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**AN EVALUATION OF THE
UTAH STATE UNIVERSITY/USAID
SHEEP PRODUCTION AND
MARKETING PROGRAM IN BOLIVIA**

511-11-190-364.2

By

E. Boyd Wennergren

Utah State University


Reference Center
Room 1656 NS

La Paz, Bolivia

September, 1974



UNITED STATES AID MISSION to BOLIVIA

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December 30, 1974

Mr. Gerald Schwab
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-GS	_____
BQ	_____
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ACTION	_____
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Dear Gerry:

I am attaching a copy of the final report on the special Evaluation of the Sheep Production and Marketing Project (364.2). This evaluation was listed under "Special Evaluations/Studies" of our schedule of FY 1975 evaluations. We have just completed the regular, final evaluation on this project and I hope to send the PAR to AID/W by the end of January.

Also underway now is the evaluation of PL 480 Title II (CRS) activities. All the discussion sessions have been completed and we are presently drafting the report. You can also expect the PAR by the end of January.

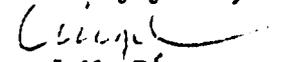
We are trying desperately to stick to our original schedule but if we do not get soon an additional person assigned to the Program Office we may fall behind. I will keep you posted.

You are right regarding Frank Brecher's participation in the La Paz Evaluation Seminar. Our Personnel Office listed Frank by mistake as he did not attend any of the sessions.

My future assignment is still undecided. I am requesting one year of university studies starting in September, 1975. If my request is approved, I would like to participate in the longer AID/W evaluation training program, either before September or at the conclusion of the proposed university training. I should know of AID/W's decision by May, 1975.

My best regards.

Sincerely yours,


Angel M. Diaz
Acting Assistant Director
for Program

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AN EVALUATION OF THE UTAH STATE UNIVERSITY/USAID
SHEEP PRODUCTION AND MARKETING PROGRAM IN BOLIVIA

Prepared by
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Utah State University

La Paz, Bolivia
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AN EVALUATION OF THE UTAH STATE UNIVERSITY/USAID SHEEP PRODUCTION
AND MARKETING PROGRAM IN BOLIVIA

E. Boyd Wennergren*
Utah State University

Summary

The following analysis of the Utah State University/USAID Bolivia Sheep Program was undertaken in September, 1974 as part of the contract requirements and at the request of the USAID Mission. The objective was to evaluate performance relative to contract specifications since its beginning in mid-1965. Since quantifiable measures were preferred wherever possible, the techniques of benefit-cost (project) analysis were applied to four amenable program phases. The remaining program phases are discussed qualitatively.

The quantitative analyses of the four program phases (ram production, improved sheep production, wool shearing, and alfalfa forage) indicated that program net benefits have been substantial. The annual rate of return of these programs to the total USAID program costs¹ was estimated to be 68 percent for a 20-year analytical period (1965 to 1985) and 62 percent for the 10-year period during which the project investment was made (1965 to 1975).

*Professor of Agricultural Economics

¹Costs of the Ministry of Agriculture which might be related to the program are not included.

The qualitative assessment of the other program phases suggested that they added benefits both to the rural population and to government institutions. These institutions gained by having the agricultural data base extended for planning and by improvements in human capital. The rural population received not only those increases in net income quantified in the benefit/cost analysis, but also a store of fundamental knowledge about agricultural processes for two major aspects of sheep production in the Altiplano. This information will promote both present and future campesino welfare.

During the past 10 years, adaptive research efforts have provided a genetic base for improving native herds. These research findings have been institutionalized under contract assistance so that private production and sale of 7/8 to 8/8 pure-blood rams currently involves from 1,500 to 1,600 animals per year. The total production of these rams is being distributed under domestic market conditions and the market is growing rapidly. Contract research has also provided technical information about supplemental feeding and herd management. A grading system for sheep wool has been developed and institutionalized. Product markets have been developed by contract economists for several classes of products, especially wool, and are now an important factor in improving the income and well-being of Altiplano farmers.

Forage agronomists and range ecologists working under the Utah State University Contract have discovered significant new information about native forage production under Altiplano range conditions. Their data contradict traditional belief about the Altiplano and offer additional possibilities for future development of the region. High

producing native forage species (thought to be extinct) have been located, growth potentials far in excess of those currently realized have been documented, and a new postulate has been formulated regarding the growth efficiency of climatic conditions on the Altiplano.

In sum, the genetic base is in place, and contract research suggests that ten- to twenty-fold increases in range forage production can be realized by modifying management practices. Lack of forage is currently limiting development of the region, but research work has been initiated at selected experiment stations.

The extension of this knowledge has been accomplished in a limited way for alfalfa production under irrigation which has benefitted an estimated 950 families. But added effort and time are needed to more completely test and refine the results of the basic postulate and to more widely implement the new knowledge. This seems particularly important in view of the large production potentials of native ranges under proper management which have already been partially documented by Utah State University scientists. While continued testing and refinement of the documentation is necessary, an extension phase is being implemented in pilot communities as the beginning of a broader effort. The momentum of these programs will likely be lost without continued technical assistance.

Future technical assistance on the Altiplano must, however, not only continue to discover and exploit technical relationships, and maintain the genetic base, but must also deal with institutional constraints. It may well be that none of the new knowledge on forage production can be adopted in the face of such constraints. Scientists

involved with the Sheep Contract have recognized the importance of the "common property" nature of the land resource of the Altiplano communities in explaining overgrazing and absence of individual investment in improving communal range lands. The existing system of range use means that if one individual does not get the forage, someone else will. The resultant tendency is to overgraze, sometimes beyond the point of normal forage regeneration. If continuing research and extension of new knowledge is to be successful, a national policy must be developed under which grazing is allocated in a manner similar to that applied on western ranges of the United States. Or, some method for encouraging communal action must be implemented; e.g. the community projects suggested for the last two years by Utah State University scientists. Only with such institutional changes in management can the extensive range resources of the Altiplano be brought to their productive potentials since it is necessary that individuals be able to capture the economic rewards of their investments. The requisite management changes would carry with them additional benefits in terms of erosion and flood control and general ecologic stability not previously considered for the Altiplano, benefits which also extend to other regions of the country.

To achieve these potentials and to realize perhaps even greater program benefits than those projected through 1985 by this analysis, the continued assistance of two or three technicians is necessary. A range management scientist is critical to continued research and extension of the new information about native ranges. A sheep production specialist will complement this research and extension effort and can

continue advising Ministry and Extension personnel on the improved sheep (genetic) program. Added inputs are needed on a limited consulting basis and from an extension specialist and agricultural economist on problems of community organization and the formulation of a national grazing policy that will address the "common property" land problems on the Altiplano. Assistance should also be given to developing formal academic programs in the Bolivian University in such fields as Ecology, Range Management, Forages and Pastures, Animal Nutrition and Breeding, and Economics. These specialists may share partial time with the new USAID technical assistance contract.

A final high priority need is increased support of agriculture programming by the Government of Bolivia. The current contract has suffered from counterpart budget deficiencies at all levels of the program. The impact of future extensions of the sheep program will also be influenced greatly by GOB participation.

Background and Objectives of the Program

The Sheep Production and Marketing Program (hereafter referred as the Sheep Program) was established in Bolivia in July, 1965, under contract between USAID/Bolivia and Utah State University. The university was charged with operational responsibilities for the program in cooperation with the Ministry of Agriculture. The contract provided for technical assistance for agricultural development in the Bolivian Altiplano and to a more limited extent, the Valley areas. The original team was composed of an agricultural extension specialist, who also served as Party Chief, an agronomist, a livestock specialist, and an

agricultural economist. During the life of the program, the manpower assigned to it has varied, but in general, these specialties have provided the major technical inputs. In 1972 a range management specialist joined the team.

The general objectives of the program as set forth in the original documents were:

1. To develop agricultural research, extension and rural programs, that result in improved economic social and cultural conditions.
2. To develop the supply of trained manpower required for sustained agricultural development.
3. To develop institutions required for improved agricultural production.
4. To develop local products to replace imported commodities and thus improve the balance of payments.
5. To increase exports by improving the quantity and quality of commodities for export.
6. To develop economic resource data required for the planning and execution of agricultural and rural development programs and for feasibility analysis of production and marketing alternatives.

Scope of the Sheep Program

The Sheep Program was developed to meet the program objectives and evolved into several distinct projects or phases between 1965 and 1974. All projects were coordinated with local Ministry institutions as well as with the Peace Corps (until its expulsion from Bolivia in 1971). These projects involved research, extension and training

functions, and were designed to fulfill the general objectives as set forth previously. However, counterpart cooperation was not always maximized due to Ministry budget and other constraints.

Assisting campesino producers to learn the technology of sheep shearing was a principal activity during the initial years of the project. Formal demonstration courses were organized and technicians participated in demonstrating the techniques of hand shearing. The goal was to replace the traditional technology of shearing with crude instruments such as glass and tin, and to introduce the management technique of using the annual shearing of animals to improve not only the attention given sheep herds in Bolivia, but also the volume of national wool production.

The training sessions involved both the demonstration of techniques to campesino producers and the instruction of extension agents and community leaders who subsequently held individual training courses within their provinces. During the life of the project, about 2,500 individuals were trained in the techniques of hand shearing by Utah State University personnel and an additional undetermined number were instructed by those who had been directly taught. Mechanical shearing was also demonstrated during the early periods of the project to cooperatives and individuals who responded progressively to the ideas being introduced by the new technology. At least eight shearing machines were imported into Bolivia and distributed to interested groups. Approximately 15 courses in machine shearing were given.

A second phase of the program began about 1968 and involved importation of improved sheep, classification of Criollo animals, and

development of capability with the country for production of improved sheep. Sheep were imported under provisions of the contract and distributed both to individual campesinos as well as to experimental stations on the Altiplano. Technical assistance was provided for reproduction experiments with improved sheep at the Ministry of Agricultural (MINAG) experiment stations. During the life of this project, approximately 2,000 improved animals were imported and distributed in Bolivia. These animals formed the basis for an improved-breeding program of 7/8 to pure-blood rams which has spread among campesino producers, and which has resulted in the establishment of several producing units that are providing a continuing supply of locally produced improved and pure-blood rams.

Sheep fattening trials were conducted as part of the improved animal production programs. Formal research was conducted at several of the Altiplano experimental stations. In addition, fattening trials were conducted under supervised conditions in campesino locations, particularly near Oruro. These experiments were concerned with whether improved rations could materially improve the productivity of both the native Criollo and Semi-improved sheep. Finally, fattening experiments in the Yungas and Santa Cruz areas helped define the potential for utilizing excess forages in regions other than the Altiplano.

To complement the expected development of improved breeds of sheep on the Altiplano, a project in forage and alfalfa improvement was implemented. Extensive research was carried out in various locations on the Altiplano to ascertain the productive capability of imported varieties of seed, grasses, and legumes, which are necessary to an integrated wool and feed production project. In addition to the

experimental work, imported improved seeds were distributed to campesinos for planting. During the project, approximately 200,000 lbs. of various classes of improved seed were imported and distributed. Improved seeds were also imported by private sources. Technical assistance and supervision were given to both experimental trials and to individual campesino plantings by members of the Utah State University Team. It was discovered that few of the introduced varieties were capable of seed production.

During the latter years of the project (since 1972) emphasis was turned from forage production based on improved varieties to an investigation of the production potential of native varieties which have existed for centuries on the Altiplano. A range management technician initiated research both at the experiment stations on the Altiplano and at other locations to identify and classify the types of local grasses and other plants which were potentially important to the development of the sheep industry. At latest report, this program has identified over 100 useful native plants, many of which were thought to no longer exist. In total, more than 1,500 species from the Altiplano have been collected, identified, described, and categorized for guides to range management. Complementary research projects have been started at the experimental stations to evaluate quality and yield of range pastures under different management systems. This research will establish the technical and economic potentials for improving the total productivity of the Altiplano. On the basis of these studies, it is estimated that the Altiplano ranges, with proper management of native forages, could sustain animal production 10-20 times above current levels.

Marketing assistance and economic analysis under the sheep program were concentrated to a large extent on the development of COMBOFLA as a marketing institution. Although in existence since 1962, COMBOFLA was still in its formative years when the contract wool project began in 1965. COMBOFLA was chosen as the institutional mechanism in which the marketing of wool as well as alpaca and llama hair would be concentrated. Technical assistance was provided this institution by the agricultural economist and the animal scientist of the Utah Contract. The COMBOFLA program involved the establishment of a system of wool collection centers throughout the Altipiano. The centers purchased campesino-produced wool and transported it to the central plant in La Paz. In addition, through a cooperative effort with COMBOFLA and the textile industry in Bolivia (primarily Forno), a grading system was established that reflected the quality of wool rather than the weight (which had previously been the basis for commercial exchange). Technical assistance and advice was provided to COMBOFLA in the operation of an alpaca yarn production plant in Pulacayo and in developing export potentials for raw alpaca and llama hair. Certain economic studies were undertaken to determine production costs of meat and wool as well as the feasibility of various kinds of technological innovations which were developed by the technical phases of the program.

In the early stages of the Sheep and Wool Contract Program, advisory assistance was provided to "Artesanías Bolivianas", COMBOFLA, FOTRAMA, and less directly to other artisan producers in the country. COMBOFLA actually initiated an artisan support phase as part of its operation in Pulacayo by training individuals to produce rugs and

ponchos from the alpaca materials available at the factory. However, this "internal" project was terminated in about 1970.

Contract advisory assistance to the artisan program was withdrawn in about 1969 and from COMBOFLA marketing in 1971.

In its final phases, the Sheep and Wool Program has provided both formal and informal training. Formal training was initiated for technicians in the Ministry of Agriculture when university level courses were brought from the campus of Utah State University. Professors from the Logan campus offered intensive courses in selected subject matter areas, including Animal Production, Plant and Forage Problems, Agricultural Economics, and Irrigation. In addition, formal extension courses were offered in subject matter areas concerned with community organization and group leadership dynamics. Informal training was an integral part of production phases of the overall program with technicians from the university working with members of the Ministry of Agriculture in day-to-day operations, as well as providing demonstration training during the various research and other activities.

The instructional phase of the program emphasized the need to develop an agricultural data base for planning efforts in the agricultural sector. A survey was made of rural and urban areas to ascertain production and consumption levels in Bolivia. The contract also contributed partial support to an agricultural sector assessment which has served as the basis for current restructuring of the USAID/Bolivia development program.

Objectives of This Evaluation

The objective of this evaluation is to estimate the relationship between benefits and costs that may be ascribed to the Sheep Program. Rates of return to the USAID/Bolivia investment in the Sheep Program Contract with Utah State University will be determined. Calculations are based upon quantifiable benefits and USAID/USU investments in the program. In addition, other non-quantifiable benefits are assessed qualitatively.

Method of Analysis

The methodology used in this analysis follows that typical of formal benefit-cost analyses, insofar as quantification of program benefits is possible. Net benefits are measured for conditions existing before program implementation and for those expected after the project. The differences in net values with and without the project constitute the measure of direct project benefits arising from the project.

Quantifiable direct benefits are estimated as per the following hypothetical example:

	<u>Without Project Benefits</u>		<u>With Project Benefits</u>		<u>Difference due to Project</u>
Total Returns	\$b 5	-	\$b 20	=	\$b 15
Production Costs	<u>3</u>	-	<u>10</u>	=	<u>7</u>
Net Returns	\$b 2	-	\$b 10	=	\$b 8

Total returns "without" the project and "with" the project will be estimated. In addition, any increased costs of production likely to be associated with the new technology under the project are taken into account. The "with" project total returns, minus both total returns "without" the project and increased project production costs yield the estimated increase in net returns due to the project, i.e., from the above example (\$b 20) - (\$b 5) - (\$b 7) = (\$b 8).

Direct benefits are defined as those accruing directly to individual farmers adopting new technologies under the program. Secondary benefits "stemming from" or "induced by" the project through the multiplier effect are excluded from the analysis. However, these are considered to be positive rather than negative and would add to the benefit estimated for the program.

Benefit measures are classed as follows for program phases permitting quantification:

1. Wool Shearing Phase. Increased net value of wool output resulting from the shearing program as measured by the added production which would not have occurred without shearing.
2. Ram Producers Phase. Increased net value of output of wool and improved animals associated with the production of improved rams and ewes.
3. Improved Sheep Phase. Increased net value of output of wool and meat associated with the introduction of improved rams in previously all Criollo herds.

4. Alfalfa Production Phase. Increased net value of production of alfalfa associated with the introduction of improved seed varieties. (The impact of improved pastures are not specifically identified in this analysis since potential double-counting may result with the analysis of the ram and improved sheep projects.)

Program benefits are qualitatively recognized in the following categories:

1. Feed Base Phase. Increased feed production potentials due to improvements in rations, introduced and native pastures, and in range-management techniques.

2. Professional Training Phase. Increased skills of Ministry, University and private sector personnel through formal and informal training.

3. Agricultural Marketing. Improved efficiency of wool marketing resulting from the development of a wool grading system and improved institutional arrangements.

4. Agricultural Data, Planning, and Agricultural Assessment. Development of agricultural data for planning, and the provision of basic data regarding the agricultural sector to underpin an analysis of sectorial performance.

5. Other Research. Discovery of physical, input-output relationships important to the future of the sheep and wool industry on the Altiplano that do not fit in the previous categories.

Project costs are the annual payments by USAID to Utah State University for support of the Sheep Program. The added costs to the Bolivian Government related to the Sheep Program could not be determined.

However, there is no evidence to suggest that the added costs incurred by the Government of Bolivia for the project were significant. In fact, contract funds were periodically sought to assist program development and operation for travel, etc., in the absence of sufficient Ministry of Agriculture (MINAG) financing. The exclusion of MINAG costs is therefore not considered to be a critical data limitation. The increased production costs to the campesino are included as part of the quantitative analysis of the four program phases.

The following section of this report contains an ex-post analysis of the four quantifiable phases of the program. The second section deals with the impact of the program on import-substitution and exports. The final section reports the qualitative assessment of non-quantifiable program phases.

Results of the Study

Ex-Post Project Analysis

The four quantifiable phases of the program are: (1) ram producers phase, (2) improved breeding phase, (3) shearing phase, (4) alfalfa production phase.

The analytical procedures used in this section follow those of benefit-cost analysis as described previously. This model provides a systematic means of incorporating existing and projected production practices into an analytical procedure that leads to quantitative measure. The data for this analysis were obtained from informed judgments of technicians from the Utah Team and the Ministry of Agriculture, and from data available in these two agencies, plus COMBOFLA, Grace Inc., and other governmental agencies.

The price level used in any benefit-cost analysis should reflect anticipated, long-term supply and demand relationships. Obviously if the intended program is successful, increased amounts of production will come to the market and unless concurrent shifts in demand occur, product prices will move downward. The amount of price change will depend upon the elasticity of demand. Since estimates of price elasticities and of expected long-term supply and demand situations are not available in Bolivia, current product and input factor prices are used throughout. This a common procedure in this kind of analysis when more reliable data are not available.

The estimating procedures attempt to represent average production conditions in regions where variation likely exists. Wherever significant variations exist, the choice has been to select those values that lead to conservative estimates. An interest rate of 12 percent is used throughout the analysis for amortizing fixed investments. The project life for all programs is 20 years, which provides for a 10-year analytical period beyond the end of the current Sheep Program. This period was agreed upon with USAID/Bolivia officials. Such analysis is consistent with general developmental philosophy, which suggests that the full impact of technical assistance development often extends well beyond the investment period. However, extending the analytical period beyond the initial 10 years will not make an appreciable difference since benefits accruing in these years yield nominal increments to "present values" at interest rates above 12 percent. Moreover, the scope of the analysis deals only with those resources influenced by the Utah Sate University contract and direct extensions of the program

by others during the contract and the extended analytical periods. No analysis is made of people, farms, and animals outside the program limits.

Finally, the rate of return on investment in the Utah State University contract is measured by the internal rate of return, a common measure for this type of analysis.

Ram Production Phase

During the contract period, approximately 2,000 improved sheep were imported by contract technicians and distributed to Altiplano producers. These importations have provided the basis for establishing ram production units, which are presently supplying pure-blood and improved rams to a wide group of campesinos. These ram production units are a distinct phase of the sheep project having observable and measurable benefits.

The estimated "without" project net benefits are based upon the current production situation on the Altiplano among typical producers of Criollo animals. Calculation of the annual flow of wool and animal products is based on knowledgeable estimates of critical production conditions such as death losses, birth rates, etc., found among these producers (Appendix Table 1). These annual product flows are then translated into annual total revenues by applying assumed product prices. Total annual revenues from all product sources are then standardized on the basis of the number of ewes bred each year (Appendix Table 2). These total revenue estimates are those which would be expected to have existed during the analytical period in the absence of the ram production phase of the program.

Estimates of "with" project benefits followed the same format, with slight changes in the production conditions to conservatively reflect

results of improved management conditions with the improved rams. Total annual values achieved through the project are also standardized on the basis of the number of ewes bred each year. (See Appendix Tables 3 and 4.)

To complete the data, the added annual costs of producing improved rams over Criollo production are estimated (Table 1). These annual added costs also reflect an improvement in the forage base above the native pastures normally grazed on the Altiplano. It is assumed that the improved rams can graze 7 months per year on native pastures. By providing 75 kg. of barley hay per year, the analysis encompasses an additional 7 months feed requirement which provides a contingency for years when native grazing supplies may be reduced.

Table 1. Added Annual Costs of Ram Production Program, 1965-1985

Source	Annual Cost per ewe
1) Ram cost @ \$60 amortized for 5 years at 12 percent (based on 25 ewes per ram)	US\$.67
2) Dipping and disease control	.15
3) Shearing cost	.15
4) Supplemental feed costs 75 kg barley hay at \$b 1.31/kilo (7 months supplemental feed - other 7 months is on native pasture of equal quantity to Criollo use)	4.91
5) Opp. cost of capital (\$5.88 - \$.67) at 12 percent interest	<u>.63</u>
Total added annual cost per bred ewe	US\$ 6.51

The total net benefits from the ram production phase for the 20-year program life reflect values expected to prevail over and above benefits existing before the introduction of the program phase (Table 2). These estimates will be used in the final part of this section in calculating the rate of return on USAID investment in the Bolivian Sheep Program.

Sheep Improvement Phase

The sheep improvement phase depends on the improved rams produced under the ram production phase. Improved rams are purchased by campesinos and placed with Criollo ewes to effect cross-breeding. Animal classification and selection is also part of this phase. Benefit calculations are confined to improved and Criollo sheep; the analysis does not double count benefits from those units which produce only improved sheep.

"Without" project total revenues are estimated using the current situation for Criollo production on the Altiplano. The annual flow of animals and products are estimated based on assumed management practices (Appendix Table 5). The annual flow of products and animals are estimated with existing product prices and expressed on a standardized "per bred ewe" basis (Appendix Table 6).

"With" project estimates make allowance for assumed changes in management practices (Appendix Tables 7 and 8). Total annual revenues are based on current prices, improved animal quality, and enhanced production. The added annual costs include the increased cost of improved sheep production over typical criollo practices, and do not provide for any increase in the native forage base. The rams are priced at \$40 which is the sale value used in the ram production phase of the

TABLE 2 - Summary of Net Benefits from Ram Production Program, 1965-1985

RAM PRODUCTION PROGRAM						
Year	Without Project Benefits per Bred Ewe	With Project Benefits per Bred Ewe	Added Production Cost per Bred Ewe	Net Project Benefits per Bred Ewe	Number of Bred Ewes	Total Project Net Benefits
	US\$	US\$	US\$	US\$		US\$
1965	Year 0	---	---	---	---	---
1966	0	0	0	0	0	0
1967	3.23	12.60	6.51	2.86	1,500	4,290
1968	4.39	15.56	6.51	4.66	2,105	9,809
1969	3.95	13.86	6.51	3.40	2,355	8,007
1970	3.54	13.11	6.51	3.06	4,125	12,622
1971	3.42	12.89	6.51	3.37	4,887	16,469
1972	3.44	14.56	6.51	4.61	5,737	26,448
1973	3.43	12.92	6.51	2.98	7,088	21,122
1974	3.41	12.87	6.51	2.95	8,516	25,122
1975	3.53	13.10	6.51	3.06	10,393	31,803
1976	3.51	14.00	6.51	3.98	12,709	50,582
1977	3.47	14.00	6.51	4.02	15,761	63,359
1978	3.46	13.00	6.51	3.03	19,659	59,567
1979	3.46	13.00	6.51	3.03	24,047	72,862
1980	3.47	13.00	6.51	3.02	29,349	88,634
1981	3.48	13.00	6.51	3.01	35,406	106,572
1982	3.48	13.00	6.51	3.01	42,299	127,320
1983	3.48	13.00	6.51	3.01	50,692	152,583
1984	3.47	13.00	6.51	3.02	60,817	183,667
1985	3.46	13.00	6.51	3.03	73,099	221,489

program. The analysis reflects current Altiplano management practices of grazing improved animals on native forages (Table 3), and presumes a substitution of 1.0 improved sheep for each 1.5 Criollo sheep (which are sold) so as to avoid exceeding the native forage base available.

Net annual project benefits to sheep improvement are summarized in Table 4. The estimated annual net program benefits represent the net value of the improved sheep program above those values expected without the project.

The benefits generated by both the improved sheep and ram bases include those from improved wool production. It is assumed that all improved animals are subject to improved management and shearing. Consequently, the animals in the improved ram and sheep phases are excluded from the shearing phase which may somewhat overstate the value of the improved animal programs and understate the value of the shearing program which follows.

Table 3. Added Annual Costs of Improved Sheep Program

Source	Annual Cost per Ewe
1) Ram cost @ \$40 amortized for five years at 12 percent (based on 25 ewes per ram)	.44
2) Dipping and disease control	.15
3) Shearing cost	.15
4) Opportunity cost of capital	.04
Total added animal cost	US\$.78

TABLE 4 - Summary of Net Benefits from Improved Sheep Program - 1965-1985

IMPROVED SHEEP PROGRAM

Year	Without Project Benefits per Bred Ewe	With Project Benefits per Bred Ewe	Added Production Cost per Bred Ewe	Net Project Benefits per Bred Ewe	Number of Bred Ewes	Total Project Net Benefits
	US\$	US\$	US\$	US\$	US\$	US\$
1965	Year 0	0	0	0	0	0
1966	0	0	0	0	0	0
1967	0	0	0	0	0	0
1968	3.14	3.04	.78	-(.88)	7,075	-(6,226)
1969	3.14	4.45	.78	.53	18,125	9,606
1970	3.14	5.31	.78	1.39	29,250	40,657
1971	3.26	5.78	.78	1.74	48,750	84,825
1972	3.31	5.75	.78	1.66	71,825	119,229
1973	3.44	6.10	.78	1.88	97,725	183,723
1974	3.52	6.25	.78	1.95	121,250	236,437
1975	3.59	6.30	.78	1.93	152,350	294,035
1976	3.65	6.30	.78	1.87	185,800	347,446
1977	3.60	6.20	.78	1.82	236,000	429,520
1978	3.55	6.10	.78	1.77	306,400	542,328
1979	3.53	6.20	.78	1.89	376,825	712,199
1980	3.52	6.10	.78	1.80	463,700	834,660
1981	3.54	6.30	.78	1.98	569,675	1,127,956
1982	3.64	6.40	.78	1.98	686,825	1,359,913
1983	3.59	6.40	.78	2.03	809,200	1,642,676
1984	3.60	6.40	.78	2.02	975,825	1,971,166
1985	3.60	6.40	.78	2.02	1,175,000	2,373,500

Wool Shearing Phase

The wool shearing phase was initiated during the first year of the overall Sheep Program with the objective of increasing campesino incomes through increased wool production and marketings. The pre-project wool production conditions in Bolivia were characterized by an almost complete absence of regular and systematic shearing of sheep, largely due to a lack of shearing technology. Campesinos commonly allowed several years of growth without shearing. In many cases, sheep were never shorn and the wool was not harvested until the death of the animal. Informed estimates indicate that sheep were completely shorn the equivalent of only once in five years. Usually small amounts of wool were removed for use in home weaving with tin or glass, or by pulling. Local wool markets lacked sufficient grading and quality standards which gave no incentives for adopting improved management and production technology.

Contract technicians began demonstrating shearing techniques using metal hand clippers and fleece preparation methods in various Altiplano locations. About 200 courses and demonstrations were conducted by contract technicians for campesino producers, village leaders, extension agents, and Peace Corps volunteers. The latter three groups then provided instruction and demonstrations elsewhere, which significantly expanded the individual efforts of contract technicians. No accurate record exists of total campesinos trained by the program. Evaluation of the program must, therefore, rely on indirect measures.

Initial estimates of the value of the program noted the increasing domestic wool purchases by local textile manufacturers since 1965. It

was reasoned that such increases reflected the impact of the shearing program since informed sources (Ministry of Agriculture, Contract personnel, and the Forno Textiles Management) estimated that only minimal amounts of domestic wool were marketed prior to 1965. The absence of quality standards for marketing led wool collection agents to add sand and water to increase wool weights. Consequently, domestic wool had been pronounced highly inferior by textile manufacturers prior to 1965 and purchases were low. However, the purchases of domestic wool reported during this study by textile manufacturers (especially Soligno) were judged unreliable based on observed evidence (Table 5). Soligno reported over 600,000 kilos purchased annually in 1965, 1966, and 1967 which far exceed reasonable levels based on other informed judgements. The large quantities reported in these years likely reflect the considerable volume of contraband wool which moves across Bolivia's borders from Perú and Argentina. When these contraband supplies are purchased, they are commonly listed as domestic wool by purchasing firms and agents. The data from Forno Textiles is judged a more accurate indication of the trend in domestic wool purchases in the post-1965 years since this company cooperated closely with COMBOFLA in the shearing program. Forno's purchase of domestic wool increased 13-fold between 1965 and 1973. The 1970 purchases were 19 times more than had been recorded in 1965 (Table 5). Much of Forno's wool came from COMBOFLA, whose supplies were in turn largely secured directly from the shearing program.

In light of the suspected data bias from textile manufacturers, an alternative procedure was devised to estimate the increase in national

TABLE 5 - Sheep Wool Purchases by Bolivian Textile Firms - 1965-1973

Year	FORNO		SOLIGNO		AMERINDIA		ANDEA		IDERTEX		TOTALS	
	Kilos	US\$	Kilos	US\$	Kilos	US\$	Kilos	US\$	Kilos	US\$	Kilos	US\$
1965	27,000	19,425	610,113	393,495	--	--	1,763	3,004	65,000	68,223	703,876	484,147
1966	38,560	27,742	645,529	441,582	--	--	1,375	2,503	70,000	71,456	755,464	543,283
1967	262,797	189,072	672,550	521,217	--	--	1,381	3,719	72,000	74,274	1,008,728	786,282
1968	339,805	244,476	702,944	509,388	--	--	1,807	4,067	78,000	81,322	1,122,556	839,253
1969	392,723	282,548	826,479	606,602	--	--	2,107	4,388	71,000	70,823	1,292,309	904,311
1970	541,650	402,774	488,175	364,604	--	--	2,558	5,003	68,000	72,456	1,100,383	844,837
1971	462,375	345,785	446,639	331,018	--	--	2,661	51,115	70,000	72,026	981,575	755,944
1972	305,188	230,149	325,697	243,116	855	2,227	3,613	7,216	73,090	74,032	708,353	556,740
1973	397,503	265,254	309,206	200,087	1,018	2,513	5,564	10,483	75,000	78,227	788,291	556,564
TOTALS	2,767,601	2,007,225	5,027,332	3,611,109	1,873	4,740	22,829	45,448	642,000	662,839	8,461,635	6,331,361

wool production resulting from the shearing program. Records of the Utah State University Contract Team and of Grace importers (the major Bolivian importer of sheep shears) indicate that approximately 4,200 pairs of metal hand shears were imported and distributed in Bolivia from 1966 to 1975. The exact annual distribution over time is not known, but for purposes of the analysis, it is assumed that 10 percent were added for each of the first 10 years, i.e., 420 new pairs of shears each year (Table 6). Present reports indicate a reduced market for the shears. Consequently, for the years 1976-1985 of the program analysis, it is assumed that only replacement purchases of shears will be made. Informed estimates from contract technicians and the Director of Research in the Ministry of Agriculture indicate that an estimated 200 sheep are shorn each year by each pair of shears. For purposes of this analysis, we have used an estimate of only 150 sheep per year per pair of shears. These two sources of data permit estimation of the total number of sheep shorn annually with the shearing program.

However, the previous analysis of improved ram and sheep production include wool shorn from those animals as a program product. To avoid double counting of program benefits, the number of improved sheep shorn each year are deducted from the estimated total number of sheep shorn with hand shears. This provides an estimate of the number of unimproved sheep shorn annually with the program. The number of shears sold each year is assumed to not increase after 1975, the number of improved sheep shorn each year is assumed to increase while the unimproved sheep will concomitantly decrease. Beyond 1979, therefore, all shearing benefits are captured in the improved sheep program.

TABLE 6 - Summary of Net Benefits From Wool Shearing Program, 1965-1985

Year	Number Shears in use	Number Sheep Shorn*	Number Improved Animals Shorn	Number Unimproved Sheep Shorn	With Project Amount of Wool from Unimproved Sheep (kilos)**	Without Project Wool from Unimproved Sheep#	Wool Due to Project	Value at US\$.91 (\$b 18.50) per kilo##
1965	Year 0	0	0	0	0	0	0	0
1966	420	63,000	0	63,000	50,400	13,860	36,540	33,251
1967	840	126,000	1,560	124,440	99,552	27,720	71,832	65,367
1968	1,260	189,000	9,547	179,453	143,562	41,580	101,982	92,803
1969	1,680	252,000	21,269	230,731	184,584	55,440	129,144	117,521
1970	2,100	315,000	34,710	280,290	224,232	69,300	154,932	140,988
1971	2,520	378,000	55,782	322,218	257,774	83,160	174,614	158,898
1972	2,940	441,000	80,714	360,286	288,228	97,020	191,208	173,999
1973	3,360	504,000	109,005	394,995	315,996	110,880	205,116	186,655
1974	3,780	567,000	134,956	432,044	345,635	124,740	220,895	201,014
1975	4,200	630,000	169,252	460,748	368,598	138,600	229,998	209,298
1976	4,200	630,000	206,449	423,551	338,840	138,600	200,240	182,218
1977	4,200	630,000	261,831	368,169	294,535	138,600	155,935	141,900
1978	4,200	630,000	339,101	290,899	232,719	138,600	94,119	85,648
1979	4,200	630,000	416,906	213,094	170,475	138,600	31,875	29,006
1980	4,200	630,000	512,770	117,230	93,230	138,600	0	0
1981	4,200	630,000	629,284	716	572	138,600	0	0
1982	4,200	630,000	758,288	0	0	138,600	0	0
1983	4,200	630,000	894,287	0	0	138,600	0	0
1984	4,200	630,000	1,078,107	0	0	138,600	0	0
1985	4,200	630,000	1,298,022	0	0	138,600	0	0

* Assumes each pair is used to shear 150 sheep per year as suggested for this analysis by Director of Research, Ministry of Agriculture and verified by field observation.

** Assumes 0.8 kilos per unimproved animal, per year when they are shorn each year, based on data of the Ministry of Agriculture.

Assumes 1.1 kilos per unimproved animal, and reflects shearing equivalent of one each five years, i.e., $(63,000/5) (1.1) = 13,860$

Less US\$.02 (increased cost per kilo of shearing with purchased shears), i.e., US\$ 10.00 amortized for 5 years at 12%.

The number of sheep estimated to be shorn each year without the project is estimated as one-fifth of the annual number shorn with the project. This reflects the estimate that sheep were shorn only once every five years before the introduction of the shearing program. Therefore, we assume only one-fifth of the animals shorn with the project in a given year would be shorn without the project. Wool yields with the shearing program are assumed to 0.8 kilos per unimproved animal shorn annually (with project), and 1.1 kilos per animal when shorn the equivalent of once each five years (without the project). For example, the "without project wool from unimproved sheep" reported in Table 6 was calculated for 1969 as follows:

$$(252,000/5)(1.1) = 55,440.$$

The net annual direct benefits from the wool shearing project are summarized in Table 6.

Alfalfa Production Phase

The forage effort was initiated in 1966 on a small basis and has grown with annual importations of improved forage and pasture seeds. Total distributions of improved seed by the Utah State Contract Team beginning in 1966 equals about 48,400 kilos of alfalfa seed, 7,740 kilos of clovers and vetch seed, and 26,541 kilos of pasture grasses. In addition, about 5,035 kilos of all types of seeds are currently on hand. The contract effort has promoted an additional import and distribution of approximately 50,000 kilos of alfalfa seed by private importers. This analysis includes only alfalfa seed importations, but encompasses the total amounts imported by both the Utah State University contract and by the private commercial sources. Grass and pasture seeds

are excluded to avoid potential double counting which may be related to the previous improved sheep analysis. According to those involved with the distribution of the alfalfa seed, most has been distributed to campesinos on the Altiplano, with a significant concentration in the Challapata region. All alfalfa produced from this seed is sold in the market place.

The analysis follows the same "without" and "with" project format previously used. The "without" project conditions reflect the assumption that lands currently in alfalfa production were previously native range lands supporting Criollo sheep production. Informed sources confirm the legitimacy of this assumption from personal observation. (There are no data available to support an assumption regarding a multi-cropping pattern involving other crops). The assumption may introduce a liberal element to the analysis but, as will be seen from the data analyzed, a 10-fold error would not significantly influence the results. The "without" project total returns are estimated for Criollo sheep production based on the data contained in Appendix Table 6. Calculation of the total number of animals per herd per year is based on recommendations from the Utah State University Contract personnel and the Ministry of Agriculture that 2.0 hectares are required to maintain each Criollo animal in the herd inventory. This reflects the carrying capacity of "fair" native ranges as classified by the Utah State University range technicians.² The total hectares are calculated by multiplying

²By using this level of carrying capacity, the analysis provides a comparison between common range conditions and alfalfa. It should be pointed out that estimates by the USU range technician indicate that these ranges can be increased from a carrying capacity of the common level of 0.57 AUMs/hectare per year to as high as 10.57 AUMs/hectare per year with improved management. Obviously, analytical comparisons using the improved range base as the "without" project conditions would yield a different result.

2.0 hectares by the number of animals. The estimate of total hectares is then divided into the total revenue estimates developed in Appendix Table 6 to derive the "without" project estimate of total revenue per hectare. These annual total returns approximated \$1.00 per hectare (Column 3, Table 8). Contract technicians indicate that data obtained informally from campesinos commonly show total returns of about \$.20 per hectare.

The "with" project estimate of total revenue is divided into irrigated and non-irrigated alfalfa production. Irrigated acreage is estimated as 65 percent of the total. Yields for irrigated and non-irrigated production are 5.5 and 2.5 metric tons per hectare, respectively. The current farm price for alfalfa is \$80 per ton. The following analysis is based on a price of \$70 per ton which is assumed for the 20-year project life. Shifts in alfalfa prices in Bolivia over time will depend upon the relation between supply and demand. The recent upward price trend reflects demand increasing faster than supply. As dairy, poultry, and other users of alfalfa continue to expand, one would expect the situation to continue. Therefore, the price used in the analysis is judged to be realistic for the period. Estimates of total hectares are estimated on the basis of total improved alfalfa seeds distributed for the years 1965-1974 at a rate of 20 kilos per hectare. The hectareage projected for 1975-85 is based on a trend line calculated from earlier years. The 11,296 hectares projected for 1985 do not seem excessive assuming some degree of dairy and poultry development.

Table 7. Added Costs of Production for Irrigated Alfalfa (Annual)

	Cost per Hectare
<u>Fixed Costs</u>	
1) Land clearing from range	\$b 300
2) Land preparation (4 man day/hectare at \$b 50 per day with equipment)	200
3) Pre-irrigation (2 man days/hectare at \$b 20)	40
4) Seed (20 kilos per hectare at \$b 82)	1,640
5) Labor (5 man days per hectare at \$b 20)	<u>100</u>
Total Fixed Costs	\$b 2,280
<u>Annual Costs</u>	
1) Annual fixed cost amortized for 10 years at 12 percent	\$b 404
2) Irrigation cost: Labor (4 man days per hectare at \$b 20 - 4 irrigations)	80
Water (charge per hectare)	31
3) Harvest (6 man days/hectare per harvest- -4 times)	640
4) Opportunity cost of operating capital (\$b 720 at 12 percent)	<u>86</u>
Total Annual Costs	\$b 1,241
Minus: Cost of producing Criollo sheep	or US\$ 62
Added cost of irrigated alfalfa production	<u>1</u>
Less Cost of irrigation (\$b 111.00)	US\$ 61.00
Added cost of alfalfa production without irrigation	<u>5.55</u>
US\$ 55.45	

TABLE 8 - Summary of Net Project Benefits from Alfalfa Production Program, 1965-1985

Year	I r r i g a t e d						N o n - I r r i g a t e d						T o t a l
	With Pro- ject Total Revenue at 5.5 MT/ha*	Without Project Total Revenue per ha**	Added Cost of Produc- tion per ha. with Project	Net Project Bene- fits per ha.	Number Hec- tares	Total Net Project Bene- fits US\$	With Pro- ject To- tal Reve- nues at 2.5MT/ha*	Without Project Total Revenue per ha**	Added Cost of Produc- tion per ha. with Project	Net Pro- ject Benefits per hectare	Number Hec- tares	Total Net Project Benefits US\$	
1965	385	.97	61.00	323.03	0	0	175	.97	55.45	118.45	0	0	0
1966	385	.97	61.00	323.03	8	2,584	175	.97	55.45	118.45	5	592	3,176
1967	385	.97	61.00	323.03	12	3,876	175	.97	55.45	118.45	7	829	4,705
1968	385	.97	61.00	323.03	294	94,970	175	.97	55.45	118.45	158	18,715	113,772
1969	385	.97	61.00	323.03	576	186,134	175	.97	55.45	118.45	309	36,638	222,772
1970	385	.97	61.00	323.03	1,183	382,085	175	.97	55.45	118.45	633	75,029	457,114
1971	385	.97	61.00	323.03	1,670	539,259	175	.97	55.45	118.45	894	105,903	645,162
1972	385	.97	61.00	323.03	2,247	725,488	175	.97	55.45	118.45	1,201	142,222	867,710
1973	385	.97	61.00	323.03	2,711	875,083	175	.97	55.45	118.45	1,450	171,607	1,046,690
1974	385	.97	61.00	323.03	3,204	1,040,026	175	.97	55.45	118.45	1,713	202,613	1,242,639
1975	385	.97	61.00	323.03	#3,048	983,528	175	.97	55.45	118.45	1,630	192,714##	1,176,242
1976	385	.97	61.00	323.03	3,497	1,128,307	175	.97	55.45	118.45	1,860	219,852	1,348,159
1977	385	.97	61.00	323.03	3,911	1,261,962	175	.97	55.45	118.45	2,091	247,198	1,509,160
1978	385	.97	61.00	323.03	4,342	1,401,163	175	.97	55.45	118.45	2,322	274,576	1,675,739
1979	385	.97	61.00	323.03	4,774	1,540,569	175	.97	55.45	118.45	2,552	301,774	1,842,343
1980	385	.97	61.00	323.03	5,205	1,679,653	175	.97	55.45	118.45	2,783	329,089	2,008,742
1981	385	.97	61.00	323.03	5,636	1,818,680	175	.97	55.45	118.45	3,013	356,257	2,174,937
1982	385	.97	61.00	323.03	6,068	1,957,900	175	.97	55.45	118.45	3,244	383,473	2,341,373
1983	385	.97	61.00	323.03	6,499	2,097,097	175	.97	55.45	118.45	3,474	410,731	2,507,828
1984	385	.97	61.00	323.03	6,930	2,235,895	175	.97	55.45	118.45	3,705	437,893	2,673,788
1985	385	.97	61.00	323.03	7,361	2,374,953	175	.97	55.45	118.45	3,935	465,077	2,840,030

* Based on US\$ 70 per metric ton.

** Calculated from figures contained in Appendix Table 5 to estimate total number animals times 2 hectares per Criollo animal. Revenue figures are from Appendix Table 6.

Estimated by trend line $Y = 833.91 + 431.35 X$ for the years 1975-1985, where Y is the estimated value and X is the year. Trend equation based on years 1965-1974.

Estimated by trend line $Y = 44.89 + 230.53 X$ for the years 1975-1985. Trend equation based on years 1965-1974.

The estimated added costs of producing alfalfa are shown in Table 7. The cost per hectare of producing Criollo sheep is assumed to be \$1.00 in the absence of other reliable estimates. Non-irrigated alfalfa costs are reduced from irrigated costs by the amount of the irrigation costs.

Total annual net returns to the forage program are summarized in Table 8.

USAID Sheep Program Costs

Several assumptions have to be made in determining expenditures related specifically to the Sheep Contract. First, during August 1, 1965 to November 30, 1969, the Utah State University contract also included cereals development and teacher training without separate budgets (Table 9).

Table 9. Utah State University Contract Expenditures as Amended, by Budget Period, 1965-1969.

Budget Period	Actual or Estimated Expenditures
8/1/65 - 8/1/67	\$ 512,570
8/1/67 - 12/31/67	113,066
1/1/68 - 11/30/68	338,132
12/1/68 - 11/30/69	340,034

Source: AID Contract LA-319 and Amendments.

The apportionment of expenditures between the three principal areas of contract focus was made on the basis of the average number of technical advisors working in each subject area during the budget period (Table 10).

Table 10. Technical Staff by Program Area by Budget Period

Budget Period	Man-Years			Total	Percent to Sheep Contract
	Sheep	Cereals	Education		
8/1/65 - 7/31/67	4	0.4	0.5	4.9	81.63
8/1/67 - 12/31/67	4	1.0	1.0	6.0	66.67
1/1/68 - 11/30/68	4	1.0	1.0	6.0	66.67
12/1/68 - 11/30/69	4	0.67	1.0	5.67	70.55

Source: AID Contract LA-319 and Amendments

By applying the share of technical personnel employed in the sheep contract during a budget period to the total expenditures, the share of total expenditures attributable to the Sheep Contract for each budget period during August 1, 1965 through November 30, 1969 can be estimated (Table 11).³

Table 11. Estimated Contract Expenditures on the Sheep Project

Budget Period	Amount
8/1/65 - 7/31/67	\$ 418,411
8/1/67 - 12/31/67	75,377
1/1/68 - 11/30/68	225,421
12/1/68 - 11/30/69	239,877

³ Between 1965-69 the Chief of Party spent approximately one-half time on Cereals, although his time was budgeted entirely under the Sheep Contract. Thus, assuming four men on the Sheep Contract overstates costs and understates the internal rate of return calculated later.

During the period December 1, 1969 to February 28, 1971, each program had a separate budget (all under one contract). However, only total expenditures for the entire period are available. Expenditures on the Sheep Program for this period (\$245,100) are estimated by applying the share of the original budget that was allocated to Sheep Program (\$41.17). (Original budget, \$515,182; actual expenditures, \$595,389). Expenditures for the period March 1, 1971 to March 31, 1974 are actual expenditures as reported in Amendment No. 5. The expenditures for April 1, 1974 to December 31, 1974 are the firm budget as reported in Amendment No. 5 to the Contract. The expenditures on the Sheep Program during August 1, 1965 to December 31, 1974 are summarized in Table 12 by budget period.

Because budget periods are not homogeneous, another assumption had to be made before the ex-post project analysis could be completed. Expenditures must be assumed to be made on an annual basis at the end of each year. Further, the project period of 20 years is assumed to start on August 1, 1965, with 20 fiscal years of August 1 to July 31 ending in 1985. Thus, the starting point--year zero--is August 1, 1965, and the end of the first period is July 31, 1966, the second period ends on July 31, 1967, etc., through July 31, 1975.

The budgets reported in Table 12 were converted to an average annual basis (Table 13). For example, the first budget period is August 1, 1965 to August 1, 1967. This covers two fiscal years according to above assumptions, at the assumed rate of \$209,206 per year. The calculation for the next budget period is more complicated but follows the same principle. During the budget period August 1, 1967 to December 31, 1967, \$75,377 were expended. During the period January 1,

Table 12. Expenditures on the Sheep Contract by Budget Period

Budget Period	Amount
8/1/65 - 7/31/67	\$ 418,411
8/1/67 - 12/31/67	75,377
1/1/68 - 11/30/68 ^a	225,421
12/1/68 - 11/30/69	239,877
12/1/69 - 2/28/71 ^b	245,100
3/1/71 - 4/30/72	329,199
5/1/72 - 3/31/73 ^c	314,461
4/1/73 - 3/31/74	377,722
4/1/74 - 12/31/74 ^d	243,514
Total	\$ 2,469,082

^a Estimated from total contract expenditures (actual and estimated as reported in Contract Amendments) by applying share of technical personnel in Sheep Contract.

^b Estimated by applying share of Sheep Contract budget in total budget to total contract expenditures.

^c Actual expenditures as reported by Controller.

^d Firm budget as reported in Contract Amendment No. 5.

1968 to November 30, 1968 an additional \$225,421 were expended for a total of \$300,798 during the period August 1, 1967 to November 30, 1968. This is a period of 16 months, so the proportionate amount spent during Fiscal Year 1968 (August 1, 1967 to July 31, 1968) would be three-fourths of the total or \$225,598.50 leaving \$75,199.50 to be added to expenditures in the next budget period. By proceeding in this manner through all the budget periods, the annual expenditures for each fiscal year are assigned (Table 13).

Table 13. Estimated Fiscal Year Sheep Contract Expenditures (8/1/65 - 7/31/85)

Fiscal Year Aug. 1-July 31	Annual Project Expenditure
0 1965	
1 1966	US\$209,205.50
2 1967	209,205.50
3 1968	225,598.50
4 1969	236,307.38
5 1970	204,548.92
6 1971	256,296.69
7 1972	304,010.11
8 1973	348,237.24
9 1974	335,768.58
10 1975	139,903.58
11 1976	0
12 1977	0
13 1978	0
14 1979	0
15 1980	0
16 1981	0
17 1982	0
18 1983	0
19 1984	0
20 1985	0
	US\$ 2,469,082.00

Rate of Return on Program Costs

The rate of return on the investment of USAID/Bolivia in the Utah State University Contract was calculated using the sum of annual benefits for the four quantifiable phases and the annual expenditures (Table 14). The internal rate of return for the 20-year project life is 68 percent annually. This return incorporates the net benefits for the 10-year period beyond contract termination. The internal rate of return for the 10 years of the contract period is calculated to be 62 percent annually.⁴ The high rate of return for the 10-year analysis indicates that significant program benefits were achieved early in the program. These rates of return on USAID investment are judged considerable even without estimated rates of return for other investments for comparison.

Impact of Program on Rural Incomes

Program impacts on rural incomes could only be roughly approximated based on the data generated in the analysis of the four quantifiable program phase (Table 15). These data provided annual estimates of animal populations for three project phases (ram production, improved sheep, and shearing) and of total hectares for the alfalfa production phase. For the animal phases, it was assumed that the ram herds average 700 animals and the other two animal programs average 100 animals per

⁴When high interest rates are involved in discounting annual benefit streams (in this case, 68 percent), the present value of benefits which occur 10-20 years in the future are reduced dramatically and do not add significantly to the present value for the full analytical period. This likely relationship accounts for the relatively small difference between the internal rates of return for the 10-year and 20-year analyses.

TABLE 14 - Summary of Sheep Program Benefits and Costs (Quantifiable) - 1965 to 1985

Year	NET PROGRAM BENEFITS					Annual USAID Avg. Investment*	Net Benefit Stream.
	Ram Production	Improved Sheep	Shearing	Alfalfa Production	Total		
	US\$	US\$	US\$	US\$	US\$		
1965	0	0	0	0	0	0	0
1966	0	0	33,251	3,176	36,427	-(209,206)	-(172,779)
1967	4,290	0	65,367	4,705	70,072	-(209,206)	-(139,134)
1968	9,809	-(6,226)	92,803	112,685	210,071	-(225,599)	-(15,528)
1969	8,007	9,606	117,521	222,772	357,906	-(236,307)	121,599
1970	12,622	40,657	140,988	457,114	651,381	-(204,549)	446,832
1971	16,469	84,825	158,898	645,162	905,354	-(256,296)	649,058
1972	26,448	119,229	173,999	867,710	1,187,386	-(304,010)	883,376
1973	21,122	183,723	186,655	1,046,690	1,438,190	-(348,237)	1,089,953
1974	25,122	236,437	201,014	1,242,639	1,705,212	-(335,769)	1,369,443
1975	31,803	294,035	209,298	1,176,242	1,711,378	-(139,904)	1,571,474
1976	50,582	347,446	182,218	1,348,159	1,928,405		1,928,405
1977	63,359	429,520	141,900	1,509,160	2,143,939		2,143,939
1978	59,567	542,328	85,648	1,675,739	2,363,282		2,363,282
1979	72,862	712,199	29,006	1,842,343	2,656,410		2,656,410
1980	88,634	834,660	0	2,008,742	2,932,036		2,932,036
1981	106,572	1,127,956	0	2,174,937	3,409,465		3,409,465
1982	127,320	1,359,913	0	2,341,373	3,828,606		3,828,606
1983	152,583	1,642,676	0	2,507,828	4,303,187		4,303,087
1984	183,667	1,971,166	0	2,673,788	4,828,621		4,828,621
1985	221,489	2,373,500	0	2,840,030	5,435,019		5,435,019

Internal Rate of Return 1965-1985: 68 percent

Internal Rate of Return 1965-1975: 62 percent

*From Table 13. Does not include Government of Bolivia Program Costs.

TABLE 15 - Estimated Net Income Increase per Capita from Sheep Program, 1965 - 1985

Year	RAM PROGRAM			IMPROVED SHEEP PROGRAM			SHEARING PROGRAM			ALFALFA PRODUCTION PROGRAM			TOTAL		
	Number Families	Number of People**	Net Increase in p/capita Income#	Number Families##	Number of People**	Net Increase in p/capita Income#	Number Families##	Number of People**	Net Increase in p/capita Income#	Number Families###	Number of People**	Net Increase in p/capita Income#	Net Project Benefits***	Number of People	Benefit C:
			US\$			US\$			US\$			US\$			
1965	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1966	0	0	0	0	0	0	420	2,310	14	3	17	187	36,427	2,327	
1967	3	17	252	0	0	0	824	4,532	-14	4	22	214	70,072	4,571	
1968	4	22	446	88	484	-13	1,221	6,716	-14	90	495	230	210,071	7,717	
1969	4	22	364	264	1,452	7	1,612	8,866	13	177	974	229	357,906	11,314	
1970	7	39	324	365	2,007	20	1,990	10,945	13	363	1,997	229	651,381	14,988	
1971	9	50	329	603	3,317	26	2,361	12,986	12	513	2,822	229	905,354	19,175	
1972	11	61	434	885	4,868	24	2,730	15,015	12	690	3,795	229	1,187,386	23,739	
1973	13	72	293	1,191	6,551	28	3,100	17,050	10	832	4,576	229	1,438,190	28,249	
1974	15	83	303	1,469	8,080	29	3,474	19,107	10	983	5,407	230	1,705,212	32,677	
1975	18	99	321	1,834	10,087	29	3,837	21,104	10	936	5,148	228	1,711,378	36,438	
1976	23	126	401	2,227	12,249	28	3,771	20,741	9	1,071	5,891	229	1,928,405	38,904	
1977	29	160	396	2,838	15,609	28	3,654	20,097	7	1,200	6,600	229	2,143,939	42,335	
1978	35	193	309	3,700	20,350	27	3,482	19,151	5	1,333	7,332	229	2,363,282	46,868	
1979	43	237	307	4,558	25,069	29	3,318	18,249	2	1,465	8,058	229	2,656,410	51,419	
1980	52	286	310	5,578	30,679	27	3,114	17,127	0	1,598	8,789	229	2,932,036	56,647	
1981	63	347	307	6,890	37,895	30	2,891	15,901	0	1,730	9,515	229	3,409,465	63,374	
1982	75	413	308	8,280	45,540	30	2,669	14,680	0	1,862	10,241	213	3,828,606	70,536	
1983	90	495	308	9,970	54,835	30	2,419	13,305	0	1,995	10,973	229	4,303,097	79,203	
1984	108	594	309	11,736	64,548	31	2,069	11,380	0	2,127	11,699	229	4,828,621	87,735	
1985	129	709	312	14,142	77,781	31	1,629	8,960	0	2,259	12,425	229	5,435,019	99,295	
Tot/aver.	731	4,025	\$319	76,612	431,140	\$29	50,585	278,216	\$ 7	21,231	116,776	\$228	\$42,102,247	830,418	

- * Based on 700 animals per family from data developed from Appendix Table 3
- ** Assumes 5.5 people per family
- *** Total program benefits, from Table 14
- # Based on total program benefits in Table 14
- ## Based on 100 animals per family from data developed from Appendix Table 7
- ### Based on 5 hectares per farm family

herd. From these data we estimated the total number of herds and families involved in each phase (assuming one family per herd). By further assuming 5.5 members per family (as reported by the Interdepartmental Committee for National Defense), we estimate the total population affected annually by the animal phases. Utilizing the total program net benefits (Table 14), estimates of increased per capita income were generated. The same procedure was followed for the alfalfa phase based on the total hectarage and 5.0 hectares per farm family.

Estimates of increased net incomes per capita ranged from a high of \$319.00 weighted average annually for the ram phase to \$7.00 per capita for the shearing phase. The overall weighted annual average for all programs is \$51.00 per capita. "Per capita" in this instance refers to the population estimate of people touched by the overall program. In 1975, 36,428 people are expected to benefit from the programs; this will increase to 99,295 by 1985. The "shearing" and "sheep improvement" phases involved the largest number of people.

Impact of Program on Import Substitution and Exports

The objectives of the Sheep Program provide specifically for import substitution and increased exports. Performance with respect to these objectives could not be measured with the formal benefit-cost procedures and attempts to do so could result in double counting of program benefits considered in the previous analysis. Consequently, this performance was analyzed separately.

Official estimates of total wool imports from 1965 through 1972 indicate some annual variations but only a slight reduction during the

period (Table 16). Imports of clean wool and carded and spun wool declined significantly while those of unwashed wool, noils, and carded and combed wool expanded. Generally, the changing composition seems related to the capacity of Bolivia's textile industry to handle the various stages of wool processing. The decrease in clean wool imports and the increase in unwashed wool purchases reflect the increased washing capacity of local manufacturers. Likewise the decrease in spun wool imported and the increase in domestically combed wool reflect increased spinning capacity achieved during the project period.

Some estimates of marketed domestic wool were available through reference to reported purchases by major textile firms for the period 1965-1972. The portion marketed for such domestic uses as mattress production, etc., which may not draw their supplies from manufacturing sources are not included nor is other home use. The reported purchases of domestic wool by textile manufacturers indicated that imports represented only 42 percent of total usage in 1965 and were reduced to a low of 27 percent in 1969 before returning to 40 percent in 1972. These trends seem highly unlikely and the data are judged suspect. Informed sources (Utah State University technicians and Forno Textiles Management) indicate that Bolivia was producing only a small portion of its total domestic needs in 1965. Estimates run as low as 5 percent. As already mentioned, a possible source of error in these data is the report of Soligno Textiles. This firm reported domestic purchases of about 600,000 kilos of domestic wool in 1965, 1966, and 1967. Given the chaotic marketing system and absence of quality standards during these years, this seems highly unlikely. Contraband shipments from Perú and

TABLE 16 - Wool Imports and Reported Domestic Use - Bolivia, 1965-1972

Type of Wool	1965		1966		1967		1968	
	Kilos	US\$	Kilos	US\$	Kilos	US\$	Kilos	US\$
Uncombed & Unwashed	27,119	36,107	49,481	37,129	124,917	55,731	273,782	91,630
Clean Wool	209,590	517,388	191,336	415,910	111,670	203,325	107,087	175,819
Carded & Spun	162,695	516,673	22,807	75,341	82,566	312,270	48,562	187,731
Noils	95,761	151,387	129,532	181,938	114,019	153,028	106,428	150,354
Carded & Combed	5,789	16,977	21,952	61,462	8,931	25,239	6,990	18,871
Total Wool Imports*	500,984		415,108		442,103		542,849	
Reported Domestic Purchases#	703,876		755,464		1,088,728		1,122,556	
Total Imports & Domestic Purchases	1,204,860		1,170,572		1,530,831		1,665,405	
Contract Wool Production##	0		50,400		105,022		152,496	
Imports as % of Total	.42		.35		.29		.33	
USU Contract Wool as % of Imported	0		.12		.24		.28	
USU Contract Wool as % of Total	0		.04		.07		.09	

Type of Wool	1969		1970		1971		1972	
	Kilos	US\$	Kilos	US\$	Kilos	US\$	Kilos	US\$
Uncombed & Unwashed	160,517	38,297	180,275	99,333	310,933	97,437	126,026	58,814
Clean Wool	86,622	132,235	79,353	132,213	66,880	107,018	102,866	163,687
Carded & Spun	86,656	291,184	96,464	271,906	58,290	216,430	82,616	317,782
Noils	131,707	192,537	114,091	157,005	126,038	156,115	126,710	169,071
Carded & Combed	18,480	59,659	50,786	161,076	14,486	46,058	32,042	79,921
Total Wool Imports*	483,982		520,969		576,627		470,260	
Reported Domestic Purchases#	1,292,309		1,100,383		981,675		708,358	
Total Imports and Domestic Purchases	1,776,291		1,621,352		1,558,302		1,178,613	
Contract Related Wool Production##	200,087		246,216		293,529		343,427	
Imports as % of Total	.27		.32		.37		.40	
USU Contract Wool as % of Imported	.41		.47		.51		.73	
USU Contract as % of Total	.11		.15		.19		.29	

Source: * Instituto Nacional de Estadística de Comercio Exterior

From Table 5 of this Report

From Appendix Tables 3 and 7 and from Table 6

Argentina that entered Bolivia outside regular import channels are probably involved. Such purchases are commonly recorded as domestic wools on the records of purchasing firms. Consequently, the reports of domestic purchases are likely overstated and accuracy in determining the trend in imports as a proportion of total domestic marketings since 1965 is virtually impossible.

However, the reports of domestic purchases plus the recorded imports are considered reasonably reliable estimates of total domestic marketings. Purchases by local manufacturers, although misleading as to domestic quantities, together with legal imports constitute a majority of domestic consumption. If we allow these data to reflect total consumption and juxtapose the calculations from the shearing and sheep improvement phases (Table 6, Appendix Tables 3 and 7), we can estimate the relative importance of wool marketed as a result of the Sheep Program (Table 16). The results indicate that contract-related wools satisfied four percent of total market demand in 1966 and 29 percent in 1972. In other words, contract-related increases in domestic production have occurred about seven times faster than rises in industry sales, thus reducing the need for importation. Contract-related domestic production was similarly related to total imports, increasing from 12 percent in 1966 to 73 percent in 1972.

Bolivian import-substitution savings have been substantial since 1965. Based on estimates of increased production of contract wool identified by the analysis for the years 1965-1975, about 2,899,488 kilos of project wool were produced at a value of \$2,638,534 (based on COMBOFLA grade III at \$.91 per kilo). Using a second measure of savings,

based on the reported domestic purchases by textile manufacturers contained in Table 5 (and judged to overstate domestic production), the savings between 1965 and 1972 were 2,122,341 kilos or \$1,931,330.⁵ These figures represent two separate estimates of domestic wool value, which would have otherwise required importation. Given the data deficiencies, however, these estimates should be judged with caution.

Exportations related to the contract have been mainly alpaca and llama hair (Table 17). A majority of these exports were made by COMBOFLA during 1967 to 1969.⁶ The export operations were coordinated and advised by a committee represented by USAID/Bolivia, Utah State University, and COMBOFLA. The contract provided advisory assistance to COMBOFLA between 1965 and 1971 and actively pursued the development of international export potentials. About 1968, such activities were suspended on USAID/Bolivia recommendation because of the difficulties of working in the international markets, high capital requirements, and low rates of return being realized. The decision to suspend export activities on a major scale significantly reduced the export development potentials of the contract since llama and alpaca were the only Altiplano animal products that had volume export possibilities.

⁵ Calculated by subtracting reported domestic purchases in 1965 from those in each year from 1966 to 1972 and summing the differences.

⁶ Data on exports related to the contract are also incomplete and suspect. Reliance is placed primarily on COMBOFLA data since the records of the National Statistics Institute were judged incomplete. However, the COMBOFLA data likely understates the actual volume since other exporters were known to be shipping during the period.

TABLE 17 - Export of Alpaca and Llama Products, 1965-1972

Type of Export	1965		1966		1967		1968		TOTALS	
	kilos	US\$	kilos	US\$	kilos	US\$	kilos	US\$	kilos	US\$
Alpaca & Llama Wool	82,110*	102,638*	110,456*	138,070*	74,241	72,000	28,782	30,462		
Alpaca Rugs					82	1,080	22	350		
Llama Rugs					12	130	6	90		
Alpaca Fabric							1,043	9,878		
Combofla Alpaca Yarn and Artesian Products										
TOTALS	82,110	102,638	110,456	138,070	74,335	73,210	29,853	40,780		

Type of Export	1969		1970		1971		1972		TOTALS	
	kilos	US\$	kilos	US\$	kilos	US\$	kilos	US\$	kilos	US\$
Alpaca & Llama Wool	36,000*	27,625*	14,361	16,403	14,361	16,077*	18,551	32,715	378,577	435,990
Alpaca Rugs	140	3,032			899	9,358	131	1,440	1,274	14,260
Llama Rugs	28	282	7,642	70,493			54	434	7,742	71,429
Alpaca Fabric	2,361	27,440	998	10,022	5,443	42,739	9,466	70,391	19,311	160,470
Combofla Alpaca Yarn and Artesian Products			863*	79,502	1,533*	85,975*			2,396*	165,477*
TOTALS	38,529	57,379	23,864	176,420	21,951	154,149	28,202	104,980	409,300	847,626

Source: Estimated from data collected from Instituto Nacional de Estadística, Comercio Exterior. Figures with asterisk (*) are taken from COMBOFLA.

During 1965 to 1972, approximately 378,577 kilos of alpaca and llama, valued at about \$435,990, were exported from Bolivia. Alpaca and llama rugs plus alpaca fabrics were also exported during the program period. The export of alpaca fabrics reflects to some degree the development of 100 percent alpaca material by Forno Textiles in cooperation with COMBOFLA and the Contract advisor. Total exports of all alpaca and llama products totaled about \$847,000 for the period.

Analysis of Other Program Phases (NonQuantifiable)

The phases considered in this section are: (1) feed base; (2) professional training; (3) agricultural marketing development; (4) agricultural data base, planning, and sector analysis; (5) other research.

Feed Base

Efforts to improve the feed base on the Altiplano were initiated in the first years of the Sheep Program. If the sheep improvement phases were to have maximum impact, a supportive feed base was essential.

Introduced Forage and Pasture. The initial work was concentrated on formal adaptive research to determine the potential productivity of introduced varieties of alfalfa, clovers, and pasture grasses. (The alfalfa program has been previously analyzed and will not be specifically treated here.) During 1966 to 1974, improved seeds of approximately 150 grasses, 50 alfalfas, and 50 miscellaneous legume types were imported for testing on the Altiplano. Test sites were primarily at the experimental stations at Patacamaya, Belén, Chinoli, Condoriri, and Toralapa. Adapted species were identified and further tested for responsiveness to irrigation

and fertilizers. About 15 species were thus identified as being capable of profitable Altiplano use. The extension of these varieties to campesino locations and demonstration of proper planting and cultivation procedures for forages were also undertaken during the contract period. Contract technicians cooperated with Bolivia extension agents and Peace Corps volunteers to establish approximately 600 demonstration plantings of introduced forage and alfalfa varieties at on-farm, campesino locations. These efforts involved planting areas under normal campesino managed conditions to demonstrate the potentials for the improved pastures. Incomplete reports indicate that at least 63 field tests incorporating 135 species were probably successfully carried to completion on a perennial basis. But the reporting system may underestimate the total of such successes, especially since the Peace Corps was expelled in 1971 without providing access to any of its reports, and the Extension reports are inconclusive. In a final phase, reproduction capabilities of the introduced varieties were investigated. Some seed-producing species were identified and the identification of seed production sites is a continuing phase of the program. A seed improvement laboratory developed under Utah State University Contract assistance was recently dedicated in Cochabamba to complement this program.

During the contract, approximately 7,740 kilos of improved clover and vetch seeds were distributed for planting along with about 26,540 kilos of various grasses. Since these pastures and forages are normally seeded at the rate of about 10 kilos per hectare, about 3,400 hectares have been seeded to improved pastures and forages (exclusive of alfalfa).

Range Management Program. The potentials of the native ranges were recognized in early phases of the forage base efforts but investigations were deferred until introduced varieties of forages had been investigated. Later, however, attention was turned to improving the management of native ranges and to defining their potentials for increasing the Altiplano forage base. A range scientist began work in Bolivia in 1972. His efforts have led to the discovery of new information that contradicts traditional knowledge about low productivity on the Altiplano, and provides a new postulate regarding the growth efficiency of climatic conditions on the Altiplano.

Cages to protect range plants were first distributed in various Altiplano locations. After one and one-half year of protection from destructive grazing, species of Bromus and Poa grasses were found that were superior in productive capability when judged against range plants found in the Western United States. In addition, plants never before classified and others thought to be extinct were found. This work constituted the first serious range plant classification on the Altiplano. Over 100 valuable herbage plants have been collected by the contract range scientist in collaboration with Bolivian Ministry counterparts who have been trained under the program (of the five that received partial training, three are now full-time employees in the Ministry of Agriculture). A herbarium has been established in the Ministry of Agriculture. It now contains 1,500 specimens of native Altiplano range plants. The interest generated by this work was also partially responsible for the establishment of the College of Pure Science and Renewable Natural Resources at San Andrés University.

The range demonstrations provided under the contract confirm independent scientific investigations related to high altitude plant growth. Contrary to popular opinion, these combined efforts suggest that plant growth at high altitudes is especially efficient because of the evapotranspiration system and the large amount of sunlight. These climatic conditions foster plants with broader leaves which can, in turn, encourage greater forage production. Cool temperatures are not so detrimental to range plant growth and survival as is poor grazing management. The main deterrent to plant growth on the Altiplano is heavy grazing. Water is scarce at times, and due to excessive runoff caused by overgrazing, severe floods and erosion can occur when precipitation is adequate. This new insight into Altiplano production efficiency implies good potentials for the developmental future of the region. Better plants will slow runoff and foster even greater herbage production.

Research results show that herbage yields of about eight metric tons (air dry) per hectare are possible. With only 300 mm/year of rainfall, five metric ton per hectare yields have been measured. A MINAG-USU range trainee has identified native grasses containing 19 percent crude protein and 33 percent phosphorus, even in late winter. Thirteen percent and 16 percent, respectively, is considered adequate for sheep. Potentials for increased range production have been estimated at 10 to 20 times existing levels, given proper management. The impact of such potentials on range improvement profitability is illustrated in Table 18.

Table 18. Example of Development Potential for Altiplano Native Range
(6-Year Development Period)

	Without Project	With Project
1) AUM/s per hectare per year	.99	10.00
2) Value per AUM	\$b 312.00	\$b 312.00
3) Total value per hectare	\$b 309.00	\$b 3,120.00
4) Added cost of range improvement per AUM		\$b 1,065.00
5) Net due to project per hectare/year	\$b 1,746.00	

The improvement potentials are reflected in the annual Animal Unit Months (AUM's) per hectare, which can be increased from 0.99 to 10.00 with improved management. The "with" project management levels are based on increases measured on the Altiplano under the contract and are considered very reasonable potentials. The added costs of the "with" project program (\$b. 1,065.00), are entirely costs of foregone forage use resulting from deferred grazing per hectare during the 6-year development period. The costs, returns, and net returns are all for a 6-year period. But as of the seventh and succeeding years, the net project benefits could be realized. This analysis does not involve year by year estimates nor discounting procedures. The intent is to provide a general impression of the potentials for change. Given these potentials and an estimated 2,000,000 hectares of land capable of undergoing this type of improvement, the opportunities for significant

impact on the Altiplano by developing the native range base are obvious.

The contract range scientist has developed detailed biological and physical data of this type that provide an analytical base for future program development.

Supplemental Feed Trials. Another phase of the feed base effort concentrated on testing the worth of supplemental feed of Criollo and Semi-improved sheep. Trials were conducted with various mixes of concentrate rations, various pastures and forage conditions, and at various geographical locations. Fattening trials were conducted for diets ranging in concentrates from 25 percent to 60 percent. Criollo sheep utilized the low concentrate diets more efficiently than some improved sheep, but the profitability varied widely depending upon the costs. In general, gains of 80 grams per day for Criollo and 120 grams per day for Semi-improved sheep were not uncommon (USU Series 14/73). Trials were also made on improved pastures on the Altiplano and on forages available in the Yungas and Santa Cruz regions (USU Series 17/74 and 4/75). One experimental trial in Santa Cruz was designed to determine the feasibility of controlling weeds on cotton land during the winter with the use of "lab-lab" (a semi-tropical legume forage) which was planted as a rotation crop to control weeds and was then grazed by sheep (USU Series 17/74). These low-land locations also provided indications as to the feasibility of fattening Altiplano animals in regions where the feed base is greater and available during seasons when Altiplano forage is greatly reduced. In general, this research confirmed the technical and economic feasibility of such

management practices and the superiority of semi-improved sheep over Criollo in utilizing supplemental feeding. Seven feeding trials were conducted under this project phase. However, the Bolivian pricing system does not differentiate meat quality nor quantity per animal; economic incentives that could lead to more widespread adoption of these management recommendations are therefore lacking. Nevertheless, the investigations completed under the contract have provided a genetic and information base for future adoption of many of these practices.

Professional Training

A professional training program was initiated in 1971 as part of the effort to provide trained manpower and effect institutional development, as set forth in the contract objectives. Formal course instruction was provided by in-country technicians from Utah State University, by selected Ministry of Agriculture professionals, and by short-term professors brought from the Utah State University campus. Courses were offered on an intensive basis directly in Spanish or with simultaneous translation. The courses were regular university courses satisfying the same academic requirements expected of students on the Utah State University campus, or they were non-credit extension courses. Wherever possible, Bolivian examples and situations were introduced into the instruction. Those attending the courses were permitted to earn regular university credits that could be applied to formal academic degrees at Utah State University or could be transferred to other universities in the United States. The training program courses are listed in Table 19. A total of 29 courses were attended by 1,219 individuals who came from the Ministry of Agriculture and other governmental ministries,

TABLE 19 - Summary of Professional Training Courses
Given by USU Staff in Bolivia, 1971 to
July 1974

Area of Training	Number Courses	Professor Hours Teaching	Hours Instructing	Number Persons Earning Credits	Number University Credit hrs Earned	Number of Participants			
						Total	Extension Workers	Ministry of Agriculture	Other
Agricultural Economic Development	10	391	13,721	112	336	350	47	125	178
General Training*	7	319	18,581	21	63	446	263	116	87
Technological Training in:									
Plant Sciences	9	876	14,128	61	131	333	156	139	38
Animal Sciences	3	180	5,520	54	192	90	51	32	7
TOTAL	29	1,756	51,900	248	722	1,219	517	412	310

*Includes organization development, leadership, communications, planning, evaluation and group processes.

the Bolivian University system, and the private sector. Participants earned a total of 722 hours of university credits in the general areas of Agricultural Development, General Capacitation, Plant and Soil Sciences, and Animal Science.

The specific courses taught are listed as follows:

	<u>Number of Participants</u>
A. Agricultural Development	
1. Ag. Planning and Project Evaluation (non-credit)	41
2. International Ag. Development (AE 580)	22
3. Advanced Ag. Development (Econ 680)	31
4. Price Theory (AE 501)	19
5. Farm and Ranch Management (AE 515)	27
6. Ag. Credit (AE 532)	19
7. Ag. Marketing (AE 560)	39
8. Livestock Economics (AE 517)	37
9. Research Methods (AE 606)	84
10. Pedagogy (ED 656)	<u>31</u>
Total participants	350
B. Staff Capacitation	
1. Public Administration	30
2. Organizational Development	143
3. Home Agent Capacitation	30
4. Bank Agent Training	55
5. Extension Methods	120
6. Cultural Change (SOC 330)	27
7. Program Development	<u>61</u>
Total participants	466

C. Plant and Soil Sciences	
1. Wheat Production and Programming	88
2. Introductory Soils (SS 358)	54
3. Forage Crops (PS 432)	31
4. Soil-Plant Relations (SS 555)	35
5. Tropical Soils (SS 515)	35
6. Irrigation and Drainage	31
7. Range and Ecology (RS 298)	27
8. Field Plot Techniques	27
9. Range and Watershed (becarios)	<u>5</u>
Total participants	333
D. Animal Science	
1. Anatomy and Physiology (VS 120)	32
2. Feeds and Feeding (AS 240)	31
3. Sheep Production (AS 562)	<u>27</u>
Total participants	90

The training course program cannot be evaluated in economic terms. In the presence of functioning labor markets which reward improved skills with increased lifetime earning such terms might be approximated. However, such indicators are not available in Bolivia. In qualitative terms, some positive indicators exist. Each course was evaluated by the students and responses were generally favorable. Attempts to revive a price reporting system for agricultural products as part of one course has resulted in periodic reporting of prices by extension agents, their summarization and distribution by the Division of Commercialization in

the Ministry of Agriculture and a proposal for implementing a price reporting system in future USAID programming in Bolivia. One course participant in training, by utilizing information and techniques acquired in these courses, has successfully organized six cooperatives in regions where he had previously been unsuccessful. Participants in these courses have also been instrumental in organizing development committees in Chuquisaca and Potosí. The training effort in Range and Wager Management has resulted in the employment by the Ministry of Agriculture of two technicians with responsibilities in this area (which previously had not been included in the Ministry program).

The training program also provided scholarships for both foreign and domestic training. Participant training was suspended under the contract in February, 1971. Prior to that time, two Bolivians were sent abroad to pursue Ph.D. degrees, 5 for Master's degrees, 2 for Bachelor's degrees, and 51 for short-course training in areas related to the Sheep Program. In addition, the Sheep Contract supported 38 nationals for thesis and research training in Bolivia (outside the Utah State University course program).

In assessing this program phase, it should be noted that the costs of some of the Utah State University courses, as well as of some other phases, were not borne entirely by the Sheep Contract. Course costs were sometimes distributed between the Wheat and Sheep contracts, but an exact accounting was not attempted.

Agricultural Marketing Development

Contract technicians were instrumental in improving the marketing of wool, raw alpaca and llama hair, and processed alpaca products.

The most dramatic improvements were realized in the marketing of wool.

Pre-project wool marketing in Bolivia was characterized by an absence of quality standards. Wool was marketed by weight only. Wool collectors reportedly added sand and water to the raw wool as a common practice to increase the sale weights. Utah State University technicians devised a quality standard that provided differential prices for improved quality. The quality grades were as follows:

<u>Type</u>	<u>Description</u>	<u>Buying Price (at \$b 12 to \$ 1)</u>
1	Long, fine, improved (58-62's)	\$b 9.50
2	Short, fine, improved (58-62's)	9.00
3	Long, coarse, Criollo and improved (50-56's)	8.00
4	Short, Criollo with Kemp (50-56's)	6.90
5 & 6	Colors, tags, etc.	2.90

COMBOFLA (which developed a nationwide collection system) and Forno Textiles Manufacturers (which purchased domestic wool on the graded basis) cooperated with the project. COMBOFLA also had representatives at the shearing courses conducted by Utah State University personnel where sheared wool was graded and purchased using the differential price scale. The campesino observed first-hand the benefit of quality wool and proper preparation of the wool fleece. Purchases of wool by COMBOFLA during the project period are summarized in Table 20. However, a comparison with Table 5 indicates that domestic wool sales were also made

by campesinos directly to textile firms. The quality grades established by the contract have become standards for all domestic sales.

Table 20. COMBOFLA's Sheep Wool Purchases (1966-1973)

Year	Quantity (kilos)	Value (US\$)
1965	--	--
1966	8,114	4,444
1967	202,980	146,186
1968	346,933	218,877
1969	208,466	135,100
1970	337,318	217,589
1971	264,749	171,717
1972	195,097	130,527
1973	<u>239,582</u>	<u>129,564</u>
Total	1,803,240	1,154,004

Development of international markets for alpaca and llama was less successful. Exports in international markets through COMBOFLA proved unprofitable. Difficulties associated with monitoring fluctuating markets, in meeting international quality-grading standards, as well as the large capital investment required for inventory maintenance, and the location disadvantage with respect to low-cost, ocean transport resulted in recommended termination of these efforts in 1968. However, COMBOFLA did continue to market alpaca and llama hair domestically and

made purchases for use in their yarn producing plant. COMBOFLA's purchases of alpaca and llama are summarized in Table 21.

Table 21. COMBOFLA's Purchases of Alpaca and Llama (1965-1973)

Year	Alpaca (kilos)	Value (US\$)	Llama (kilos)	Value (US\$)
1965	112,931	118,511	80,675	60,295
1966	81,035	87,188	53,333	33,489
1967	127,978	134,030	21,604	11,095
1968	34,316	45,702	1,264	229
1969	62,962	81,624	2,000	1,282
1970	48,625	48,207	35	17
1971	40,146	39,856	--	--
1972	25,256	24,524	113	43
1973	<u>44,474</u>	<u>59,249</u>	<u>12,730</u>	<u>10,108</u>
Total	577,726	638,891	171,755	116,558

Domestic marketing of 100 percent alpaca yarns from COMBOFLA's Pulacayo plant proved more successful than attempts at international marketing. Markets were established with local distributors of yarn products and with artisan users when alpaca yarn became available through the foregoing programs. Forno Textiles also developed an alpaca sport coat material using COMBOFLA yarns which is widely distributed in Bolivia. The markets for alpaca yarn and its products

have increased since the beginning of the project. But the ability of COMBOFLA to supply the market has been restricted by the quality of the yarn and operating capital restrictions. COMBOFLA has GOB support but its financial position remains marginal. The sales of COMBOFLA alpaca yarns since 1962 are summarized in Table 22. Contract advisory assistance to COMBOFLA was terminated in 1971.

Table 22. COMBOFLA's Alpaca Yarn Sales (1965-1973)

Year	Quantity (kilos)	Value (US\$)
1965	--	--
1966	--	--
1967	4,506	37,532
1968	14,699	97,251
1969	17,057	106,824
1970	21,298	135,890
1971	27,096	153,495
1972	19,208	115,162
1973	26,784	137,145

The marketing project has led to a general improvement in market efficiency for wool and has somewhat modernized the domestic marketing of alpaca and llama products. COMBOFLA has continued to operate on a marginal commercial basis since the removal of USAID technical assistance

and currently fills an important institutional position in the wool, hair, and artisan industries of Bolivia. Its basic organization was established during the period of contract advice, which coincided with a training period for a large portion of its administrative and working staff. The development of skills, especially by previously unemployed labor in the mining village of Pulacayo is a significant consequence of the project. This labor supply had previously become unemployed when the COMIBOL mine closed, and the area was a source of potential social unrest in Bolivia. The productivity of this labor was zero or perhaps even negative since some social costs may have existed in relation to the extreme poverty of the area. The establishment of COMBOFLA's yarn producing plant in Pulacayo had social and political overtones and did provide a positive impact on the area. Even though the plant was underfinanced and suffers even today from inferior equipment, it is producing and the employment skills of much of the populace have been improved. Unemployed laborers now are skilled electricians, textile machine operators, dye technicians, office managers, wool sorters, etc. Overall, COMBOFLA has employed about 60 persons annually at the plant since its beginning and has paid approximately \$256,305 in salaries during the project life. In addition, the purchases of raw materials from the rural areas of Bolivia have amounted to \$1,909,453 or about \$212,161 average annually since 1965.

Agricultural Data, Planning, and Sector Analysis

Bolivia's only agricultural census was in 1950 and its value as a benchmark had been badly eroded by the radically changing structure of

the agricultural sector brought by the land reform in 1952. A program of agricultural assessment was proposed in 1965-1966 by the contract economist, but it was administratively delayed for several years by USAID and MINAG deliberations.

In 1970, a program was initiated under the Sheep Contract to develop a more adequate data base, improve personnel capability to carry out agricultural planning, and initiate analyses of agricultural production programs for the purpose of defining Ministry program priorities. The personnel aspect was incorporated into the professional training program summarized previously in this report. Several individuals from the Planning and the Agricultural Economics Sections of the Ministry of Agriculture, plus other governmental agencies such as Colonization and the Agricultural Bank, attended relevant courses. The Agricultural Economics courses dealt with various aspects of agricultural planning, project evaluation, and agricultural firm and market analysis.

Development of an agricultural data base has been directed along two lines: (1) an urban-rural consumption survey, and (2) analysis of several agricultural production programs. The consumption survey was undertaken in 1972 to obtain data on both agricultural production and consumption, plus basic socio-economic data which would permit more comprehensive analysis of relevant relationships for planning.

The urban survey was conducted by Institute of Social Studies and Economics (IESE), San Simón University, in all large cities except La Paz.⁶ This was a contract directly with USAID/Bolivia. The survey followed procedures established by Brookings Institution in other Latin

⁶La Paz household consumption survey data are available from other sources.

cities and the results are fully compatible with such other work.

The rural survey included about 2,500 households stratified according to ten production (ecologic) zones. The Statistical Section of the Ministry of Agriculture had a major role in designing, planning, and execution of the survey. The data coding and preparation was accomplished at San Simón University, and transcribed to computer tapes by CENACO in La Paz. Two Ministry of Agriculture employees were sent to the Utah State University campus to assist in the final data analysis and to learn the analytical procedures. At this writing, the data are being analyzed.

The output of the surveys will include: (1) estimates of crop and livestock production for Bolivia; (2) estimates of domestic consumption of crop and livestock products; (3) development of provisional estimates of income elasticities; (4) projection of long-run supply and demand estimates for major agricultural products in Bolivia; and (5) patterns of food and non-food consumption in urban and rural areas according to income levels and other categorizations. Results will be jointly published with the Ministry of Agriculture.

A continuing involvement with the Office of Planning (MINAG) to establish a permanent system of data collection, analysis, and planning procedures is anticipated (at least to the end of the contract period).

Approximately sixteen agricultural commodities judged important to future planning of the Ministry of Agriculture were analyzed by Ministry personnel with contract personnel supervision. Benefit-cost analysis techniques were used and technicians were trained in the mechanics of this type of analysis. The projects were only partially completed (marketing and other commercialization aspects were not

studied), and did not provide their anticipated final benefits of establishing a list of project priorities. However, the studies did produce a significant amount of economic data and the experience gained by technicians of the Ministry will prove valuable as further competence in agricultural planning is developed.

Contract resources have also partially supported a full-scale agricultural sector assessment by Contract and RDD/USAID technicians. The assessment includes the following general sections: (1) An analysis of past governmental development policy; (2) A study of the performance of the agricultural sector and its role in overall economic development; (3) A description of the agricultural sector; (4) An appraisal of the factor and product markets in Bolivian agriculture; (5) An analysis of the human capital resources of Bolivia; (6) An appraisal of the role of public sector organization, public investment in agricultural development, and foreign donor assistance; and (7) An identification of positive and negative conditions related to future agricultural development and a suggested development policy for the agricultural sector. The agricultural assessment has provided the basis for development of a long-term program by the USAID/Bolivia Mission to underpin its future investments in Bolivia's agricultural sector.

Other Research

Several specific studies that fell outside the general categories listed in this section also represent important contract activities.

One such study investigated the feasibility of marketing sheep, llama, and alpaca processed in the form of ham, salami, frank-

furters, and bologna products. In a taste test, a public panel of 400 people could not distinguish the products prepared with these meats from regular processed meat products. The local market for processed meats is restricted, which makes widespread domestic use unlikely. Export potentials exist, however, but have not been fully explored due to political resistance to the potential for a resultant widespread reduction in animal numbers.

Flushing trials were also conducted with Altiplano sheep during the contract period. Flushing is the practice of feeding ewes nutritious rations prior to and during the breeding season to improve lambing percentages. One flushing trial increased the lamb crop from 15 to 85 percent the first year. Flushing has become a management practice on some Altiplano farms; and is generally practiced on those farms included in the ram production and sheep improvement programs analyzed earlier. Campesinos are successfully flushing their animals with alfalfa and barley hay and on native pastures that are managed especially toward this end.

A third major project effort was the preparation of a development program for the Altiplano based on available evidence and experience of Contract technicians. The program outlined a community development plan which was to confront the common property resource problem by demonstrating the positive effects of grazing restrictions and improved range management (USU Series 38/74). The program analysis projected a 20-fold increase in campesino earnings over a 10-year period. The proposed program has been presented to several agencies, including IICA, CORDEPAZ, CORDEO, CORDEPO, the universities of Oruro and Potosí, the World Bank, United

Nations, and the Extension Service. Many of these agencies are reportedly focusing their resources and programs in the direction of activating the proposal.

Areas of Deficiency

Prior sections of this report have documented the Sheep Program activities and given quantitative and qualitative assessment where appropriate and possible. Unfortunately, several contract goals have not been completely met. The following deficiencies are not listed in any order of priority.

1. No adequate source of national alfalfa seed production has been established. Consequently, Bolivia still must rely on imports for most of its forage seeds. Investigations in the Abapo-Izozog area are promising, but the problem still lacks satisfactory resolution.

2. The National Sheep Committee has not reached the desired level of development and maturity, and has not become the central coordinating force for sheep development as intended. Contract technicians have worked with the organization during the contract period, even to the extent of providing limited financial support for travel, etc. The effectiveness of the committee has fluctuated because of political maneuvering, inadequate support by the Ministry, and shortage of operating funds.

3. The standard of quality for ram grading has not been sufficiently institutionalized to insure a continuation of improved lines. Twelve individuals have been trained who can accomplish the grading process. But neither the National Sheep Committee nor other government institutions

have developed the capability to control the grading process and insure that no irregularities occur. Furthermore, there is no organized plan, program, or funding to continue the importation of improved rams. Discontinued importation, plus improper grading of domestically produced rams, may lead to deteriorations of the blood lines and loss of the improvement base now in place.

4. The sale of rams has not been institutionalized to the extent that might be desirable for most efficient marketing and program success. Rams are reportedly being sold within the current market structure and the demand is high. But the institutionalized auction sales or other forms of centralized sales that would be more efficient and orderly are only in the formative stages.

5. No national policy for range and watershed management has been established. Contract efforts have developed technical information vital improvement and management of Bolivia's native ranges and their natural resources. But the information has not generated national policy. Furthermore, basic issues related to the common property nature of the land resource of the Altiplano have been recognized and preliminary attempts made in trial villages to organize appropriate corrective measures. But the complete impact and importance of this situation has not been sufficiently demonstrated and incorporated into program phases and into a national resource use policy. Utah State University Team members think they understand the problem, but the empirical test has not been made. Activation of the Altiplano development plan would help provide such a test.

6. The institutional development of MINAG remains inadequate. Salar scales are still too low to encourage needed individual improvement. The level of financial support of agricultural programs is insufficient and budget control within the Ministry is too centralized, being outside the direct influence of department heads. Political influence continues to affect personnel selection and appointments rather than job descriptions and academic qualifications. A critical mass of skilled human capital is not in place. Many of those trained under the contract have left the Ministry and Bolivia for better salaries. The professional training program began to provide educational opportunity for improving technical skills. However the program has not been institutionalized, either within MINAG or the Bolivian University system. This deficiency is reflected throughout both the Research and Extension divisions of the Ministry of Agriculture.

7. The agricultural data base for planning and analysis is lacking, as is the amount of quality human capital needed to upgrade the collection, analysis, and dissemination of data. Contract efforts have made a beginning through the urban and rural surveys, professional training activities, etc. But there has been no institutional capability established to provide a continuing flow of reliable data and analysis, and Bolivia lacks a "critical mass" of technical experts to accomplish this development.

8. The institutional development of COMBOFLA is incomplete. Considerable contract effort was given to this program until 1971. COMBOFLA did become reasonably self-sufficient prior to that time, but it did not reach the projected level of institutional maturity and

financial independence. There are reasons for its slow development. COMBOFLA still remains a potentially important institution in the development of sheep, alpaca, and llama production in Bolivia.

9. Ministry of Agriculture personnel and others have received training in group dynamics, decision making, etc., and recommendations have been made to strengthen the organization and operation of cooperatives. However, cooperatives affiliated with the aspects of the sheep production and marketing program are generally weak and ineffective. Those cooperatives now in operation need strengthening in all phases and elements of their functions--administrative operations, member participation in decision making and implementation, buying, selling, planning, evaluation, etc.

APPENDIX

APPENDIX TABLE 1 - Ram Production Program Without Project - Animal and Product Inventory, 1965-1985

Year (1)	Number of Ewes (2)	Yearly Increase of Ewes (3)	Number Lambs Produced (4)	Yearly Wool Clip from Ewes (kg)* (5)	Number Culled Ewes Market- ed (6)	Number Male Animals Marketed for Meat (7)	Number Rams Used with Ewes (8)	Yearly Wool Clip from Rams (kg)* (9)	Number Old Rams Culled (10)
1965	Year 0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0
1967	1,500	0	622	1,200	0	311	60	60	11
1968	2,105	311	874	1,684	243	437	84	84	15
1969	2,355	138	969	1,884	175	484	94	94	17
1970	4,125	172	1,711	3,300	126	855	165	165	31
1971	4,887	477	2,028	3,909	90	1,014	195	195	37
1972	5,787	654	2,401	4,629	212	1,200	229	229	43
1973	7,088	1,037	2,941	5,670	141	1,470	283	283	53
1974	8,516	1,036	3,534	6,812	148	1,767	340	340	64
1975	10,393	1,436	4,313	8,314	306	2,156	415	415	78
1976	12,709	1,778	5,274	10,167	345	2,637	508	508	96
1977	15,761	2,343	6,540	12,608	370	3,270	630	630	119
1978	19,659	2,993	8,158	15,727	441	4,079	786	786	149
1979	24,047	3,369	9,979	19,235	535	4,989	961	961	182
1980	29,349	4,071	12,179	23,479	682	6,089	1,173	1,173	222
1981	35,406	4,651	14,693	28,324	870	7,346	1,416	1,416	269
1982	42,799	5,293	17,554	33,839	1,032	8,777	1,691	1,691	321
1983	50,692	6,445	21,037	40,553	1,209	10,518	2,027	2,027	385
1984	60,817	7,776	25,239	48,653	1,420	12,619	2,432	2,432	462
1985	73,099	9,432	30,336	58,479	1,655	15,168	2,923	2,923	555

NOTE: Calculations assume:

- a. 50 percent lamb crop with 17 percent death loss.
- b. 10 percent annual death loss for ewes.
- c. 1 percent death loss for rams and 25 ewes per ram.
- d. Old ewes and rams are sold and replaced at 5 years of age.

* Assumes 0.8 kilo per year per head

** Assumes 1.0 kilos per year per head

APPENDIX TABLE 2 - Ram Production Program Without Project - Total Revenue Estimates, 1965-1985

Year	Annual Wool from Ewes (kilos)	Value at US\$.90 per kilo	Number Criollo Ewes Culled	Value at US\$ 10 per Head	Number Criollo Males Marketed for Meat	Value at US\$ 11.50 per Head	Annual Wool From Rams (kgs)**	Value at US\$.90 per kilo	Number Culled Rams	Value at US\$ 12.50 per Head	Total Annual Value	Total Annual Value per Bred Ewe
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1965	Year 0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0
1967	1,200	1,080	0	0	311	3,576	60	54	11	138	4,848	3.23
1968	1,684	1,516	243	2,430	437	5,025	84	76	15	188	9,235	4.39
1969	1,884	1,696	175	1,750	484	5,566	94	85	17	213	9,310	3.95
1970	3,300	2,970	126	1,260	855	9,837	165	149	31	388	14,599	3.54
1971	3,909	3,518	90	900	1,014	11,661	195	176	37	463	16,718	3.42
1972	4,629	4,166	121	1,210	1,200	13,800	229	206	43	538	19,920	3.44
1973	5,670	5,103	141	1,410	1,470	16,905	283	255	53	663	24,336	3.43
1974	6,812	6,131	148	1,480	1,767	20,320	340	306	64	800	29,037	3.41
1975	8,314	7,483	306	3,060	2,156	24,794	415	373	78	975	36,685	3.53
1976	10,167	9,150	345	3,450	2,637	30,325	508	457	96	1,200	44,582	3.51
1977	12,608	11,347	370	3,700	3,270	37,605	630	567	119	1,488	54,707	3.47
1978	15,727	14,154	441	4,410	4,079	46,908	786	707	149	1,863	68,042	3.46
1979	19,235	17,311	535	5,350	4,989	57,373	961	865	182	2,275	83,174	3.46
1980	23,479	21,131	682	6,820	6,089	70,023	1,173	1,056	222	2,775	101,805	3.47
1981	28,324	25,491	870	8,700	7,346	84,479	1,416	1,274	269	3,363	123,307	3.48
1982	33,839	30,455	1,032	10,320	8,777	100,935	1,691	1,521	321	4,013	147,244	3.48
1983	40,553	36,498	1,209	12,090	10,518	120,957	2,027	1,824	385	4,813	176,182	3.48
1984	48,653	43,788	1,420	14,200	12,619	145,118	2,432	2,189	462	5,775	211,070	3.47
1985	58,479	52,631	1,655	16,550	15,168	174,432	2,923	2,631	555	6,938	253,182	3.46

Year	Number of Ewes	Yearly Increase of Ewes	Number Lambs Produced	Number Young Rams for Sale	Yearly Wool Clip from Ewes (kilos)*	Number Culled Ewes Marketed	Number Young Culled Rams Marketed	Number Rams Used With Ewes	Yearly Wool Clip from Rams (kilos)*	Number Old Rams Culled from Herd
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
965	Year 0	0	0	0	0	0	0	0	0	0
966	0	0	0	0	0	0	0	0	0	0
967	1,500	0	810	283	5,110	0	122	60	360	11
968	2,105 (200 imp.)	405	1,137	442	7,157	243	170	84	504	15
969	2,325 (70 imp.)	250	1,255	445	8,007	170	190	94	564	17
970	4,125 (1545 imp.)	225	2,228	780	14,025	146	334	165	990	31
971	4,887 (140 imp.)	622	2,638	923	16,615	70	395	195	1,170	37
972	5,737	850	3,673	1,285	19,505	121	550	229	1,374	43
973	7,088	1,351	3,827	1,340	24,099	141	573	283	1,698	53
974	8,516	1,428	4,598	1,609	28,954	148	690	340	2,040	64
975	10,393	1,877	5,612	1,964	35,336	306	841	415	2,490	78
976	12,709	2,316	7,629	2,668	43,210	345	1,143	508	3,048	96
977	15,761	3,052	9,456	3,309	53,587	370	1,418	630	3,780	119
978	19,659	3,898	10,615	3,715	66,840	441	1,592	786	4,716	149
979	24,047	4,388	12,985	4,544	81,759	535	1,947	961	5,766	182
980	29,349	5,302	15,848	5,546	99,786	682	2,377	1,173	7,038	222
981	35,406	6,057	19,119	6,691	120,380	870	2,867	1,416	8,496	269
982	42,299	6,893	22,841	7,994	143,816	1,032	3,426	1,691	10,146	321
983	50,692	8,393	27,373	9,580	172,352	1,209	4,106	2,027	12,162	385
984	60,817	10,125	32,841	11,494	206,777	1,420	4,926	2,432	14,592	462
985	73,099	12,282	39,473	13,815	248,536	1,655	5,921	2,923	17,538	555

NOTE: Calculations assume:

- a. 60% lamb crop and 10% annual death loss
- b. 10% annual death loss of ewes
- assumes 3.4 kg/year/animal c. 70% of young rams are sold annually to improved sheep ranches
- d. 30% sold as meat
- assumes 6.0 kg/year/animal e. 5 years life for breeding rams and 5 year life for breeding ewes
- f. 25 ewes per ram and 1 percent death loss of old ram

APPENDIX TABLE 4 - Ram Production Program With Project - Total Revenue Estimates, 1965-1985

Year	Number Young Rams Sold	Value at US\$ 40 per head	Annual Wool Clip from Ewes (kilos)	Value at US\$ 1.00 per kg*	Number Culled Ewes Sold	Value at US\$ 17.50 per head	Number Culled Rams Sold	Value at US\$ 15.00 per head	Annual Wool Clip from Rams (kilos)	Value at US\$ 1.00 per kilo*	Number Old Rams Culled	Value at US\$ 21.25 per head	Total Annual Value	Total Return per Ewe Serviced
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1965	Year 0	0	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	283	11,320	5,100	5,100	0	0	122	1,830	360	360	11	233	18,843	12.60
1968	442	17,680	7,157	7,157	243	4,252	190	2,550	504	504	15	319	32,462	15.56
1969	445	17,800	8,007	8,007	175	3,062	190	2,850	564	564	17	361	32,644	13.86
1970	780	31,200	14,025	14,025	126	2,205	334	5,010	990	990	31	659	54,089	13.11
1971	923	36,920	16,615	16,615	90	1,575	395	5,925	1,170	1,170	37	786	62,991	12.89
1972	1,285	51,400	19,505	19,505	121	2,117	550	8,250	1,374	1,374	43	914	83,560	14.56
1973	1,340	53,600	24,099	24,099	141	2,467	573	8,595	1,698	1,698	53	1,126	91,585	12.92
1974	1,609	64,360	28,954	28,954	148	2,590	690	10,350	2,040	2,040	64	1,360	109,654	12.87
1975	1,964	78,560	35,336	35,336	306	5,355	841	12,615	2,490	2,490	78	1,657	136,013	13.10
1976	2,668	106,720	43,210	43,210	345	6,037	1,143	17,145	3,048	3,048	96	2,040	178,200	14.00
1977	3,309	132,360	53,587	53,587	370	6,475	1,418	21,270	3,780	3,780	119	2,529	220,001	14.00
1978	3,715	148,600	66,840	66,840	441	7,717	1,592	23,880	4,716	4,716	149	3,166	254,919	13.00
1979	4,544	181,760	81,759	81,759	535	9,362	1,947	29,205	5,766	5,766	182	3,867	311,719	13.00
1980	5,546	221,840	99,786	99,786	682	11,935	2,377	35,655	7,038	7,038	222	4,717	380,971	13.00
1981	6,691	267,640	120,380	120,380	870	15,225	2,867	43,005	8,496	8,496	269	5,716	460,462	13.00
1982	7,994	319,760	143,816	143,816	1,032	18,060	3,426	51,390	10,146	10,146	321	6,821	549,993	13.00
1983	9,580	383,200	172,352	172,352	1,209	21,157	4,106	61,590	12,162	12,162	385	8,181	658,642	13.00
1984	11,494	459,760	206,777	206,777	1,420	24,850	4,926	73,890	14,592	14,592	462	9,817	789,686	13.00
1985	13,815	552,600	248,536	248,536	1,655	28,962	5,921	88,815	17,538	17,538	555	11,793	948,244	13.00

*Based on Combofla wood Grade II

APPENDIX TABLE 5 - Improved Sheep Program Without Project - Animal and Product Inventory, 1965-1985

Year	Number of Ewes	Yearly Replacement of Ewes	Total Ewes Bred to Rams	Number of Rams used with Ewes	Yearly Lamb Production	Number Culled Criollo Ewes	Annual Wool Clip from Rams (2 kgs.)	Number Culled Criollo Rams	Criollo Males Sold for Slaughter	Annual Wool Clip from Ewes (Col. 4) (0.8 kg.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1965	Year 0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0
1968	0	0	7,075	283	2,936	0	283	0	1,468	5,660
1969	1,468	1,468	18,125	725	7,522	0	725	0	3,760	14,500
1970	5,082	3,614	29,250	1,170	12,140	0	1,170	0	6,070	23,400
1971	10,644	5,562	48,750	1,950	20,231	200	1,950	280	10,115	39,000
1972	19,544	8,900	71,825	2,873	29,807	690	2,873	437	14,903	57,460
1973	31,803	12,259	97,725	3,909	40,555	2,373	3,909	440	20,247	78,180
1974	46,527	14,724	121,250	4,850	50,318	3,651	4,850	772	25,159	97,000
1975	63,383	16,856	152,350	6,094	63,225	5,841	6,094	914	31,617	121,880
1976	82,825	19,442	185,800	7,432	77,107	8,045	7,432	1,302	38,553	148,640
1977	105,051	22,276	236,000	9,440	97,940	9,666	9,440	1,364	48,870	188,800
1978	133,850	28,739	306,400	12,256	127,156	11,061	12,256	1,667	63,589	245,120
1979	172,982	39,132	376,825	15,073	156,328	12,758	15,073	2,088	78,191	301,460
1980	221,117	48,135	463,700	18,548	192,435	14,582	18,548	2,892	96,217	370,960
1981	280,641	59,524	569,675	22,787	236,415	18,897	22,787	3,674	118,209	455,740
1982	351,887	71,246	686,825	27,463	285,032	25,677	27,473	4,139	142,516	549,460
1983	433,538	81,651	809,200	32,368	385,818	31,582	32,368	5,090	171,636	647,360
1984	526,566	93,028	975,825	39,033	404,967	39,055	39,033	6,263	202,483	780,660
1985	637,338	110,772	1,175,000	47,000	487,625	46,029	47,000	7,502	243,812	940,000

NOTE: Calculations assume:

- One ram for each 25 ewes
- 50 percent lamb crop and 17 percent death loss
- 10 percent death loss of the ewes
- One percent death loss rams
- Old ewes and rams are sold and replaced at 5 years of age.

APPENDIX TABLE 6 - Improved Sheep Program Without Project- Total Revenue Estimates, 1965-1985

Year	Number Criollo Ewes Culled	Value at US \$10 per head	Annual Wool Clip from Rams (kilos)*	Value at US \$90 per kilo	Number Criollo Rams Culled	Value at US \$12.50 per head	Number Criollo Males Sold for Meat	Value at US \$ 11.50 per head	Annual Wool Clip from Ewes (kilos)**	Value at US \$.90 per kilo	Total Annual Value	Total Value per Bred Ewe
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1965	Year 0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	00	283	254	0	0	1,468	16,882	5,660	5,094	22,230	3.14
1969	0	0	725	653	0	0	3,760	43,240	14,500	13,050	56,943	3.14
1970	0	0	1,170	1,053	0	0	6,070	69,805	23,400	21,060	91,918	3.14
1971	200	2,000	1,950	1,755	280	3,500	10,115	116,332	39,000	35,100	158,687	3.76
1972	690	6,900	2,873	2,586	437	5,462	14,903	171,384	57,460	51,714	238,046	3.31
1973	2,373	23,730	3,909	3,518	440	5,500	20,239	232,748	78,180	70,362	335,858	3.44
1974	3,651	36,510	4,850	4,365	772	9,650	25,085	288,477	97,000	87,300	426,302	3.52
1975	5,841	58,410	6,094	5,484	914	11,425	31,466	361,859	121,880	109,692	546,870	3.59
1976	8,045	80,450	7,432	6,689	1,302	16,275	38,299	440,438	148,640	133,776	677,628	3.65
1977	9,666	96,660	9,440	8,496	1,364	17,050	48,567	558,520	188,800	169,920	849,600	3.60
1978	11,061	110,610	12,256	11,030	1,667	20,837	63,122	725,903	245,120	220,608	1,088,988	3.55
1979	12,758	127,580	15,073	13,565	2,088	26,100	77,593	892,320	301,460	271,314	1,330,879	3.53
1980	14,582	145,820	18,548	16,693	2,892	36,150	95,436	1,097,514	370,960	333,864	1,630,041	3.52
1981	18,897	188,970	22,787	20,508	3,674	45,925	117,320	1,349,180	455,740	410,166	2,014,749	3.54
1982	25,677	256,770	27,473	24,725	4,139	51,737	141,476	1,626,974	549,460	539,514	2,499,720	3.64
1983	31,582	315,820	32,368	29,131	5,090	63,625	166,685	1,916,877	637,360	582,624	2,908,077	3.59
1984	39,055	390,550	39,033	35,130	6,263	78,287	200,920	2,310,580	780,660	702,594	3,517,141	3.60
1985	46,029	460,290	47,000	42,300	7,502	93,775	241,911	2,781,976	940,000	846,000	4,224,341	3.60

* Assumes 1.0 kilos of wool per head, Combofla grade III

** Assumes 0.8 kilos of wool per head, Combofla grade III

APPENDIX TABLE 7 - Improved Sheep Program With Project- Animal and Product Inventory, 1965-1985

Year	Number of Ewes	Yearly Increase in Ewes	Total Ewes Bred to Rams	Number of Rams Used With Ewes	Number Lambs Yearly	Yearly Wool Clip from Ewes (kg) (2.5 kg/head)	Number Culled Criollo Ewes	Number Culled for Rams**	Number Males Sold for Slaughter	Yearly Wool Clip from Rams (4.5 kg/head)	PFC Rams Produced from up Grading 5 Generations	Criollo Ewes Sold as Replaced by Improved Ewes at Ratio 1.5 to 1.0*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1965	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	7,075	283	2,936	0	0	0	1,468	1,273	0	0
1969	1,468	1,468	18,125	725	7,522	3,670	0	0	3,760	3,262	0	2,202
1970	5,082	3,614	29,250	1,170	12,140	12,705	0	0	6,070	5,265	0	5,421
1971	10,644	5,562	48,750	1,950	20,231	26,610	200	0	10,115	8,775	0	8,343
1972	19,544	8,900	71,825	2,873	29,807	48,860	690	280	14,903	12,928	0	13,350
1973	31,803	12,259	97,725	3,909	40,555	79,507	2,373	437	20,239	17,590	31	18,388
1974	46,527	14,724	121,250	4,850	50,318	116,317	3,651	440	25,085	21,825	38	22,086
1975	63,383	16,856	152,350	6,094	63,225	158,457	5,841	772	31,466	27,423	75	25,284
1976	82,825	19,442	185,800	7,432	77,107	207,062	8,045	914	38,299	33,444	146	29,163
1977	105,051	22,226	236,000	9,440	97,940	262,627	9,666	1,302	48,567	42,480	254	33,339
1978	133,850	28,799	306,400	12,256	127,156	334,625	11,061	1,364	63,122	55,152	403	43,198
1979	172,982	39,137	376,825	15,073	156,382	432,455	12,758	1,667	77,593	67,828	466	58,698
1980	221,117	48,135	463,700	18,548	192,435	552,792	14,582	2,088	95,436	83,466	598	67,702
1981	280,641	59,524	569,675	22,787	236,415	701,602	18,897	2,892	117,320	102,541	781	89,285
1982	351,887	71,246	686,825	27,473	285,032	879,717	25,677	3,674	141,476	123,628	887	106,869
1983	433,538	81,651	809,200	32,368	335,818	1,083,845	31,582	4,139	166,685	145,656	1,040	122,478
1984	526,566	93,028	975,825	39,033	404,967	1,316,415	39,055	5,090	200,920	175,648	1,224	139,542
1985	637,338	110,772	1,175,000	47,000	487,625	1,593,345	46,029	6,263	241,911	211,500	1,563	166,158

* Criollo ewes are being replaced by improved sheep at a ratio of 1.5 to 1.0. The feed base will not allow an increase in N of sheep.
 ** Size or weight reflects use of native forage and no improved feed.

NOTE: Calculations assume:

- One ram per 25 ewes
- 50 percent lamb crop and 17 percent death loss
- 10 percent death loss on ewes
- 1 percent death loss on rams
- Old ewes and rams are sold and replaced at 5 years of age.

APPENDIX TABLE 8 - Improved Sheep Program With Project - Total Revenue Estimates, 1965, 1985

Year	Annual Wool from semi-Improved Sheep (kilos)*		Number Semi-Improved Ewes Culled**		Number Improved Rams Culled**		Number Semi-Improved Males for meat		Annual Wool from Improved Rams (kgs)***		Number Criollo Ewes # Replaced by Improved		Value Total per Annual Bred Ewe	
	Value at US\$.96 per kilo	Value at US\$ 14.00 per head	Value at US\$ 15.00 per head	Value at US\$ 13.80 per head	Value at US\$ 1.00 per kilo	Value at US\$ 10 per head	Value at US\$ 1.00 per kilo	Value at US\$ 10 per head	Value at US\$ 1.00 per kilo	Value at US\$ 10 per head	Value at US\$ 10 per head	Value at US\$ 10 per head	Value at US\$ 10 per head	Value at US\$ 10 per head
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1965	year 0	0	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	1,468	20,258	1,273	1,273	0	0	21,531	3.04
1969	3,670	3,523	0	0	0	0	3,760	51,888	3,263	3,263	2,202	22,020	80,694	4.45
1970	12,705	12,196	0	0	0	0	6,070	83,766	5,265	5,265	5,421	54,210	155,437	5.31
1971	26,610	25,545	200	2,800	0	0	10,115	139,587	8,775	8,775	8,343	83,430	281,668	5.78
1972	48,860	46,905	690	9,660	280	4,200	14,903	205,661	12,928	12,968	13,350	133,500	412,854	5.75
1973	79,507	76,326	2,373	33,222	437	6,555	20,239	279,298	17,590	17,590	18,388	183,880	596,871	6.10
1974	116,317	111,664	3,651	51,114	440	6,600	25,085	346,173	21,825	21,825	22,086	220,860	758,236	6.25
1975	158,457	152,118	5,841	81,774	772	11,580	31,466	434,230	27,423	27,423	25,284	252,840	959,965	6.30
1976	207,062	198,779	8,045	112,630	914	13,710	38,299	528,526	33,444	33,444	29,163	291,630	1,178,719	6.30
1977	262,627	252,121	9,666	135,324	1,302	19,530	48,567	670,224	42,480	42,480	33,339	333,390	1,453,069	6.20
1978	334,625	321,240	11,051	154,854	1,364	20,460	63,122	871,083	55,152	55,152	43,198	431,980	1,854,769	6.10
1979	432,455	415,156	12,738	178,612	1,667	25,005	77,593	1,070,783	67,828	67,828	58,698	586,980	2,344,364	6.20
1980	552,792	530,680	14,582	204,148	2,088	31,320	95,436	1,317,016	83,466	83,466	67,702	677,020	2,843,650	6.10
1981	701,602	673,537	18,897	264,558	2,892	43,380	117,320	1,619,016	102,541	102,541	89,286	892,860	3,595,920	6.30
1982	879,717	844,528	25,677	359,478	3,674	55,110	141,476	1,952,368	123,628	123,628	106,869	1,068,690	4,403,802	6.40
1983	1,083,845	1,040,491	31,582	442,148	4,139	62,085	166,685	2,300,253	145,656	145,656	122,478	1,224,780	5,215,413	6.40
1984	1,316,415	1,263,758	39,055	546,770	5,090	76,350	200,920	2,772,696	175,648	175,648	139,542	1,395,420	6,230,642	6.40
1985	1,593,345	1,529,611	46,029	644,406	6,263	93,945	241,911	3,338,371	211,500	211,500	166,158	1,661,580	7,479,413	6.40

* Based on 2.5 kilos per head and Combofla grades II and III wool.

** Size and weight by all animals sold reflect reduced value due to use of native forage.

*** Based on 4.5 kilos per head and Combofla grade II wool

Criollo ewes are replaced at the ratio of 1.5 to 1.0 improved ewe.