a clinical disease in Peru and OPP in the U.S. Our research has been directed toward increasing knowledge of the cause, pathogenesis, transmission and diagnosis of both diseases in order to develop methods for their control. Presently, there are no satisfactory means for prevention of either disease, and there is not even a serological test for detection of infected carriers of the SPA virus. Sheep infected with the OPP virus may be detected using an agar gel immunodiffusion (AGID) test.

During the period 1984-86, work in Peru has been done to clarify the seroprevalence by age of OPP in seven flocks in the Central Sierra and to attempt to control SPA and OPP in two test flocks of 1,600 sheep through rigorous selection and culling procedures. In 3,369 two to seven year old sheep, the mean seroprevalence rate was 19%; it was only 2-8% in the two test flocks and 25-40% in four comparison flocks. A direct correlation with age was found and 5 year old sheep were twice as likely to be infected as 2 year old sheep. Incidence data for SPA in these flocks remains to be summarized.

Investigations on OPP at CSU have resulted in development of neonatal lamb model for studies of the acute pathogenesis and immunology of OPP. Six of six lambs inoculated with low passage OPP virus (OPPV) developed lesions of lymphoid interstitial pneumonia whereas none of seven lambs injected with high tissue culture passage or 4 media-injected lambs developed lung lesions. In these studies, we have developed methods for isolation and culture of OPPV, detection and analysis of antibody responses in sheep, and new techniques for detection of the viral genetic material in tissues.

Research on SPA in the U.S. has been hindered by the extremely rare prevalence of the disease in the U.S. (only eight cases have been reported) and the inability to import the infectious agent from Peru or other countries for study. However, we have been fortunate within the last 18 months to locate two SPA cases near Colorado. These have served as a source of inoculum for experimental transmission studies. To date, in various studies, we have inoculated with infectious material from these animals 32 newborn lambs of which 21 have developed evidence of SPA between two and six months of age. An interesting finding was that in almost all of these cases, OPP was transmitted concurrently as detected by seroconversion, virus isolation, or lesions. We are currently in the process of determining whether we are transmitting two viruses or one virus with the potential of causing both diseases.

Further studies on SPA at CSU have involved characterization of antigens of SPA virus, in vitro culture of its presumed lung target cell, the type II alveolar cell, and isolation of retroviruses from cultures of these cells. Coculture of neoplastic type II cells or alveolar macrophages from SPA sheep with goat synovial membrane cells has yielded 15 retrovirus isolates, some or all of which may be ovine lentiviruses. Pathogenicity and antigenic characteristics of these agents are presently under study. We have found that rabbit antibody to p27 of Mason-Pfizer monkey virus, as reported previously, consistently detects in an immunoblotting assay a 25 kd protein in lungs and lung fluid of sheep with SPA whether from the U.S. or Peru. This reaction is being used as a basis for isolating proteins for production of antiserum to homologous viral proteins and for attempts to clone SPA viral DNA in the expression vector lambda gt 11. Other attempts to detect sheep serum antibody to SPA virus by immunoblotting and radioimmunoprecipitation are under way.

b. Infectious diseases of goats in Peru.

Caprine Arthritis-Encephalitis (CAE) has been diagnosed in Peru on the basis of clinical, pathological, and serological findings. As seen in Table 1, CAE infection seems to be widespread in Peru, but the greatest number of seroreactors were found on a goat farm near Lima which imported Anglo-Nubian and Alpine goats from the U.S. It seems likely that CAE is being spread throughout Peru through the sale and distribution of breeding males from such herds.

Mycoplasma infections in goats have been associated with pneumonia, keratoconjunctivitis, arthritis, and mastitis. Mycoplasma mycoides subsp. mycoides (large colony type) has been isolated from a goat kid at a dairy farm in Lima which was experiencing severe death losses in kids at about one month of age. Sixty-five serum samples have now been collected from goats with forelimb arthritis (14), unilateral arthritis (6), coughing and arthritis (2), coughing (9), pneumonitis (1), and clinically normal (34). Results of agar gel immunodiffusion and hemagglutination tests have been inconclusive because of lack of reference sera, but further investigations are underway.

c. Causes and control of perinatal mortality in alpacas.

Perinatal mortality in alpaca, a major problem in Peru, has been approached through a study of the bacteria responsible for enteritis and through investigations of the role of colostral immunoglobulin transfer from the dam in protecting the newborn crias from infection.

Table 1
 Serological Survey to Detect Caprine Arthritis-Encephalitis
 Using AGID Test in Peru

<u>ZONE</u>	<u>PLACE</u>	<u>NO. SAMPLES</u>	<u>REACTORS</u>	<u>PERCENT</u>
North Coast	Piura	254	9	2.5
	Chiclaya	196	9	4.8
Central Coast	Lima (Farm Fe y Luz)	119	35	29.0
	Chincha	17	2	11.0
	Ica	531	27	5.0
	Ica	61	00	0.0
TOTAL		1,278	82	6.42

The enterotoxins from alpaca and human isolates of Clostridium perfringens type A were purified. Their molecular weights were very similar, and corresponded to the molecular weight of a reference enterotoxin from human C. perfringens type A. Methods were developed for detecting enterotoxin and anti-enterotoxin including ELISA, immunoblot procedures, and countercurrent immunoelectrophoresis. Monoclonal antibodies have been produced against the enterotoxin. The antibodies will be used in several procedures, including enterotoxin assays and purification. Partially purified enterotoxin, vegetative C. perfringens, and control buffers were injected into ligated intestinal loops of 2-month-old alpacas at the LaRaya IVITA laboratory. Alpacas receiving enterotoxin or C. perfringens which subsequently produced enterotoxin, exhibited signs of enterotoxemia including lacrimation, abdominal pain, reluctance to stand, some paralysis, neurologic signs such as opisthotonus, and gross pathologic changes in the intestine (hyperemia, fluid accumulation, and some evidence of intestinal bleeding). These results support the hypothesis that the C. perfringens type A enterotoxin is pathogenic and that anti-enterotoxin antibodies should protect against the disease.

A vaccine trial utilizing partially purified enterotoxoid was initiated in December, 1985. It was designed to compare the occurrence of enterotoxemia in alpaca crias from vaccinated dams to that in crias from nonvaccinated dams. Serum and milk samples were collected and will be evaluated for presence of anti-enterotoxin antibodies.

A role for enteropathogenic E. coli (EEC) in neonatal enteritis of alpaca has been postulated. Electron microscopic studies have demonstrated that many alpaca EEC isolates are well piliated (possess colonization

antigens) when grown at 37C, but do not produce the pili when grown at 18C or 14C. These results are consistent with results of other animal and human EEC. Hemagglutination studies have produced evidence that the pili present on alpaca EEC are colonization pili and not merely "common" pili (which do not contribute significantly to gut colonization). Rabbit antisera against some of the alpaca EEC were produced. These studies are not complete, but it appears that we have at least two different antisera against pilus antigens on alpaca EEC. These will allow serologic identification of EEC important in alpacas.

The possibility that failure of maternal colostral antibody transfer to the neonate is a predisposing factor to development of infectious disease in alpaca cria has been studied in a collaborative project involving Washington State University, CSU, and IVITA. It was found that alpaca colostrum contains high levels of IgG which are absorbed by the neonate and are very important in protection against infectious disease. In 7 of 10 crias that died of infections within 30 days of birth among 82 studied, the serum IgG level was more than two standard deviations below the mean of crias that lived.

d. Causes of Infertility and Abortion in Sheep in Peru.

During the past year, emphasis has been placed on studies of chlamydiosis, leptospirosis, and ram epididymitis as causes of infertility or abortion in sheep in Peru. In addition to abortion, Chlamydia psittaci may also be responsible for enteritis, arthritis, mastitis, conjunctivitis, and other diseases depending on agent strain and host age and immunologic status. Using an ELISA test, 60 ewe serum samples had an 8.3% reactor rate. Present studies involve serologic testing before and after parturition of a flock that has had reproductive problems. Leptospirosis is a cause for infertility, abortion, and perinatal mortality in virtually all of the important sheep-raising areas of the world, but the role of this agent in clinical disease in Peru is unknown. Using a microagglutination test and 14 leptospiral serovars, 147 sheep serum samples from the Department of Ancash (SAIS Atusparia) have been evaluated. The reactor rate was 24% and a higher proportion of samples were positive for antibodies to L. autumnalis (5%) and L. icterohemorrhagiae (4.8%) than other serovars. These results reflect a similar rate of infection of sheep in the central Sierra (23.4%) and underscore the need to determine the clinical manifestations and economic consequences of leptospirosis in Peru.

A program to identify and eliminate Brucella ovis infected rams has been tested at CSU and has been found to be very effective. The program consists of palpation for epididymitis defects, collection and microscopic examination of semen for presence of leukocytes or sperm abnormalities, culture of semen for presence of B. ovis, and use of ELISA for detection of B. ovis antibodies in the serum. Yearly or twice-yearly evaluation programs are necessary to remove infected rams, and testing of all new rams prior to introduction into the herd is necessary. By following the above protocol, it is possible to remove all reactor rams and reach a B. ovis-free or minimal level in three years. The evaluation procedure was applied to the two enterprises in Peru (Table 2), one of which had used REV 1 vaccine for 10 years. A marked difference was observed in the proportion of rams with seminal leukocytes or sperm abnormalities.

e. The effects of chronic exposure of sheep to a zinc smelter in Peru

Liver levels of a number of heavy metals were assessed in sheep living at various distances from a zinc producing smelter in Peru. Metals assayed included arsenic, cadmium, copper, lead, manganese and zinc. Soil samples were analyzed for the same environmental contaminants at locations at varying distances from the smelter. The study was conducted on a large cooperative in the Central Sierra of Peru. The cooperative was divided into seven management units, and operated under a centralized management system of extensive grazing.

Samples for analysis were collected on 5 units from a total of 153 sheep. The livers of adult sheep contained elevated quantities of all heavy metals included in the analysis except copper. There were significant differences in the levels of liver metals in sheep obtained from the various units. The largest differences between units were noted for arsenic, copper, lead manganese and zinc. Liver burdens of these metals were higher than those found in control sheep from the southern part of Peru or from Colorado, USA, with the exception of copper levels which were higher in controls.

Analysis of soil samples for heavy metals revealed a gradient of contamination around the emitting smelter. In general, the soil concentrations for the metals sampled decreased with increasing distance from the smelter although topographic features also seemed to play a role in their distribution.

Mortality rates for pulmonary adenomatosis, coenurosis and pneumonia were calculated from summary data for 1978-1979 for each unit of the cooperative. Linear regression analysis revealed little relationship between specific metals and mortality rates except for an association between liver lead and pulmonary adenomatosis and between liver cadmium and death due to pneumonia. The study detected significant contamination of the environment around the smelter with accumulation of heavy metals in sheep grazing in vicinity of the smelter. Significant associations between heavy metal accumulation and biologically plausible mortality rates were not detected. The quality of the mortality data examined may have precluded detecting significant associations with specific disease entities.

Table 2

Ram Semen Quality in Relation to Clinical Palpation,
Sperm Motility, WBC and/or Separated Cell Sperm Heads
in Two Enterprises of the Country

	Enterprise A 10 yrs REV I Vaccination and Palpation Program		Enterprise B No Vaccination 1 yr Palpation Program	
	<u>NO.</u>	<u>PERCENT</u>	<u>NO.</u>	<u>PERCENT</u>
Excellent	612	95.03	411	76.54
Good	11	1.70	38	7.08
Poor	10	1.55	10	1.86
WBC and/or SH >25%	-- -	-- ---	78 ---	14.52 ---
Total	644	100.00	537	100.00
Palpable lesions	8	1.24	14	2.6
Hypoplasia	5	0.24	7	1.3
Seminal Leukocytes	6	0.93	66	12.29

Excellent: Motility 40% or > and normals 85% or >
 Good: Motility 30% and normals 70% or >
 Poor: Motility < 30% or normals < 70%
 WBC and/or SH: Samples with seminal leukocytes or separated heads > 25%

Enterprise A: SAIS Tupac Amaru, Department of Junin
 Enterprise B: SAIS Picotani, Department of Puno

f. Investigations of patterns of disease in community sheep in the Central and Southern Sierra of Peru.

The "community project" is an interdisciplinary effort among SR-CRSP projects working in Peru to establish baseline data on the biological and socioeconomic factors which regulate livestock production in these smallholder community flocks. These data would then serve as a base for evaluation of the efficacy of new management strategies or biological interventions that comprise "technology packages" under development by the SR-CRSP. To date, few studies have been completed on the prevalence of disease and causes of mortality in the community flocks near Huancayo and Quishuara, the two sites of study in the Central and Southern Sierra respectively. One completed investigation provides data that utashayli, a wild tobacco plant, is useful for treating external parasites of sheep. A World Bank-funded study has applied a questionnaire to managers of community and cooperative sheep and alpaca herds in the Department of Puno in southern Peru. This questionnaire is now being used to develop information on herd composition, management practices, and disease problems in community flocks near Huancayo.

VII. Significance of Findings

In the research accomplishments section above, the significance of the findings and their implications for future research have been considered to some extent. In this section, these aspects of each of the animal health projects will be summarized.

Chronic viral respiratory diseases of adult sheep cause major losses both in cooperative livestock enterprises and in smallholders sheep flocks; no effective methods for control of sheep pulmonary adenomatosis (SPA) or ovine progressive pneumonia (OPP) currently exist. Our success in transmitting the viruses of both diseases to newborn lambs will permit further efforts to identify viral antigens that can be used in serologic diagnosis of carrier sheep and perhaps eventually as the basis of a vaccine. Meanwhile, in Peru, we are attempting to demonstrate that the prevalence of both diseases can be controlled by serologic test and cull procedures (OPP) or by prompt removal of clinically ill sheep (SPA) in flocks established from lambs born of primiparous ewes. Both field and laboratory research will be continued in the future.

CAE has been shown to have a much higher prevalence in goats imported to Peru and their contacts than in indigenous criollo animals. There is a need to expand this data base, to ascertain the frequency of clinical disease, and to obtain Peruvian isolates of CAE virus. Government authorities must be informed of measures that can be taken to prevent further dissemination of CAE within Peru.

Research on the prevalence and significance of mycoplasma-associated diseases of sheep, alpaca, and goats has recently been undertaken as a SR-CRSP project because a group of experienced and enthusiastic investigators at IVITA wished to study this problem and because of lack of information regarding mycoplasma diseases in Peru. Now that the first mycoplasma isolation in Peru has been made, further efforts will be devoted to development and application of serologic test procedures and a search for clinically affected animals.

Some interaction with investigators of the WSU mycoplasma project is anticipated.

To date, our approach to the alpaca neonatal mortality problem has involved studies of bacteria associated with enteritis and the role of colostral immunoglobulin transfer. This has led to development of methods for detection of C. perfringens-associated toxins, a potential vaccine for enterotoxemia, and strategies for reduction of neonatal mortality by enhancing colostral antibody transfer. These procedures will be evaluated in the field in Peru and further research on other causes of alpaca mortality will be pursued. Three Peruvian veterinarians will be returning to Peru after obtaining PhD degrees in microbiology, pathology, and immunology. Plans have been made to incorporate their expertise into a team approach for solution of the alpaca neonatal mortality problem. This will constitute a major priority for fiscal support from the resources of our project.

Poor reproductive performance is an important problem in sheep and alpaca in Peru and our results on the seroprevalence of leptospirosis, brucellosis, toxoplasmosis, and chlamydiosis are useful starting points to develop control strategies for these diseases. Substantial progress has already been made in control of epididymitis through application of serology, semen examination, and REV-1 vaccine. In the near future, we plan to deemphasize research on epididymitis, but we will assist cooperatives in developing control programs and in training extension personnel. Some research on prevalence and economic importance of the other causes of infertility and abortion will be continued.

The investigation on the effects of sheep exposure to heavy metal contamination originating from a smelter have been completed. Although significantly high levels of most heavy metals were found in sheep nearer the smelter, no increase in the mortality rates of these sheep to other infections was apparent. One study is planned to directly assess whether there is an association between the occurrence of SPA and liver arsenic levels, as has been observed in human lung cancer patients with industrial exposure to arsenic.

PERU

Health - Colorado State University

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SR-CRSP

ANNUAL REPORT

1985-86

- I. **Project Title:** Improving Small Ruminant Nutrition, Management, and Production through Proper Management of Native Range and Improved Pastures
- II. **Host Country:** Peru
- III. **Principal Investigator:** Fred C. Bryant
- IV. **Personnel:** Host Country Co-Workers
- A. Florez, UNA - Central Sierra
 - R. Farfan, INITA - La Raya
 - J. Astorga, UNTA - Puno
 - J. Gamarra, UNA - Central Sierra
 - G. Atamari, UNTA - Puno
 - T. Huisa, IVITA - La Raya
 - R. Higaonna, INIPA -North Coast
 - J. Atto, U.N. Piura - North Coast
- U.S. Co-Workers:
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 - C. Britton, Dept. of Range & Wildlife
 - D. Wester, Dept. of Range & Wildlife
 - G. Matches, Dept. of Plant and Soil Sciences
 - B. Allen, Dept. of Plant and Soil Science
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V. **Introductory**

Texas Tech University has been the leader of the Range and Forages Component in Peru since 1979. Our goals have been to develop projects of applied research which ultimately will be of benefit to both the small holders of communities and the residents of the large social cooperatives. While the SR-CRSP has mandated that we help the "poorest of the poor", there is hardly any difference in the poverty level between the two groups. More important, our range management research goals have always been keyed to arrest or slow the deterioration of the grazing resource...native rangeland. The rationale is obvious--millions of small ruminants, including sheep, goats and camelids, rely solely on native plants for their subsistence. Further, improved forages are a small, but vital source of nutritious feed during stress periods. Thus, our research goal has been to understand how these forages can be integrated into a concept of a rangeland production system which strategically utilizes improved forages.

VI. Research Accomplishments

Peru. Research has been accomplished in two separate thrusts. First, high quality, intensive research projects have been conducted in Peru by Peruvian, U.S., and developing country graduate students while they were being trained at Texas Tech University. These research projects have included (1) establishing the relationship between soils and plant communities (Brad Wilcox, M.S.), (2) documenting acute impacts of excessive grazing pressure on rangeland vegetation (Brad Wilcox, M.S.), (3) learning of the native plants which are of significant dietary importance to alpacas (Ramiro Farfan, M.S.), (4) understanding the water-use efficiency of native range plants (Lucrecia Aquirre, M.S.), (5) uncovering the nutritional stress periods and nutrient flow to sheep (Carlos Fierro, Ph.D.) and alpaca (Rich Reiner, Ph.D.), (6) establishing stocking rates and animal equivalents through dry matter intake of sheep (Carlos Fierro, Ph.D.), alpaca (Rich Reiner, Ph.D.), and llamas (Felipe San Martin, Ph.D.), (7) documenting the effects of grazing strategies on wool production (Jim Carey, M.S.), and (8) understanding the competitive interrelationships among sheep, alpacas, and llamas (Carlos Fierro, Ph.D., Rich Reiner, Ph.D., Felipe San Martin, Ph.D.).

A second research thrust in Peru has been to establish long term research projects which were developed collaboratively between M.S. and Peruvian scientists, but were guided, directed, and administered solely by Peruvian scientists with technical assistance provided through short-term visits by Texas Tech University personnel. Additionally, many of the research projects became the theses of numerous Peruvian graduate students who received their degrees from Peruvian universities. In general, this research focused on grazing management, animal nutrition, proper use and management of improved, irrigated pastures, range ecology and range improvements.

Last, two separate, but significant, projects were developed through integration with other U.S. institutions. With Winrock economics, research results were published which give clear economic alternatives and constraints for sheep and alpaca production in the Andes of Peru (conducted by Mauricio Jaramillo). This publication entitled "Economic Analysis of Range and Forage Management Strategies for Increasing Small Ruminant Productivity in the Peruvian Andes" (1985) will prove to be one of the most significant publications yet produced in Latin America which attempts to define the economic constraints of small ruminant production. Through joint collaboration with the Texas A&M University systems component, sheep production alternatives were tested with their model to evaluate both the accuracy of the model and the efficiency of numerous alternatives.

Besides numerous articles and abstracts published in scientific journals, proceedings, and symposia and numerous research papers given at international scientific meetings, three publications of 1985 and 1986 are noteworthy.

A Spanish translation of 25 research papers from the Texas Tech Range and Forages program were published in Volume I (1985) and Volume II (1986) entitled "Investigacion sobre pastos y forrajes de Texas Tech University en el Peru." These have been distributed to scientists at International Research Centers, Universities, and research and extension centers all across Latin America.

Texas Tech University. On-going research in the U.S. by Peruvian graduate students will contribute to the understanding of the comparative digestive physiology of new world camels and sheep (Felipe San Martin, Ph.D.), root dynamics of leguminous plants for future research in the Andean environment (Custodio Bojorquez, M.S.), and plant secondary metabolites and goat nutrition in the North Desert (Francis Villena, M.S.). We have completed research which has contributed to a better understanding of the dynamics of livestock production and vegetation in response to short duration grazing (John Pitts, M.S. and Sergio Soltero, M.S., Ph.D.)

VII. Significance of Findings

Information on managing small ruminants dependent upon native rangeland and/or improved forages is applicable to all range production systems in South America above 3,800 m. A great majority of the research results also will be applicable to the Andean rangeland between 3,500 and 3,800 m. In particular, the following data we have will apply not only in Peru, but in the Andes of Bolivia, Ecuador, Columbia, Chile and Argentina:

- . proper stocking rates
- . interspecific competition, animal equivalents and mixed species grazing
- . rotational grazing; complementary grazing
- . strategic use of cultivated pastures
- . proper management of cultivated pastures
- . relationships between soils and plant communities
- . proper use of prescribed burning
- . timing and extent of supplementation
- . nutritional stress periods

Research accomplishments on the arid North Coast are also noteworthy, and have application in similar ecosystems along the arid Andean chain, in northeastern Brazil, and portions of Africa and the Middle East:

- . nutrition and management of tropical goats and hair sheep in pastoral societies
- . nutritional value and quantity of available browse species
- . delineation of range sites and determination of grazing capacity
- . effects of water deprivation on animal production and nutrition
- . establishment, survival, and management of Aleucaena leucocephala as supplemental animal fodder
- . assisting establishment and survival of Acacia albida as an alternative source of animal feed

VIII. Future Research Directions

Major research efforts beyond 1986 will be focused at the southern Sierra at La Raya and Chuquibambilla and a minor effort will continue on the North Coast. Specific research will include (1) the potential of altering grazing management and strategies to improve overgrazed rangeand; (2) the dietary interrelationships among sheep, alpaca, and llama; (3) prescribed burning as a management tool to improve native rangeland; (4) proper use and

management of cultivated, irrigated pastures for alpaca and sheep production; (5) water economy of goats and sheep and nutritional effects on animal production; (6) manipulation of coppice regrowth of trees for improved forage production; (7) introduction of drought resistant fodder trees and shrubs; (8) behavioral aspects of llama, alpaca, and sheep grazing; and (9) nutritional value of aquatic vegetation from Andean lakes and floodplains for sheep.

In the U.S., research will continue on the dynamics of short duration grazing through the guidance of Sergio Soltero, Ph.D. candidate.

IX. Funding

Subgrant amount:	\$239,850
Matching amount:	\$111,928
Host Country contribution:	\$100,000 (facilities, animals, and technical support staff)

PERU

Range Management/Forages - Texas Tech University

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SR-CRSP

ANNUAL REPORT

1985-86

- I. Project Title:** Improving Reproductive Performance of Small Ruminants
- II. Host Country:** Peru
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Gerardo S. Riera, Investigator
- IV. Personnel:** Cesar Novoa, IVITA-UNMSM, Co-Principal Investigator
H. William Vivanco, UNA-LA Molina, Co-Principal Investigator
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- V. Research:**
1. The Influence of Environment on Semen Characteristics of Criollo and Corriedale Sheep in the Peruvian Southern Altiplano.

This research was carried out at the La Raya Experiment Station, Cusco, Peru (4200 m elevation, 15' south latitude and 71' west longitude). The effects of age (1.5, 2.5, 3.5 years), month (12), and year (2, 1982-84) on semen and testicular characteristics was measured for the native Criollo and the Corriedale breed. Statistically significant differences occurred among or between one or more of the variables for body weight and each semen characteristic measured, as well as one or more interactions. Body weights were significantly affected ($P < 0.01$) by breed, age, year and month. Overall body weight was 45.1 kg for Corriedale (40.7, 45.6, 49.0 kg for 1.5, 2.5, 3.5 years of age, respectively) and 39.0 kg for Criollo (37.2, 39.6, 40.7 kg for 1.5, 2.5, 3.5 years of age, respectively). Testicle volume was directly associated with body weight and breed size, showing statistically ($P < 0.01$)

larger in Corriedale (445.9 ml) than the Criollo (413.5 ml). Mean overall semen ejaculate volume was higher ($P < 0.01$) in the Corriedale (0.90 ml) than the Criollo (0.74 ml). There was also a significant difference ($P < 0.01$) between years and months. Differences ($P < 0.05$) in sperm concentration occurred only for year and months with no apparent pattern (Corriedale lowest in August-October and Criollo in January-February). Mean concentration was 2.35×10^9 /ml for Corriedale and 2.28×10^9 /ml for Criollo ($P > 0.05$). Sperm motility differed only for months and tended to be lower for both breeds in October-November (33.6 percent for Corriedale and 48.61 percent for Criollo). The overall mean was 55.7 percent for the Corriedale and 56.3 percent for the Criollo. Testicle volume did not statistically differ ($P > 0.05$) between ages in Corriedale rams, but in Criollo 3.5 years old showed ($P < 0.05$) larger testicles compared to rams 1.5 and 2.5 years old.

Weight changes during the year were associated with feed availability (January through July), but the heaviest weights appeared to occur earlier in the Criollo than the Corriedale. Lowest ejaculate volumes were during June to October in the Criollo and September to October for the Corriedale. All rams (ages and breeds) served the artificial vagina during each month of the year.

In conclusion, the body weights were affected by breed, age, year, and month. The testicle volume was different among breeds. The overall ejaculate volume was higher in Corriedale rams compared to Criollo. The sperm concentration differed only among years and months. Sperm progression motility differed between months.

The results of this study also demonstrate that both breeds produce usable semen throughout the year.

2. Ram Effect Upon the Incidence of Ovulation in Junin Ewes

The effect of the presence of the ram upon the incidence of ovulation in Junin ewes was studied during May and September 1985, in the central Sierra of Peru. A total of 75 two-year old Junin ewes kept isolated from rams were divided into three groups of 25 ewes each and assigned to the following treatments:

- A. Control ewes (No ram + no progesterone)
- B. Ewes exposed to rams only (no progesterone)
- C. Ewes exposed to rams and to progesterone implants

On Day 1 (beginning of the study) ewes from Treatment C received subcutaneous implants containing 375 mg of progesterone, which were removed seven days later. On Day 7, the ovaries of all ewes were observed via laparoscopy for eventual ovulations. The next day (Day 8), ewes from Treatments B and C were exposed for seven days to vasectomized rams and then slaughtered for examination of the ovaries for the presence of corpora lutea.

The incidence of ovulation in ewes of all treatments during May ($\chi^2 1.103, 2df$) before exposure to males were statistically similar ($P > 0.05$).

The incidence of ovulation in ewes exposed to males in May were 5/25, 10/25 and 20/25 ($\chi^2 = 18.745$) and in September 0/23, 2/22 and 6/22 ($\chi^2 = 14.223$) for Treatments A, B and C, respectively ($P < 0.01$). The incidence of ovulations of ewes under Treatment A and B were statistically similar ($P > 0.05$) during both May and September. However, the incidence of ovulations of ewes under Treatment C (exposure to male + progesterone) was statistically higher ($P < 0.01$) compared to A and B during both May and September.

In conclusion, the incidence of ovulation was not significantly affected by the presence of ram alone during both May and September, whereas progesterone plus exposure to rams had a significant effect upon ovulations.

3. Hormone Therapy to Induce Estrus and Ovulation in Sheep During the Anestrous Season

The main goal of using hormone is to induce and synchronize estrus and ovulation in ewes, to shorten the lambing interval and increase the lambing rate. Because sheep are seasonal, additional lambing per year can be realized only if matings occur during the anestrous season or when the incidence of estrus and ovulation are the lowest.

Sheep fertility, prolificacy and fecundity in the Peruvian altiplano are low. Many factors seem to be involved. However, no single factor has been shown to be responsible for this reproductive wastage.

The purpose of this study was to establish the effectiveness of hormonal induction and synchronization of estrus and ovulation and resulting fertility of Junin and Criollo sheep. This study was conducted at the Central Sierra of Peru (12° South latitude and 76° West longitude, 3.800 m elevation).

All ewes were managed together on native pasture. The progestogens, silicone rubber implants containing 375 mg (10 percent) progesterone or vaginal sponges containing 40 mg fluorgestone acetate, were applied on November 17, 1983 (Day 0) and remained in the animals for 14 days. The PMSG, 400 or 700 IU, was administered via intramuscular injections, 24 hours prior to progesterone withdrawal (Day 13).

Fertile males were introduced into the female flock on Day 9 and remained there until five days after hormone withdrawal (Day 19). Males were fitted with crayon containing marking harnesses to identify the occurrence and time of breeding. All ewes were laparoscoped during the subsequent estrous cycle to observe the incidence and rate of ovulations. Relevant statistical comparisons were made based on data obtained on occurrence of estrus, ovulation and ovulation rate, lambing rate, and fertilization failure in relation to breed and hormone treatments.

The incidence of estrus was significantly higher in Criollo than in Junin (85.7 versus 57.1 percent; $P < 0.05$). Fertilization failure and/or embryo/fetal loss in ewes receiving FGA in intravaginal sponges was higher than those receiving progesterone in implants (78.7 versus 56.8 percent; $P < 0.01$). All other responses to main effects were nonsignificant ($P > 0.05$). However, an interaction existed between breed and level of PMSG for ovulation rate, with the Criollo being higher than the Junin.

In conclusion, progesterone and PMSG are effective in the induction of estrus and ovulation in the indigenous breed of sheep in the highland of Peru. The low level of fertility is due primarily to fertilization failure and/or embryo fetal losses. The progesterone implants showed greater efficiency than FGA intravaginal sponges. The 700 IU of PMSG did not show an advantage to 400 IU. The response to PMSG may be related to body weight.

Many factors could be acting on the level of fertility of sheep in Central Sierra. Further studies are necessary to indicate the specific factors affecting the reproductive performance under the conditions of high altitude with the existing management conditions.

4. Hormonal Control of the Estrous Cycle in Sheep in the Southern Altiplano of Peru

Approximately 56.1 percent of the 15.3 million national sheep population is located in the southern altiplano of Peru. The majority of these sheep are the Criollo type and belong to the small producers in the communities.

The fertility level in the sheep industry in Peru is low and is influenced by a reduced proportion of ewes showing estrus, low ovulation rate and high fertilization failure and/or embryo-fetal loss.

Although the breeding season tends to coincide with the shorter day lengths (February to August), ewes and rams run together throughout the year, and some lambing does occur at other periods of the year.

Information on the use of hormones to induce estrus and ovulation in sheep in the highlands of Peru is not available. This study is an attempt to measure the effectiveness of progesterone and PMSG on the control of the estrous cycle and fertility of sheep during two periods of the year.

This study was conducted at the La Raya Experiment Station of IVITA, Cusco, Peru (15° south latitude, 71° west longitude, 4,200 m. elevation). A total of 183 ewes were assigned to four age groups, two hormone treatments and to two breeding periods. All animals were grazed on native pasture during the total experimental period (June, 1984, to July, 1985). A group of 88 ewes (46 Corriedale and 42 Criollo) were bred in June, and 95 ewes (46 Corriedale and 42 Criollo) were bred in November. In each breeding period, approximately half of the ewes served as control ewes and the other half were synchronized using intravaginal sponges containing 40 mg of FGA (14 days) and 500 IU of PMSG IM at the time of sponge removal. Ten percent fertile painted rams were introduced into the flock of ewes at the time of progestogen withdrawal, and the incidence of estrus was recorded. During the breeding periods, Corriedale and Criollo rams were bred to Corriedale and Criollo ewes, respectively. Laparoscopies were performed in all ewes during the post-breeding estrous cycle to obtain the incidence (ewes ovulating). Fertility (ewes lambing/ewes exposed), prolificacy (lambs born/ewes lambing) and fertilization failure and/or embryo-ova loss (ova shed - lambs born/ova shed) were also determined.

The incidence of estrus, fertility and the fertilization failure and/or embryo-fetal loss did not differ statistically ($P > 0.05$) among age groups, breeds, hormone treatment or breeding periods. Yearling ewes had a statistically lower ($P < 0.05$) incidence of ovulations (75.6 percent) than

older ewes (90.6, 92.7 and 92.3 percent, respectively, for 2.5, 3.5 and 4.5 years of age). Nevertheless, yearling ewes tended to show higher ovulation and lambing rates than the older ewes ($P < 0.05$) when expressed as an overall average, which is in contrast to information generally reported that the older ewes have higher ovulation or lambing rates than the ewe lambs.

No statistical differences ($P > 0.05$) between the Corriedale versus Criollo) and breeding periods (June versus November) on all observed reproductive traits except for fertilization failure and/or embryo-fetal loss.

The fertility rate did not differ ($P > 0.05$) between the Corriedale (67.4 percent) and Criollo (75.8 percent). These levels differ from 40 to 55 percent for Junin and Criollo sheep during the anestrus season (October - November) and 65 and 84 percent for the same breeds during breeding season (March - April) obtained at Central Sierra of Peru. Variable responses to hormone treatment in sheep have been reported and relate mainly to the level of PMSG administered in a particular season of the year. Treatment with 500 IU PMSG significantly increased ($P < 0.05$) the ovulation rate (1.68 versus 1.03) and lambing rate (1.37 versus 1.02) over the controls.

There was no difference ($P < 0.01$) in fertility of control and synchronized ewes, which indicates that the ewes were still cycling naturally during both breeding seasons. Ewes receiving hormones had a significantly higher ($P < 0.05$) proportion of fertilization failure and/or prenatal mortality (34.8 percent) than control ewes (17.7 percent). It is known that ewes with a high ovulation rate lose a higher proportion of ova compared to ewes with a low ovulation rate. The two breeds did not differ ($P > 0.05$) in fertilization failure and/or embryo-fetal loss (30.3 percent, Corriedale versus 27 percent, Criollo). In this study, twice as much ova loss occurred in hormone treated ewes compared to a low ova loss in control ewes.

The reproductive performance of ewes during June and November were similar ($P > 0.05$). However, the ovulation rate (1.55) and lambing rate (1.26) tended to be higher in relation to the June breeding period compared to the November period (1.20 and 1.14, respectively). The fertilization failure and embryo-fetal loss in ewes bred in both breeding periods were similar (34.9 and 34.5 percent; $P > 0.05$).

The results of this study demonstrate that a moderate level of PMSG can be effective in increasing ovulation and lambing rates in breeds of sheep in the highlands of Peru where these traits are normally very low. Loss due to fertilization failure and/or embryonic mortality is doubled in hormone treated ewes.

5. Postpartum Interval (PPI) in Sheep Lambing During the Breeding and Anestrus Seasons in the High Central Sierra of Peru

The potential reproductive efficiency in sheep is reduced by a long postpartum interval (PPI). The PPI can be affected by both the anestrus season and the postpartum anestrus due to physiological, endocrinological and anatomical modifications during pregnancy, parturition and lactation. The influence of gestation, parturition, lactation and suckling and their interactions are not properly understood. During the PPI, ovarian inactivity was observed.

The purpose of this study was to determine the length between parturition and the first postpartum estrus in the Criollo and Junin breeds of ewes lambing during breeding and anestrus seasons.

This study was undertaken at the SAIS Tupac Amaru, CONSAC, Central Sierra of Peru (12° South latitude and 76° West longitude, 3,800 m. elevation). One group of 180 ewes were equally assigned by age (1.5, 2.5 and 3.5 years old at breeding) and breed (Criollo and Junin). They were bred to fertile males during the 65 days of regular (Fall) breeding season (beginning May 3) to lamb during the season when some ewes are in seasonal anestrus (October - November, 1983). The second group of ewes (22 Criollo and 22 Junin), approximately 2.5 years of age at breeding, were bred to fertile males during November, 1983 (Spring) to lambs during the regular breeding season (April - May, 1984; Fall). Estrus and ovulation were induced using intravaginal sponges containing 40 mg FGA for 14 days and 500 IU of PMSG I.M. administered 36 hours prior to progesterone withdrawal. All animals were managed and grazed on native pasture. Following the first parturition, the ewes were exposed to vasectomized teaser rams fitted with marking harnesses until all ewes had shown their first postpartum estrus. Dates of first PP estrus were recorded to calculate the PPI based on the date of parturition. Live body weights of ewes at lambing and the birth weight of lambs were recorded. Least square analysis of variance with information on PPI and weights were performed.

There were no statistical differences ($P > 0.05$) between ages within breed for live body weight at parturition, lamb birth weight or the length of the PPI during Spring lambing. Lambs born from Criollo ewes 1.5 years old produced significantly ($P < 0.05$) lighter lambs than ewes 2.5 and 3.5 years old. Junin ewes had significantly ($P < 0.01$) heavier live body weights at parturition than Criollo ewes. Younger ewes (1.5 years old) had significantly ($P < 0.05$) longer PPI (161 days) than ewes 2.5 and 3.5 years old (126.8 and 150.7 days, respectively).

To compare the performance of ewes lambing during Spring with those that lambing during Fall, all information of Spring lambing ewes was pooled by breed over all ages. Statistically significant differences ($P < 0.01$) occurred between Criollo and Junin sheep for live body weight and parturition, lamb birth weight and length of PPI. The Criollo ewes had lighter live body weights at parturition as well as the weights of lambs at birth. Fall lambing ewes had a shorter PPI than Spring lambing ewes for each breed, and when the two breeds were combined (Criollo 85.5 versus 148.5 days; Junin 93.5 versus 161.9 days and combined breeds 89.9 versus 156.9 days). In average, the Criollo breed have shown shorter PPI to the first ovulation 18.6 days and higher progesterone levels (1.8 ng/ml) assessed by plasma progesterone levels compared to Junin sheep (30.5 days and 1.4 ng/ml). The interval from parturition to the first postpartum ovulation during Fall season tended to be shorter (24.3 days) than during Spring season (26.4 days). The first progesterone peak observed during Spring (1.9 ng/ml) tended to be greater during during Fall (1.3 ng/ml). No significant difference was found among seasons for live body weight at parturition (34.3 versus 33.6 kg.). The mean birth weight was statistically ($P < 0.01$) higher for lambs born in the Fall (2.7 kg.).

In conclusion, the live body weights at parturition and the birth weights of Criollo sheep are lower than Junin sheep under the same management and grazing conditions. The Criollo breed showed shorter PPI at both Spring and Fall lambing. This provides Criollo sheep with a higher potential for intensive breeding programs. The postpartum interval was longer in the Spring than in the Fall for both breeds.

It is possible that the level of nutrition and the high elevation at Central Sierra of Peru could affect the length of PPI. Although there is no information available on the influence of high elevation, this might also be considered a factor.

6. Reproductive Performance of Ewes Bred During a Restricted Breeding Season at Different Periods of the Year.

Previous studies have shown that a high proportion of the ewes at the Peruvian Altiplano ovulate from January to September (approximately nine months) with reduced incidence of ovulation during the remaining months of the year. Some ovulations were not associated with estrus.

The objective of this study was to determine the best restricted breeding season within the extended ovarian activity to improve sheep productivity through better reproductive management.

This study was conducted at the Central Sierra (CONSAC) with 30 Junin and 30 Criollo ewes for two consecutive years. Three restricted breeding periods were used: First = 3/25 - 5/03; second = 5/03 - 6/15; and third = 6/16 - 7/31. Live body weights before and after the breeding period, body weights at lambing of ewes and at birth of lambs, date of matings, fertility, prolificacy, abortion rate and lamb mortality were recorded.

Partial and preliminary results show that no differences seem to exist between breeds and years in almost all reproductive traits observed. The incidence of estrus (ewes bred), the percentage of ewes lambing and/or total fertility seem to be similar among the first and second breeding periods. However, ewes breeding during the third period have shown less reproductive efficiency. The Criollo breed showed better performance than the Junin during the third breeding period, indicating that Junin sheep have the shorter breeding season and Criollo the longer. The lambing rate of all breeds, periods and years were similar (1.0).

The live body weights increase from the first to third breeding periods. This performance is due to better food availability as a response to the residual effect of the last period of rainy season on the forage production.

The live body weight increase from the first to third breeding periods. This difference might be due to the maturing (growth) process of sheep. The lamb birth weight tends to increase from the first to third breeding period.

The first two breeding periods seem to have more advantages over the third, which is probably the transition from the breeding season to anestrus season.

7. Incidence and Rate of Ovulation in Crossbred Ewes

It has been reported that the incidence and rate of ovulation in sheep at Central Sierra of Peru are low. Many factors might be involved in this decreased reproductive performance.

The SR-CRSP Utah Reproduction and Montana Breeding Projects were collaboratively measuring the potential benefit of crossbreeding exotic and more prolific (Targhee, T. and Targhee x Finn T.F.) rams with Junin (J) ewes. The female progeny were observed through laparoscopies during three consecutive years for ovulation performance.

A total of 289 laparoscopies were performed to obtain data on the ovarian activity of four crossbred genotypes. Data showed a similar ($P > 0.05$) incidence of ovulation of 82.5 and 87 percent between T.F x J and T.F.J x J ewes. Equal ($P > 0.05$) incidence of ovulation was also found among T x J and J x J ewes (59.3 and 66.7 percent, respectively) However, both crossbred ewes influenced by FINN sheep (T.F x J and T.F.J x J) have shown significantly ($P < 0.05$) higher incidence of ovulation compared to T x J and J x J ewes.

The ovulation rate of T. F x J, J x J, T.F.J x J and T x J was 1.15, 1.09, 1.00 and 1.00, respectively.

These results show that potential ovulating performance of indigenous ewes can be increased by introducing prolific genotypes. However, a better nutrition management should be provided in order that the crossbred ewes can express their genetic potential. Additional data on lambing rate will be provided when the field information becomes available.

8. Reproduction and Production Performance of Privately-Owned Small Flocks of Sheep Under Traditional System in the Central Sierra of Peru.

Since April, 1982, three privately-owned flocks of sheep have been used in collaboration with small producers of The Canchayllo Community (Central Sierra, Peru) to study reproduction and production performance. A fourth flock was added during 1983-84 and during 1982-83 one flock was not observed, because all sheep were lost.

From the beginning to the full second year, 901 breeding ewes were observed and records kept to estimate the production base line (flock composition, fertility, frequency of lambing and mortality) under the traditional sheep management system.

During the third year (May, 1984 to April, 1985), an additional 582 observations from breeding ewes of the same flock were recorded to estimate fertility, prolificacy, mortality and live body weights for each individual private sheep flock. In Flock 1 (Juan Perez), two management practices were introduced (control of internal parasites and a restricted breeding season [May to June]). Flock 2 (Timoteo Rojas) served as a control flock. This flock was kept under the traditional management system. Flock 3 (Eugenio Rivera) received systematic internal-parasites control throughout the year. All animals of these three flocks were grazed on the same native pasture used during the previous two years.

Ewes from Flocks 2 and 3 were continuously exposed to the males. They could breed and lamb at any time, as is usually observed under the traditional system in the community flocks.

During the first two years of the study, the overall fertility was 60.3 percent. The fertility varied between flocks from 38.2 to 74.9 percent, indicating that difference exists in management practices among producers. The lambing rate (prolificacy) in all age groups and all flocks was low (1.0). The mean birth weight of lambs varied from 2.9 to 3.5 kg with an overall mean of 3.2 kg. Older ewes produced heavier lambs, compared to yearlings. The mean live body weight of ewes at parturition increased from 25.3 to 34 kg in direct relationship with the age of ewes. The overall mean weight at parturition was 32.0 kg.

The flock composition in relation to categories seems to be adequate. However, a higher proportion of ewes older than four years indicates that culling unproductive and older ewes should be imposed to increase the production performance.

The higher proportion of lambings occur during the period of April to July. This indicates that the majority of matings in most of the ewes occur soon after the initiation of the rainy season or when the forage availability increases. During the remaining period of the year, additional lambings were recorded in response to the reproductive activity at a lower rate throughout the year.

Higher incidence of mortality (lambs and adults) was observed during May to September (95.7 percent of all losses), characterized by dry-cool season and shortage of available forage. This depresses the body condition of ewes, lowering lactation and enhancing lamb losses. The overall mortality was 10.1 percent. Taking into account this figure, the level of mortality seems to be a relative factor which can be improved using proper management practices. The low fertility rate seems to be the most striking factor and the causes and solution should be investigated to gain reproductive efficiency. Many factors might be involved in this lowered reproductive performance such as lack of improved general management, proper breeding season, nutrition, selection, and culling unproductive animals, health control, and the number of ewe lambs considered as breeding ewes, during this study.

Ewes belonging to Flock 1 (parasites control + breeding season) and Flock 3 (parasites control only) have shown higher fertility rate (57.6 and 54.6 percent, respectively) compared to 21.1 percent in Flock 2 (control). Flock 1 has shown an additional 3.0 percent fertility of ewes exposed to a restricted breeding season. It appears that internal parasites control increases the reproductive performance compared to traditional sheep management systems in Flock 2 (control).

In all flocks and age groups, the prolificacy was again low (1.0).

The lambs born from ewes in Flocks 1 and 3 tended to have heavier birth weights compared to lambs from the control flock. The same trend was observed in ewe live body weight at parturition. The lamb birth weights and ewe body weights at parturition increases concomitantly with the increase in age of ewes.

Approximately 69.4 percent of lambing in Flock 1 has been recorded during October - November, with an additional 30.6 percent during July to September. This last figure corresponds to lambings as a result of matings previous to the breeding season. In Flocks 2 and 3, the peak of lambings was recorded from May to September, indicating that almost all matings occur during the rainy season (November - March).

The overall mortality rate (lamb and adults) was low, 7.6 percent based on all breeding ewes observed. For each individual flock, the mortality was 8.3, 5.6 and 8.7 percent for Flocks 1, 2 and 3, respectively. The off-take rate for the same flocks was 28.6, 22.2 and 35.1 percent, respectively. Considering year one as the initial breeding-ewes population (100 percent), the second and third year breeding-ewes population was 210.2 and 200.7 percent, respectively. This may also explain the low fertility and low body weights observed during the third year in response to an inadequate balance (stocking rate) between numbers of sheep and pasture area. Generally, the sheep losses were low and the reproductive efficiency seems to need to be substantially improved. During the third year of study, the deaths occurred throughout the year and no tendency to concentrate into a certain period was observed. The same trend was also obtained for sheep marketing.

The results reported up to the third year are preliminary. This project is in progress and further data obtained and analyzed will provide more detailed information from which to draw definitive conclusions. However, presently these conclusions may be drawn:

- a. High reproduction and production potential exist in the producer sheep flocks.
- b. The sheep mortality is low, the low fertility may account for most of the reproductive inefficiency.
- c. Reproduction and production levels can be improved by applying low-cost management practices, such as internal parasite control, restricted breeding season, selection and culling unproductive animals.

9. Growth Rate and Reproductive Characteristics from Birth to 13 Months of Age in Male Huacaya-Type Alpacas

The productivity of alpacas is limited by low fertility rates. Male-related infertility may account for much of this inefficiency. Few studies have been conducted to describe the anatomy, growth and function of the genital tract of male alpacas.

The age at puberty in alpacas is not well documented. However, it was observed that alpacas one year of age show sexual interest and may breed females in heat. No fertility estimates were recorded of these matings, and it seems to be low due to a high proportion of young males with the penis still attached to the prepuce. It was reported that penis detachment is slow in alpacas, such as 8, 70 and 100 percent at one, two and three years of age, respectively. The semen collection technique in alpacas is not well-developed. Therefore, it was not possible to correlate libido and penis detachment with semen characteristics at the age of first ejaculate containing sperm cells.

The objective of this study was to describe the process of body and testicle growth and the age at penis detachment from the prepuce of alpacas from birth to 13 months of age.

This study was conducted at SAIS Pachacutec in Corpacancha, Ayacucho, Peru (11° south latitude and 76° west longitude; 856 mm rainfall and 4,100 m. elevation) with 10 Huacaya alpacas grazed and managed on native pasture. Monthly, live body weight (kg), testicle size index as a product of length x width x depth of the testicle in cm including the scrotum, and the degree of penis detachment from the prepuce were recorded from February, 1983 through February, 1984. At the time of penis detachment, age and length of the penis were also recorded. Libido was evaluated using seven female alpaca in estrus, three the same age as the males and four that were older. The sexual interest (libido) of the males was assessed during two hours/week. Monthly semen collection was attempted using Plectron electro-ejaculator build for sheep (0-25 volts output) beginning at four months of age, to estimate the weight and age at the first ejaculate containing sperm cells.

The mean live body weight gain from birth to 13 months of age in alpaca was 102 g/day. The birth weight (8.2 kg) of the animals used in this study represents 18.8 percent of the live body weight at one year of age (43.7 kg) and 13.1 percent of adult body weight (62.5 kg) for alpaca males in La Raya Experiment Station of IVITA, Cusco, Peru. The body growth in alpaca fits the linear regression up to 13 months of age ($y = 13.5 + 2.64x$). The live body weight from birth to one year increased 5.3 fold and represents 70 percent of adult weight.

At birth, the testicles are small and located in the scrotum. However, it was difficult to accurately measure dimensions due to the non-pendulant position and the flaccidity of the testicles. However, measurements were possible and therefore obtained beginning at five months of age. The correlation coefficient ($r = 0.99$) between body weight and testicle size was statistically significant ($P < 0.01$). Testicular size may indicate the amount of parenchyma for sperm production, and the males can be selected for breeding soundness based on the criteria of body weight.

The degree of penis detachment from the prepuce in alpacas is slow and begins at six months of age from tip to base. However, it was observed that the rate of this process was high between 12 and 13 months of age thus rendering complete erection possible. The penis was free in 40% of the animals at 13 months of age. These findings do not agree with 8, 70, and 100 percent of males having the penis freed from prepucial adhesion at one, two, and three years of age, respectively. Statistical significance ($P < 0.01$) was found for the correlation coefficient ($r = 0.93$) between the degree of penis detachment and live body weight and ($r = 0.93$) between penis detachment and testicle size index.

All animals showed widely varying degrees of libido, ranging from total lack of sexual interest to true libido which was demonstrated at an average of 10.3 months of age. Based on these observations, sexual behavior was divided into three stages. The mating behavior at stage A (5.9 months of age) was characterized by olfaction of females with no clear attempt to breed. Behavior of males at 8.5 months of age (stage B) consisted of olfaction, chasing, courting, and forcing the female to assume a mating position without

copulation. Males at 10.3 months of age approached stage C, characterized by the same mating behavior of males in stage B, however, they were more aggressive and copulated normally, including the characteristic blowing-guttural sound. Mating-like behavior was noticed in some animals soon after birth. These animals demonstrated stage C sexual behavior at a younger age than animals not showing this behavior. The mating performance of male alpacas is sequential. It seems to follow a learning process. The bodyweight could be used as a predictive criteria to determine the capability of the males for mating.

A total of 80 percent of males reached stage C at 10.3 months of age, which coincides with previous reports. None of the males released semen through electrical stimulation.

Fertility of Female Alpacas Based on the Size of Testicles of the Breeding Males

The reproductive efficiency in alpaca is low. This low performance may be due in part to lowered reproductive efficiency in the male due to several forms of abnormal testicles (unilateral and bilateral hypoplasia, cryptorchidism and other forms of ectopic testes) as well as abnormal epididymis.

This study was conducted at the La Raya Experiment Station of IVITA to determine the level of fertility in female alpacas sired by males with different size of testis.

Eighty parous adult alpacas were randomly assigned to two groups (40 alpacas each). One group of alpacas were bred by four males with small testis (3.0 x 1.9 cm) and the other group by four males with large (normal) testicles (4.8 x 3.2 cm) for a 42 day breeding period (May 6 to June 16, 1981). The fertility rate at parturition was the only criteria used to estimate the effect of testis size.

The over all fertility was low (38.8%), probably due to the short mating period and also due to the matings that occurred during the non regular breeding season. Even through alpacas bred to males with large testicles showed higher fertility rate (47.5%), the difference (17.5%) was not statistically significant ($P > 0.01$) compared to alpacas bred by males with small testicles (30%).

In conclusion, the fertility tended to be higher when the alpacas were bred to males with large testicles. However, the study should be repeated with more number of females during the proper breeding season and the proper length of breeding period.

PERU

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SR-CRSP
ANNUAL REPORT
1985-86

- I. Project Title:** Sociological Analysis of Small Ruminant Production Systems
- II. Host Country:** Peru
- III. Principal Investigator:** Michael F. Nolan
- IV. Personnel:**
- Host Country Co-Workers:
C. Espinoza, INIPA
J. Flores, Univ. of Cusco
J. Portugal, DCCN
L. Jimenez
- U.S. Co-Workers:
M. Fernandez, UMC Research Associate
K. Jamtgaard, UMC Research Associate
C. McCorkle, UMC Research Assistant Professor

V. Introductory

Just as the SR-CRSP experience in Peru represents an occasion for biological scientists to improve their understanding of the constraints of a high altitude environment upon the production characteristics of small ruminants, for social scientists the SR-CRSP has provided a unique opportunity to research the importance of animal production for one of the major forms of rural social organization in the Andes, the peasant community.

About half of Peru's rural population are members of the more than 3,000 officially recognized peasant communities, located primarily in the Sierra of central and southern Peru. Whereas previous research on Andean peasant communities tended to focus on their impressive agricultural and cultural diversity, it was clear from the beginning that the Rural Sociology project of the SR-CRSP should focus on supporting research on the significance of sheep and alpaca, in particular, for the economy of peasant communities. This commitment has become more explicit with the CRSP's work in the community projects in the central and southern sierra. Nearly all of Rural Sociology's research efforts over the past year and a half have been built around the community projects as the primary sites for research in Peru. Also issues have been selected to meet the needs of the community projects as well.

VI. Project Goals

To goals of the Rural Sociology project in Peru are as follows:

1. To continue to build and expand upon the series of community case studies that Rural Sociology has been conducting since 1980.

2. To actively support the Community Projects that are underway in the Central and Southern Sierra.
3. To elaborate upon research begun in 1980 concerning ethnoveterinary concepts and practices employed by peasant community producers.
4. To support efforts towards establishing a permanent location for rural sociological research within the Peruvian agricultural research environment.

VII. Research Accomplishments

A number of important accomplishments were achieved during the past year. Work was completed on several theses research projects which were conducted in two of the community project sites. An important step was completed in documenting the kind of methodology that has been employed in working with the community projects since their inception in 1983. Finally, writing was completed on a study of a peasant community which formed part of the Northern Peru Goat Project.

Described as "Participatory Action Research," the central notion behind intervention in peasant community production systems concerns peasant farmers as the key actors in both the definition of the problems to be included in agricultural research. Farmers also participate in the studies which may suggest alternative solutions to the problems posed. This method contrasts with more traditional research efforts, which often rely heavily upon capital-intensive, sophisticated technologies, and external expertise as a primary vehicle to achieve greater productivity. The Participatory Action Research model strives rather to directly address some of the organizational problems often associated with peasants, by increasing self-confidence, organizational capabilities, and awareness of a collective ability to overcome problems.

For instance, in the case of the central sierra site, a committee of five community-member collaborators was formed to act as the principal counterparts for the community project. Ms. Fernandez and the team of community project workers were advised by this committee that one of the main diseases affecting local sheep was external parasites. The community members were aware of commercially available veterinary products, and had tried these with some success, but they were too expensive for all but a small number of farmers. The community recalled that traditional cures were practiced by their grandparents, but had largely fallen into disuse. The SR-CRSP team therefore sought to document the procedures followed for one of the traditional treatments. With the help of community members, an experiment was designed. Results indicated that the traditional treatment was surprisingly effective. Thus another low-cost and locally available alternative for combatting ectoparasites became available.

Most of the Rural Sociology research projects completed during this period were master's theses based upon fieldwork in one of the community projects. One of these was conducted by Ms. Lidia Jimenez, a Peruvian. She spent four months studying alpaca producers in a highland community, Quishuara, located in the Department of Puno. One of her findings was the importance of the sexual division of labor. Even in a predominantly livestock-producing community, the role of women was critical for the day to

day management of the herds, while men tended to focus on the limited agricultural tasks that were possible at high altitudes (over 4000 meters), and on marketing. She also found that the organization of labor bore some resemblances to that of agro-pastoral communities studied earlier by other CRSP researchers. Reciprocal pasturing strategies were most frequently employed, but these were more apt to be used among relatives than friends, due to the delayed reciprocity. Another organizational device less often used in Quishuara was al partir. In this arrangement, one person provides animals and another provides the labor to care for them. Literally meaning "to divide," the offspring from the herd are usually divided between the two parties.

Paula Bilinsky also studied labor and other non-monetary exchanges in the agro-pastoral community of Aramachay in the central Sierra. The complex array of means available for exchanging services and products in the agropastoral peasant economy became increasingly evident. In differentiating between acquisition of labor for pastoral as vs. agricultural tasks, it was found that family members were used more often in herding than in cropping labors. This was due in part to the character of pastoral labor, which requires relatively small amounts of labor over extended periods. In contrast, peak agricultural periods such as harvesting and planting can efficiently utilize teams of workers for short periods. Still, a number of labor-sharing arrangements were used with some frequency, including reciprocal, as well as al partir, exchanges.

A major concern for the Rural Sociology project in Peru has been the lack of strong counterpart relationships during initial work in Peru. It was felt that, if sociological research were to become an integral part of the Peruvian agricultural research establishment, "institutionalization" should be an objective of the highest priority. Institutionalization in this case was interpreted as supporting the creation of a social science unit within the agricultural research agency (INIPA), and developing research relationships with the sociologists working in this unit. A number of important steps in this direction have been taken by INIPA--creating a socio-economic unit within INIPA and hiring a staff sociologist, Ms. Cristina Espinoza.

Another accomplishment was Espinoza's completion of a study of a northcoast goat producing community, Salas, located in the department of Lambayeque. This study began as one component of a larger project headed by Perevolotsky during 1982-1984; but it was of sufficient value to be considered as research report for its own merits. Salas makes for an interesting addition to the sample of case studies of peasant communities due to: (1) its location in a fundamentally different ecology, that of the dry coastal climate of Northern Peru; and (2) the area's extensive commercial development in the agricultural sector, particularly for sugar and rice. Yet a relatively stable peasant subsistence agriculture has survived in Salas, based in part upon irrigated cultivation and goat raising.

As in the cases of Aramachay and Quishuara, Salas has also undergone a process of enclosure, or "privatization" of communal land. In consequence, a large proportion of the community's lands are no longer subject to communal control, but rather are privately managed. Likewise, a sexual division of labor was also reported for coastal goat production. Although less markedly than in the sierra, women clearly had greater obligations in livestock management, while men assumed more control over agricultural and marketing

tasks though they also held certain obligations pertaining to livestock. The principal advantage behind raising goats in this context is precisely the fact that they require little management and a minimum of investment. It is their ability to survive under harsh climatic conditions as a low-cost and income-generating addition to the peasant household's broad range of productive activities, which makes them a desirable complement to the peasant economy. Also among the organizational tools of these producers are al partir arrangements. Here, the sharing tends to occur between those specializing in agriculture on the one hand, and in herding on the other.

Of critical importance in Peru is that agro-pastoral communities' livestock production. Jamtgaard developed a typology of peasant community production systems, based on data gathered as part of a 1977 study conducted by Peru's Direccion de Comunidades Campesinas y Nativas. He compared the contribution of agro-pastoral communities to small ruminant populations with that of more purely pastoral communities. In terms of animal numbers, the agro-pastoral communities actually held slightly more sheep -- with 45% of all sheep found in communities at the time of the study, compared with 44% for the pastoral communities. The remainder were found in either agricultural or lowland communities. Looking at alpaca holdings, however, the livestock-producing communities were clearly the more important -- with 72% of the animals, compared to 27% for the agro-pastoral producers. Beyond their importance as livestock producers, though, the agro-pastoral communities also accounted for half the acreage in potatoes and over two-thirds of the barley planted in peasant communities (more purely agricultural communities accounted for much of the remainder).

VIII. Significance of Findings

An important observation is that labor exchanges are surprisingly similar across such diverse settings as agro-pastoral communities of the central sierra and pastoral communities in southern Peru. This information should help focus extension efforts aimed at disseminating improved livestock management practices. For example, the fairly widespread occurrence and acceptance of practices such as al partir, may be suggestive of strategies that government could employ to distribute animals with improved traits, should that be a goal.

Likewise for the finding that women and children are usually responsible for livestock management. The repeated evidence of women's importance in herding tasks points to the necessity of making them the focus of, or at least participants in, any management improvement endeavors. The work of Fernandez and the community project counsels that it is possible to include women in consultation groups, although more work needs to be done on this topic.

Even more fundamentally, Espinoza's work in Salas (as well as Primov's work in Brazil) points out that the some of the features of small ruminant production with appeal to peasants conflict with increasing productivity from the animals. That is, the requirements for more management time, expertise, and capital that often accompany improved production may not be viewed with enthusiasm by peasants who value the animals precisely because of their ability to store and create value with a minimum of attention.

It is also now clear that livestock development must give equal attention to agro-pastoral communities as well as more purely livestock producers -- particularly where sheep are the focus of development. The experience of the Central Sierra community project suggests that although agro-pastoralists themselves often consider their cropping more important than their herding, it is possible to address livestock management issues over time in these locations as well.

XI. Future Directions

During the past year, preparations were undertaken to engage in interdisciplinary research on how local animal-management practices impact upon the incidence and control of small ruminant diseases. Participants would include the animal health and rural sociology projects in the U.S. and Peru. This will be an important baseline study of veterinary-related husbandry systems and of the intracommunity socioeconomic variation associated with practitioners of different systems. Findings should guide future recommendations for improving animal health practices at low or no cost and in economically, ecologically, and socioculturally appropriate ways among peasant communities. During August-September 1985, field visits were made by U.S. co-researchers from UMC and CSU to peasant communities in central and southern Peru. The community of Quishuara, Province of Melgar, Department of Puno was selected as the pilot research site. Upon return to the US, trial questionnaires were designed, and then revised in joint meetings at Colorado State University in December 1985. The questionnaires were then translated into Spanish. They were then refined and pretested on a return trip to Quishuara in January-February 1986. A 12-month period of data collection was slated to begin in May-June 1986, pending completion of all personnel and logistic arrangements. Data will be coded and compiled as they are collected, on a bimonthly basis. The data are of four types: baseline household socioeconomic information drawn from the on-going Community study, in-depth monthly questionnaire data on management practices and ethnoveterinary techniques, monthly mortality/morbidity figures, and quarterly biological samples. The study will focus primarily upon parasitic diseases, as this was the community's own assessment of their major herd health problem. Household socioeconomic and husbandry data will be correlated with differential levels of herd disease, as indicated in veterinary diagnostic data.

X. Funding

Subgrant	\$250,000	
Peru		\$73,912
Matching	83,400	
Host Country Contribution (Estimate)		
Peru		15,000

PERU

Sociology - University of Missouri

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