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If more information is desired, the Principal Investigator of the
specific project may be contacted at his U.S. institution or by enquiry
from the Management Entity, Small Ruminant Collaborative Research
Support Program, University of California, Davis 95616. In addition to
this series of annual reports by host country, the Management Entity has
compiled a complete roster of trainees and a full listing of over 2000
theses, book chapters, scientific journal articles, abstracts of papers
presented at meetings, and written and verbal technical presentations
which reflect the activity of the SR-CRSP prior to 1988.
1986-87 Annual Report

INTRODUCTION

During 1986-87 three SR-CRSP projects were involved in work in Morocco: Sociology, Nutrition and Breeding. Cuts in USAID funding for the program as a whole, announced in early 1986, led to interruption of support for the Range project. One-year funding from the USAID Mission (Rabat) was provided to the Moroccan range scientists who have been working in the SR-CRSP, to continue portions of that work. However, no U.S. PI was involved, and the work is not included in this year's report. With the phase-out of the SR CRSP in Brazil at the end of 1986-87, the PI of the Brazil range project has been funded to work on range in Morocco, so there will be a range project included in 1987-88.

This was also a transition year for the Sociology project. The External Evaluation Panel, following a review in Morocco in mid-1985, recommended that the Sociology project shift the site of its activity from the High Atlas to the Tadla region, a different but also important sheep production area, where the biological projects have focused their work. This was agreed, but further funding cuts at the start of the 1986-87 program year necessitated a decision to terminate the Sociology project at the end of that year. This therefore represents the final report for the Sociology project in Morocco. As detailed in the attached project report, the year was devoted to summarizing the work from the High Atlas; one thesis research project is still in progress. Among results of particular interest from the project are identification of the units (family, village, tribe) involved in decisions on range land use, and the fact that different patterns exist in different areas. Results also showed that production was higher in transhumant systems utilizing zones from the plains to the mountains than in those utilizing a more limited range of ecological zones.

Work on the breeding project involved two principal emphases. Evaluation of D'Man and Sardi breeds, $F_1$'s, $F_2$'s and backcrosses continued at the Tadla Farm. Several papers detailing results on ovulation rate, prenatal survival, litter size and growth rate are nearly ready for submission to scientific journals. Three doctoral students at IAV are using data from the project for their dissertations, and senior faculty members from IAV presented papers in 1987 at meetings of the International Atomic Energy Commission and the European Association of Animal Production, on response of D'Man and Sardi ewes to different photoperiods, and on effect of natural heat stress on growth of lambs, respectively. Both studies involved several different genotypes from the Tadla flock.

The comprehensive sheep production manual being prepared for publication in English and in French brings together information from the CRSP in Morocco and from other sources. The focus is on cereal-sheep agricultural systems in Mediterranean climates, with particular emphasis on Morocco. The publication is expected to be ready for printing in early 1988.
The Nutrition project report presents information from several different trials. Cereal stubble and straw are very important sources of sheep feed in Morocco and in Mediterranean climates generally, and a major emphasis of the nutrition project at Tadla has been studies of stubble grazing. Work in earlier years involved pregnant ewes and showed that some supplementation late in the stubble grazing period was needed for normal lamb birth weights. Growing lambs were used in the 1986-87 trials, which showed that stubble without supplement promoted gain of lambs for about 4 weeks. After that, unsupplemented lambs lost weight, whereas those supplemented with 300g/day alfalfa or 130 g cottonseed meal continued to gain an additional 4 weeks but lost weight during the final 4 weeks of the 12-week trial. Both the ewe and lamb trials provided data on possible stocking rates on wheat stubble. Supporting work on strategies for supplementing straw-based diets were carried out in the U.S. Other studies in Morocco involved evaluation of feeding value of local by-products, and value of different mineral supplements.

All projects involved in the Morocco CRSP continued to be involved during 1986-87 in training of Moroccan scientists in the participating U.S. Institutions.
RESEARCH RESULTS

The evaluation of the prolific D'Man and non-prolific Sardi breeds of sheep and various crosses between them at the Tadla Experimental Farm at IAV continued as planned during 1986-87.

The first phase of the project, 1982-1985, involved comparison of three mating groups: D'Man x D'Man, Sardi x Sardi and D'Man rams by Sardi ewes. Briefly, the greater prolificacy of the D'Man ewes (32 kg) consistently weaned more total weight of lamb than the larger (48 kg) Sardi ewes. Sardi ewes mated to D'Man rams produced slightly but non-significantly more lamb than Sardi ewes mated to the larger Sardi rams, because of better mating success of the D'Man rams.

F₁ lambs weighed less than pure Sardi lambs at birth, as expected, but surprisingly, grew as rapidly as pure Sardi lambs to one year of age. We infer from this that, in the crosses, a faster maturing rate transmitted by the D'Man breed compensated for their smaller mature size, an important point in exploitation of the breed.

F₁ ewe lambs were close to the early maturing D'Man breed in age at puberty and fertility, and intermediate between the two breeds in ovulation rate and litter size. The net effect of all of these differences is clear superiority of the F₁ ewe to the pure Sardi ewe in terms of lamb production. The Sardi is superior to the F₁, and much superior to the D'Man, in wool quantity and quality, but with meat being by far the more important product, it appears from this phase of the study that infusion of some D'Man inheritance will substantially increase overall productivity. Three papers are being prepared for publication from these data.

The second phase (1985-89) involves comparison of a total of about 400 ewes carrying 0, 25, 50, 75 and 100% D'Man (and the reciprocal percentage of Sardi) inheritance.

Data from the first two lamb crops of these ewes indicate that performance is fairly linearly related to proportion of D'Man genes, for
ovulation rate and litter size. Fertility shows a high degree of heterosis, due to a very high fertility of F₁ ewes, and a low fertility of pure Sardi ewes at young ages. The latter was also observed in phase I. Body weights show evidence of a substantial difference in maternal effects between D'Man and Sardi breeds, and it is possible that the observed mature weight of the D'Man breed is below the breed's additive merit due to this effect. This would contribute, along with the difference in maturing rate, to the higher than expected weight of D x S F₁ ewes. One paper and a doctoral thesis are in preparation from this phase of the work.

Studies are also in progress on puberty in ewe lambs, seasonal and breed variation in male reproduction parameters, female response to modified photoperiod, and on the responses of growing lambs and pregnant ewes of the different genotypes to heat stress. A paper on the effect of photoperiod on estrus cyclicity of D'Man, Sardi and F₁ ewes was presented at the International Atomic Energy Association Conference in Rabat in March 1987, and one on the physiological responses to stress is being presented at the meetings of the European Association of Animal Production in Lisbon in September 1987. Reprints of these papers are not yet available.

A major effort during the past year has been devoted to preparation of a draft of a sheep production manual for cereal-sheep producing areas of the Mediterranean Region, with emphasis on the Moroccan environment. Completion of this project is expected in 1988.

TRAINING

Ismail Boujenane, Lahsen Derqaoui and Ahmed Tibary of IAV have continued research toward the doctorate degree, under the University of Minnesota/IAV Training Program, with substantial research support from the SR-CRSP Breeding Project. These candidates are expected to complete their degrees in 1988 and 1989.
1986-1987 ANNUAL REPORT

Title: Nutrition and Confinement Feeding for Sheep in Semi-intensive Production Systems in Morocco

Principal Investigator: W.L. Johnson

Reporting Institution: North Carolina State University

Host Institution: Hassan II Agronomic and Veterinary Institute, Rabat

Other Collaborating Institutions: National School of Agriculture, Meknes National Association of Sheep and Goat Producers

Personnel:

Hassan II Agronomic and Veterinary Institute
Dr. Fouad Guessous (Co-Principal Investigator)
Nacif Rihani (on study leave at Univ. California, Davis)
A. Outmani (resigned October 1986)
Dr. J. Garrett (Univ. of Minnesota)

3rd Cycle (M.S.) students:
E. Dahbi M. El Fadili
A. El Hilali M. Ouchkif

National School of Agriculture, Meknes
Dr. Ahmed Kabbali
M. Haseeb
A. Ilham

2nd Cycle (B.S.) thesis students
F. Camara (from Niger)
H. Chebabi
K. Ennaciri
R. Hazzam
Angeline Koundouno (from Guinea)
L. Sali
N. Zrirak

National Association of Sheep and Goat Producers
A. Outmani

North Carolina State University
Dr. W. L. Johnson (Principal Investigator)
P. A. Hatch
J. M. Luginbuhl
O. Udewumi (from Nigeria)
L. J. Samsell
Dr. J. W. Spears
RESEARCH RESULTS

1. Alfalfa or cottonseed meal as supplements for lambs grazing wheat stubble during the dry season. F. Guessous, A. Ouitmani, E. Dahbi, J. Garrett, W.L. Johnson.

At the Tadla research farm, 48 lambs, initial weight 36 kg., were assigned to one of six paddocks of wheat stubble at a rate of 24 animals/hectare, for 12 weeks of the dry season. Two control groups received only mineral supplement, while after 4 weeks the other groups received either 300 g alfalfa hay or 130 g of cottonseed meal, per animal per day. During the first 4 weeks all lots gained an average of 56 g/day, which is a reflection of the grain residue plus weeds which the animals could glean from the field. The groups receiving only mineral supplement lost weight after 4 weeks, for a net loss of 2.2 kg in 12 weeks. The alfalfa and cottonseed meal supplemented groups continued to gain through 8 weeks (86 and 57 g/day, respectively) but lost weight thereafter, for a net gain of 2.2 and 2.4 kg across 12 weeks. Extrusa collected from esophageal-fistulated wethers declined in crude protein content from 8% of organic matter in the first month to 6% in the last, but did not change in in vitro organic matter digestibility (44%). The mineral-only group consumed an average of 46 g of organic matter per unit of metabolic weight per day; sampling period (1st, 2nd or 3rd month) did not affect their intake.


Carob pulp is plentiful in Morocco, and potentially available throughout the semiarid tropics where this tree is common. More information is needed about the use of carob byproducts in diets for small ruminants. Two trials were conducted at the Tadla farm by Mr. El Hilali for his 3rd cycle thesis: the first a fattening trial with 30 F1 Sardi x D'Man male lambs, in which carob meal progressively replaced citrus pulp in the diet; and the second a digestibility trial at maintenance intake. The carob pulp contained 4.5% crude protein, 35% cell-wall fiber (NDF). Intake of diets with 0, 15 and 30% carob meal in trial 1 was 89, 107 and 117 g per unit metabolic weight per day; the animals gained 19, 228 and 241 g/day on these three diets. Carcass yield was 54.5% across treatments.

A followup study on carob meal is presently being conducted by M. Ouchkif, third cycle student.

3. Compensatory growth in lambs of three genotypes. A. Kabbali, E.A. Allen, W.L. Johnson and D.W. Johnson (Collaborative with the University of Minnesota).

Two trials were conducted at the National School of Agriculture, Meknes. In trial 1, 20 Timahdit and 24 D'Man male lambs were allowed to lose weight from 25 to 20 or 17 kg, and subsequently refed to initial body weight, in a pattern that mimics seasonal weight changes that are commonly experienced wherever animals are exposed to wide variability in feed availability. In trial 2, 47 Timahdit, 30 D'Man and 27 Ile de
France x D'Man lambs were fed to compare weight loss followed by realimentation, compared to weight stasis.

Total empty body weight loss consisted of 63% carcass and 37% viscera; 75% of the viscera loss occurred during the first half of total weight loss. Carcass loss consisted of 53% water, 37% fat and 9% protein; as carcass loss progressed the proportion of fat loss increased while the proportion of protein loss decreased, while an opposite trend was observed for viscera. Fat reduction during underfeeding was more pronounced in the D'Man than the other breeds.

Maintaining a constant body weight at 22 kg for 6 weeks resulted in no change in carcass weight, but an internal fat increased while the weights of the digestive tract and liver decreased by 12 and 29%, respectively.

Refeeding after weight loss was associated with rapid increases in liver, kidney, caul fat and kidney fat. The major organs returned to original weights, but internal fat did not, which means that refed animals had the same carcass weight but a leaner composition than those animals which were fed to maintain weight. This was true for carcass and non-carcass as well.

Allowing lambs to lose weight during short periods of feed shortage is a strategy which may prove to be economically efficient. Refed lambs did not suffer in overall efficiency at time of final slaughter, compared with normally fed animals.

Deuterium oxide was used to estimate body composition, as well as slaughter and proximate analysis of samples from half the carcass. Coefficients of determination were highly acceptable for the deuterium-derived estimates, which will permit body composition estimates without slaughter in future trials.


Twenty member farms of the National Association of Sheep and Goat Producers were surveyed in April 1987. Records were available covering the period from 1981 on these farms. The average number of ewes per farm was 512; four farms kept more than 1000 ewes. A few head of cattle and goats were counted, but 90% of the standard livestock units were accounted for by sheep. However, since 1983 both cattle and goat numbers have increased faster than sheep numbers (which also increased by 60% on the surveyed farms). Two breeding seasons (spring, fall) are generally practiced. During the colder winter months, purchased feeds may be used (barley, wheat bran, and straw, as well as minerals).

Mr. Outmani has planned to initiate some on-farm feeding demonstrations this fall, involving the use of protein supplements for the breeding flock. He will continue to maintain close contact with the Departments of Animal Production (Dr. Kabbali) and Economics (Mr. Haseeb), and involve their students in the continued monitoring of participating farms.
5. Studies on mineral supplementation for growing lambs. A. Ilham, with 2nd cycle students.

Two experiments were conducted at the National School of Agriculture, Meknes. In the first, a mineral mix was offered to one-half of a group of 20 Timhadit and 20 D'Man lambs (half male, half female) in addition to a basal diet of 20% oat/veäch hay and 80% beet pulp/wheat bran. Intake did not vary between treatments, but least square means of gain were 169 g/day for the animals with minerals, compared to 121 g/day for those without. In trial 2, forty Timhadit lambs were fed a mineral mix with three levels of calcium (the lowest level followed NRC recommendations). There was no response to additional calcium when the basal ration was 20% straw, 38% corn grain, 38% oat grain and 1.5% urea. Average daily gains were 155 g. Mr. Ilham is planning further studies on the utilization of calcium from Moroccan feeds, which he will present for a Ph.D. dissertation to IAV Hassan II through the University of Minnesota project.

Supporting Research in Raleigh


Growing lambs were fed wheat straw (ad libitum) plus 80 g of soybean oilmeal as a basal diet, which was sufficient for maintenance only (animals gained 4 g/day); diet dry matter digestibility was 37%. Adding 90 g/day of a fish meal, corn meal and cottonseed meal mixture (high in rumen bypass protein) decreased straw intake and did not improve gains, although digestibility increased to 54%. Adding 235 g/day of alfalfa resulted in the same increase in digestibility, but higher total intake and rate of gain (52 g/day). Offering the same amount of crude protein as in the previous two treatments, but half from the concentrate mix and half from alfalfa, improved intake slightly over the alfalfa treatment, but digestibility and weight gains were lower (47% and 23 g/day). In a fifth treatment in which both protein supplements were offered at the same levels as in the 2nd and 3rd treatments, wheat straw intake was reduced to 40% of treatment 1, total intake was the same as treatments 3 and 4, digestibility was 59%, and gains were 88 g/day. According to the relative cost of ingredients and the objective of the feeder, several alternative strategies are available for maintaining body weight or achieving modest rates of gain.


Marginal zinc deficiencies may present problems for ruminant livestock in certain grazing situations. Zinc is known to be essential for normal reproduction in both the male and female. In a study with ram lambs, 3 levels of zinc oxide were added to a diet of 70% temperate forage hays and 30% concentrate; results indicated that the basal diet provided sufficient zinc (22mg/kg) for normal gains (144 g/day), testicular growth, and sperm production. In a second trial with lambs fed a zinc-deficient basal diet, two sources of zinc supplement were compared; zinc oxide and zinc methionine were absorbed with equal efficiency, but zinc retention in lambs fed the Zn-methionine was higher.
Wether lambs were fed chopped wheat straw or cottonseed hulls in a trial to test the effect of supplemental nickel. Average daily gain (219 g for cottonseed hulls, 42 g for wheat straw) was not influenced by added nickel, but rumen epithelial urease, which facilitates recycling of urea nitrogen from the bloodstream to the rumen, had increased activity with nickel supplementation, especially with wheat straw.

PUBLICATIONS

**Refereed Journal Articles** (none)

**Refereed Journal Articles** (from supporting research in U.S.)


**Manuscripts Submitted** (none)

**Theses - Ph.D.**


**Theses - B.S. and M.S.**


Abstracts


Abstracts
(from supporting research in U.S.)


Technical Communications
(from supporting research in U.S.)

Verbal Presentations


TRAINING

Training activities in Morocco continue at three levels: Ph.D. level training for IAV Hassan II and ENA/Meknes junior faculty; M.S. (3rd cycle) training for persons preparing for leadership in various institutions which serve Moroccan agriculture; and B.S. (2nd cycle) training. At all three levels, the major role of the nutrition and feeding systems project is to support an appropriate research activity for the student, providing valuable hands-on experience in animal feeding and management as well as an appropriate experience (taking into account the student's level) in the scientific method.

During the year covered by this report, Nacif Rihani of IAV Hassan II was at the Univ., of California, Davis, conducting his Ph.D. coursework (sponsored by the Minnesota project). Plans were initiated for his research in Morocco, to start in the fall of 1987. Equipment (a gas chromatograph) was purchased and shipped to Rabat, which will support the work that Mr. Rihani has planned in byproduct feed evaluation for ruminants.

Mr. Ilham, who completed his Ph.D. coursework at the Univ. of Minnesota, returned to Meknes and started some research toward his Ph.D. dissertation on mineral availability in Moroccan feeds.

Third cycle student M. Ouchkif conducted research at the Tadla farm of IAV, with SR-CRSP support. Mr. A. El Hilali, another 3rd cycle student, completed his research and defended his thesis.

At Meknes a large group of 2nd cycle students worked with Dr. Kabbali, Mr. Ilham, and Mr. Hassib (economist), including two from other African countries:

- Fode Camara (from Niger)
- Hamid Chebabi
- Ms. Khadouj Ennaciri
- Ms. Rachida Hazzam
- Ms. Angeline Koundouno (from Guinea)
- Ms. Laaziza Sali
- Ms. Naima Zrirak
RESEARCH RESULTS

Sociology Project research during the reporting period concentrated on examining ways in which Moroccan livestock producers and government agencies can mobilize resources to improve small ruminant production. Until mid-1986, work was carried out primarily in the valleys of the High Atlas Mountains -- a region characterized by land scarcity, marginal climatic conditions and dependence on income generated from off-land employment. Project activities focused on attempts to determine range management practices and strategies prevalent in the High Atlas. These activities included:

1. An enumeration of the various forms of communal pasture management systems employed in the Central High Atlas. Results indicated that the two primary forms of pasture management (rain-fed and irrigation), were accompanied by different forms of communal support. Whereas rain-fed pasture was characterized as either a multi-tribe, multi-village or single village management system, irrigated pastures were characterized as either family or multi-village management patterns. Identifying the various communal management patterns can serve as the basis for molding future extension (and other) activities regarding small ruminant production and management techniques.

2. An evaluation of the productive efficiency of different transhumant patterns prevalent in the region. Results have shown that production is greater when the mountains and plains are utilized, rather than a more limited range of ecological zones.

3. An evaluation of the biological efficiency of pasture management practiced in the Oukaimeden agdal. The results of this study are still preliminary and form the basis for a thesis in progress.

In 1986, the External Evaluation Panel, concerned over budgetary constraints, recommended that the Sociology Project terminate activity in the High Atlas and refocus its efforts at the Tadla Research Station. Two primary considerations went into this decision. First, the Tadla Station is the site for a major thrust of SR-CRSP activity (breeding and nutrition). Second, since the area is irrigated and
recently developed, the EEP felt that Tadla held greater or unrealized potential for small ruminant production. While plans were put in place to transfer activity to Tadla, further budgetary reductions and the absence of an identified counterpart scientist have halted these plans. As a result, the last six months have been spent primarily completing data gathering from studies in-place in the High Atlas.

TRAINING


PUBLICATIONS


COLLABORATING ORGANIZATIONS

Federal (U.S.):
United States Agency for International Development
  Science and Technology Bureau
Board of International Food and Agriculture
Joint Committee on Agricultural Development

Overseas Collaborators:
  BRAZIL--Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA)
  INDONESIA--Agency for Agricultural Research and Development (AARD)
  KENYA--Ministry of Agriculture and Livestock Development (MALD)
  MOROCCO--Institut Agronomique et Veterinaire--Hassan II University (IAV)
  PERU--Instituto Nacional de Investigacion y Promocion Agropecuaria (INIPA)

State Subgranted Institutions:
  University of California, Davis
  Colorado State University, Fort Collins
  Montana State University, Bozeman
  University of Missouri, Columbia
  North Carolina State University, Raleigh
  Texas A&M University, College Station
  Texas Tech University, Lubbock
  Utah State University, Logan
  Washington State University, Pullman
  Winrock International Institute for Agricultural Development, Morrilton, Arkansas
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Kenneth Schneeberger  University of Missouri

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Saul Fernandez-Baca  Santo Domingo
William Flinn  Ohio State University
Gerald Thomas, Chair  New Mexico State University

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William C. Weir  Program Director after 9/30/87
James Scott  Assistant Program Director
Lindy Watts  Administrative Assistant
Marcella Pieratt  Accounting Assistant until 10/1/87

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