

PD-ABA-242

64220

AGRICULTURAL RESEARCH CORPORATION

WESTERN SUDAN AGRICULTURAL RESEARCH PROJECT



LIVESTOCK PRODUCTION SPECIALIST/CHIEF OF PARTY  
FINAL REPORT: PROJECT STATUS AND RECOMMENDATIONS  
FOR FUTURE PROGRAM FOCUS

WSARP PUBLICATION No. 54

FEBRUARY 1986

PD-ABA-242

64220

AGRICULTURAL RESEARCH CORPORATION  
WESTERN SUDAN AGRICULTURAL RESEARCH PROJECT

THE GOVERNMENT OF SUDAN  
UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT  
THE WORLD BANK  
CONSORTIUM FOR INTERNATIONAL DEVELOPMENT  
WASHINGTON STATE UNIVERSITY

LIVESTOCK PRODUCTION SPECIALIST/CHIEF OF PARTY  
FINAL REPORT: PROJECT STATUS AND RECOMMENDATIONS  
FOR FUTURE PROGRAM FOCUS

RICHARD H. COOK, PH.D., DVM

LIVESTOCK PRODUCTION SPECIALIST/  
CHIEF OF PARTY

WSARP PUBLICATION No. 54

FEBRUARY 1986

The Western Sudan Agricultural Research Project

is supported by

The Government of Sudan

The Agricultural Research Corporation

US Agency for International Development

The World Bank

The US AID Portion of the Project is Being Implemented by

The Consortium for International Development  
Tucson, Arizona, USA

with

Washington State University, Pullman, Washington, USA  
As the Lead University

Correct Citation:

WESTERN SUDAN AGRICULTURAL RESEARCH PROJECT

Livestock Production Specialist/Chief of Party Final Report:  
Project Status and Recommendations for Future Program Focus  
by Dr. Richard H. Cook, February 1986  
WSARP Publication No. 54  
Khartoum, Sudan and Pullman, Washington, USA

## TABLE OF CONTENTS

TABLE OF CONTENTS .....	1
PREFACE .....	1
PROJECT OUTPUT AND IMPACT .....	3
Establishment of Research Infrastructure .....	3
Provision of Physical Resources .....	5
Provision of Human Resources .....	6
Sudanese Scientists .....	6
Technical Assistants .....	6
Provision of Training .....	7
WSARP Research Program Development and Management .....	8
Development of Information Networks/Linkages .....	8
Logistical/Communication Linkages .....	10
Establishment of Applied Research Program .....	11
Kadugli Station Research Program .....	12
1984/1985 Research Results and Recommendations .....	13
Traditional Sedentary Production System, Nuba Mts .....	13
Future Research Activities/Sedentary Production System ..	15
Baggara, Transhumant Livestock Production System .....	15
Future Research Activities/Baggara Transhumant System ..	18
TECHNICAL PROGRAM - LIVESTOCK PRODUCTION .....	19
Introduction .....	19
Producer Orientation .....	20
Sentinel Herds/Flocks .....	22
Supplemental Feeding Trials .....	25
Cattle .....	26
Sheep .....	27
Conclusions .....	28
RECOMMENDATIONS .....	31
Training .....	31
Formation/Establishment of Information Networks .....	32
REFERENCES .....	34
MEETINGS, CONFERENCES AND WORKSHOPS .....	34
ARTICLES/PUBLICATIONS .....	35

## PREFACE

During my tenure on the Western Sudan Agricultural Project (WSARP), which commenced in July, 1982 and continued until December, 1985, I functioned in the capacities of Senior Livestock Production Specialist, Coordinator of Nomadic Systems Programs, and Chief of Party from January, 1984 to May, 1984 and July, 1985 through December, 1985. As a result of these multiple roles with WSARP, I have attempted in this report to include accomplishments, perspectives, and recommendations pertaining to Project administration and research management, research program development, and scientific program content, both present and future.

Within the pragmatic framework of an applied research project such as WSARP, project success is determined in the short term by the effectiveness of the research activities in addressing solvable production constraints for its producer clientele and dissemination of adoptable technologies to the greatest possible number of farmers. Sustainability will be determined by the success of efforts to institutionalize the concept of an integrated, applied research approach within the management infrastructure of the Agricultural Research Corporation (ARC).

In terms of the Project's long term impact on affecting this institutionalization process, it should be realized that WSARP is just one component of what was visualized in 1977/78 as a national effort to reorient the management/research program structure of the ARC to more effectively address the needs of farmers, particularly those in the rainfed sector. The documented outputs of WSARP during the past five years will, I feel, substantiate the conclusion that considerable progress has been made in this effort. More progress would likely have been made in this regard had many of the recommendations of the Ford Foundation/IADS study of 1976 for strengthening the research program design and management capabilities of ARC been implemented. As merely an adaptive/applied research arm of the ARC in Western Sudan, WSARP had a limited ability to influence, much less to demand, such a reorientation.

This is not to imply that the ARC was uncooperative, unreceptive, or unsympathetic to the needs and expectations of WSARP. Quite to the contrary, and as will be discussed, ARC management staff served as valued members of several WSARP research program committees, and scientists resident in Wad Medani were most willing to collaborate with their colleagues who were resident in the West. The basic point is, however, that WSARP's ability to encourage institutionalization of a production systems philosophy within ARC management was through its accomplishments, i.e., success of its research program, not by dictate. Insufficient time has elapsed, in my opinion, to make a final assessment of WSARP's success in this regard.

Descriptions and results of the author's research activities addressing livestock production constraints for sedentary and transhumant producers in Southern Kordofan have been detailed in other Project reports and documents and have only been summarized in this report to the extent necessary to support for recommendations for future research activities.

I want to acknowledge the support, cooperation, and collaboration of my colleagues during my tenure on the Project. Many individuals both from WSARP, as well as from other research/development projects, the University of Khartoum, and the Department of Veterinary Services provided me with invaluable help and suggestions. In particular, I wish to acknowledge the support and council of Dr. D. Dafalla, WSARP Director, Dr. Babo Fadlalla, Dr. W. Trent Bunderson, Dr. Tom Gillard-Byers, Dr. Ibrahim Hashim, Mr. Hashim Mukhtar, and Mr. Mukhtar Kenani, Kadugli Station Director. Mr. Osman Abdullah, Administrative Director of the Project Support Unit in Khartoum, provided invaluable assistance, as did the staff of the Project Support Office at Washington State University, particularly Drs. J. Noel and J.B. Henson. I also want to express my sincere appreciation to my technicians, Mr. Ahmed Hashim and Mr. Mohamed Sulieman and to my driver, assistant, and friend, Mr. Juma Waru, all of whom were chiefly responsible for the execution and completion of our research activities. A special note of thanks is due to Mr. Stephen Horton for his assistance and council during the last hectic months of my time in Sudan.

## PROJECT OUTPUT AND IMPACT

As a result of several studies (Ministry of Agriculture, Food and Natural Resources and the Ford Foundation, 1975; International Development Services, Incorporated (IADS), 1977; and the World Bank, 1978) the Government of Sudan requested IDA to develop and finance an agricultural research project for the rainfed, arid and semi-arid areas of Western Sudan. The project's aim was to develop improved production systems for livestock and crops, to conserve and rehabilitate the natural resources, and improve the standard of living of traditional farmers and pastoralists of the region. The project was also to strengthen national agricultural research efforts through the development and implementation of support activities at the headquarters of the Agricultural Research Corporation (ARC).

Funding of this research effort commenced in 1979 under the sponsorship of the Government of Sudan (GOS), the Agency for International Development (AID), and the World Bank (IBRD), in the form of the Western Agricultural Research Project (WSARP). During its six years of funding WSARP was to create the infrastructure necessary to support an applied/adaptive research program which would design and test production-increasing technologies for traditional producers of the Region. However, shortly after commencement of the Project, Sudan entered a critical period of foreign exchange imbalance, ultimately turning to the International Monetary Fund (IMF) to undertake an economic stabilization program. Economic conditions did not improve during the course of the Project, and, even despite a continuing climate of economic and political uncertainty, the WSARP continued to evolve as a functional, applied research arm of the ARC for traditional producers in Western Sudan. However, much still remains to be done.

### Establishment of a Research Infrastructure

The WSARP was envisaged and has developed as an integral part of the ARC's national agricultural research effort, having special programmatic emphasis for adaptive research activities in the rainfed areas of Western Sudan. The Project was expected to: (1) develop an

infrastructure in the West necessary to incorporate research program management and planning into existing administrative structures of the ARC; (2) strengthen the ARC's central management capacity in the areas of research planning and evaluation and in training and extension. However, because of limitations in funding these latter management inputs were restricted to the establishment of a Project Support Unit (PSU) and the recruitment of a senior technical assistant to fill the position of Senior Advisor to the Director General of the ARC. A Research Planning and Evaluation Unit (PEU) and a Training and Extension Unit (TEU) were not established within ARC's central administrative structure as outlined in the original Project design. However, a senior Sudanese scientist presently being trained under WSARP will establish a Training/Extension Unit at WSARP headquarters in El Obeid. The PSU, which is located in Khartoum, provided critical logistical support services such as: (1) the purchasing, clearing, and forwarding of supplies (especially fuel) and equipment to the research stations in Kordofan Region; (2) coordination of aircraft schedules, maintenance, and operations; (3) organization of in-country and international travel; (4) liaison with GOS/donor agencies/national and international research groups and organizations; and (5) provision of administrative support through the provision of technical assistants.

The development of the WSARP's research program management infrastructure was also established with a view towards integrating Project activities with those of the ARC. Accordingly, the Director General of the ARC was designated, and has served, as chairman of the Project Advisory Council. This council, composed of representatives from various organizations within the Sudan, as well as from donor organizations and the International Agricultural Research Centers (IARCs), met annually to review research program results and to propose future activities. In addition to providing the Project with a broad spectrum of research expertise for program development, the Project Advisory Council was to ensure that the WSARP maintained a research program emphasis which was consistent with Regional and National agricultural research priorities and was complementary with the ARC's other research activities. ARC scientists and national coordinators also served on the WSARP System Program Committee, while

the Director of the WSARP was a member of the Technical and Finance Committees of the ARC.

#### Provision of Physical Resources

A major development aspect of the Project has been the construction of facilities to support research activities at Kadugli and El Obeid in Kordofan Region and at El Fasher and Ghazala Gawazet in Darfur Region. In addition to the construction of laboratory, administrative, library, maintenance, and research station farm facilities, a substantial commitment has been made to construct attractive housing for senior scientific staff as one means of encouraging the recruitment of scientists for rural Western research stations. In addition, an ARC-Liaison Office facility has been completed in Khartoum to provide the ARC with improved capabilities for maintaining and expanding research and programmatic ties with organizations based in Khartoum, as well as providing a physical linkage with the WSARP Project Support Unit, the research stations in the West, and other ARC staff stationed in Khartoum.

The Project's construction strategy was to concentrate initial efforts on rebuilding existing research facilities at Kadugli. As a result, the Kadugli Research Station was completed in November, 1982, at approximately projected costs, thereby allowing for the immediate implementation of a multi-disciplinary research program in Southern Kordofan. Construction at the other sites, eg. El Obeid, El Fasher, and Ghazala Gawazet, has been delayed by numerous factors, including, among others, managerial problems within the construction firm, a deteriorating economic situation making construction material procurement difficult, and transportation problems between Port Sudan and the western construction sites. However, recent estimates by Grube-Zimmer and Karplen Consultants project station completion at these sites in mid-1986.

## Provision of Human Resources

### Sudanese Scientists

The Project has experienced some difficulties in the identification and the recruitment of qualified Sudanese scientists for its research stations, with recruitment efforts to date focusing on the Kadugli and El Obeid stations. Two factors appeared to have been of primary importance in hindering recruitment efforts: (1) delays in the construction program which made it impossible to adhere to projected staffing schedules; and (2) the reluctance of many Sudanese scientists to leave the Khartoum-Wad Medani area to take up assignments in more rural western locations without substantial monetary incentives, and improved housing and social service provisions.

By the conclusion of the present training program, and with the arrival of trainees back in-country, Sudanese scientific staffing will still be below the optimal number to effectively implement an applied adaptive research program at the Project's four research stations. Technical deficiencies will be most critical in the areas of animal production and socio-economics. Additional expertise in the area of forage agronomy will also be required.

### Technical Assistants

In spite of continual delays in the construction schedule, which prevented the timely recruitment of many of the technical assistant scientists, CID/WSU provided a total of approximately 862 person-months of technical assistance during the contract period from 15 August, 1979 until 31 December, 1985. This corresponds to an estimated technical assistance level of effort of 100% as specified in the contract amendment of August, 1985. The level of consultant effort was approximately 93% (33.6 person-months/36 person-months), even though four additional consultants, projected for November-December, 1985 were prevented from traveling to Sudan due to a U.S. Embassy travel advisory. In addition, WSU/CID supplied approximately 7.6 person-months of consultant effort from non-Project

funds, resulting in a total consultant effort of 41.2 person-months, or a level of effort of 114%.

### Provision of Training

Original Project documents (PIO/T), 20 January, 1979) called for the training of eleven (11) Sudanese candidates in formal degree courses, six at the Ph.D. level, five at the M.S. level, and seventeen in non-degree courses. Due to delays in the identification and recruitment of appropriate candidates, the scheduled training program was extended over original projections. However, by September, 1986, it is anticipated that six Sudanese scientists will have been trained at the masters level in the areas of agronomy, soil science, animal science, agricultural economics, and extension. Two additional scientists trained to the M.S. level in agricultural engineering/soil-water and forestry will continue in Ph.D. programs. It is also anticipated that by August, 1987, eight Sudanese scientists will have been trained at the doctorate level in the areas of range/forage science, agricultural economics, agricultural engineering, agronomy, soil science, and forestry.

Approximately twelve professional staff will have participated in non-degree training courses by 31 December, 1985. Areas of study have included, among others, animal nutrition, biology and control of Striga, accounting and finance, and research management. The number of staff receiving on-the-job training is somewhat below the anticipated number of 80 primarily because of delays in the construction program and consequent delays in the recruitment of staff and establishment of research programs. Only the Kadugli and the El Obeid research stations and the Project Support Unit had an opportunity to initiate "in-house" training programs. Generally this has been done on an informal basis emphasizing those techniques and methodologies currently being utilized in on-going research and support activities, including quantitative methods for evaluating rangeland herbaceous and woody vegetation, laboratory techniques for nutritional analysis for forage and browse species, routine animal health diagnostic procedures, procedures for designing and implementing reconnaissance surveys, and data analysis techniques

utilizing an IBM microcomputer and software, vehicle maintenance, and others.

#### WSARP Research Program Development and Management

The WSARP established a research management infrastructure for program development and coordination which aimed to integrate all individual research station programs into a complementary and integrated Project-wide research effort. Programmatic emphasis at the research station level was prioritized on designing and testing potentially adoptable production-increasing technologies which addressed important production constraints for the research station's clientele. Station Research Committees, composed of senior scientists and chaired by the station directors, were established to formulate, discuss, and finally integrate various discipline/commodity research areas into a unified, multi-disciplinary production system research program. A Project Systems Committee, composed of a sedentary, transhumant, and nomadic system coordinators, nominated by Project management, examined each of the research station programs to try and ensure that individual stations were functioning in a complementary nature and providing a clear Project research focus for the major production systems served by the Project's research stations. The Project Advisory Committee, chaired by the Director General of the ARC, and composed of representatives from both national and international organizations and research interests in the Sudan, was concerned primarily with making recommendations to the Project Director to ensure that Project programs were compatible with research programs being concurrently implemented by other national and international organizations in the Sudan, and consistent with Regional and National priorities for agricultural research and development.

#### Development of Information Networks/Linkages

It was recognized that the most effective applied research program for traditional producers in the West would be one which: (1) provided scientists with the information necessary to make knowledgeable decisions regarding the selection of available technologies for use in applied research programs; and (2) provided

the mechanisms necessary to disseminate information regarding successful research results to the largest possible number of consumers and consumer groups. Such a research program, therefore, required the establishment of information networks and linkages at several professional levels, and the WSARP has begun the process of establishing such linkages.

The WSARP, primarily as a result of the efforts of the Senior Advisor to the Director General of the ARC, Dr. James J. Riley, established and maintained formal and informal linkages with many research organizations which were addressing agricultural production problems for traditional producers in Western Sudan, such as the University of Khartoum; the German Technical Assistance (GTZ) Mechanized Farming Project, Kadugli; the Nuba Mountain Rural Development Project, Kadugli; Hunting Technical Services Ltd., Khartoum; the Western Savannah Development Corporation, Nyala; the Jebel Mara Development Project, Jebel Mara; Ministry of Animal Resources/ Department of Veterinary Services, Khartoum/Soba; Livestock Meat Marketing Corporation, Khartoum; and international organizations such as INTSORMIL, (sorghum/millet CRSP) and the bean and groundnut CRSP. In addition, close linkages have been established with several of the IARCs, such as ICARDA, ICRISAT, AVRDC, IITA, and ILCA, as well as CSIRO, in Australia.

Moreover, the WSARP has continued the process of establishing an information network at the Project level. Each research station has been programmed to have a small library, primarily to house selected books and publications. Facilities for microfiche review of relevant documents and reference material maintained at the central reference and information center in El Obeid is being initiated. In addition, the Project well recognized the problems associated with professional isolationism, common in the rural settings where most of the Project's research activities take place. Accordingly, efforts to keep research staff abreast of relevant national and international meetings, and encouraging research staff to participate in such meetings has been part of the research management philosophy being developed by WSARP. However, on the output side of the research program, less effort has

been expended to date on the establishment of formal linkages with the local and regional extension service and consumer groups.

Although WSARP is only now beginning to generate research results which could culminate in promising technological packages for producer adoption, the extension linkages necessary to diffuse this information to large numbers of producers and consumer groups are poorly developed. In an effort to overcome part of this problem, the WSARP has made provisions for the recruitment of "production specialists" for each research station. These individuals will be charged with the responsibility of establishing solid linkages between local extension service representatives and consumer groups, and the research station. Such linkages are intended to facilitate the dissemination of appropriate research results to producers as well as providing a mechanism for information to flow back to the research station from producer for consideration and potential incorporation into future research programs. In addition, the Project has already experimented with the establishment of an annual "Farmers' Field Day," where interested individuals from research, production, marketing and trade groups can come to the research station to view and discuss with station staff on-going research activities and future research plans. Such opportunities help to keep both consumer and research groups enlightened as to the needs and expectations of one another and to better focus research efforts on current and future needs of the research station's clientele. However, considerable efforts are, and will be required to strengthen existing extension services in the West.

#### Logistical/Communication Linkages

Each of the Western research stations has a radio which enables it to maintain daily contact with each of the other stations as well as with the Project Support Unit in Khartoum. Such communication is vital to provide for the transmission of professional information among research stations and between the Project and other research organizations working in the area, as well as for maintaining security for Project families stationed in the West, particularly in terms of possible medical emergencies.

In addition, the Project maintains an aircraft, DeHavilland Twin-Otter, which is intended to maintain a weekly flight schedule to all stations in the West. The maintenance of these communication linkages is of vital importance for the operation of research activities in both Darfur and Kordofan Regions.

#### Establishment of an Applied Research Program

In addition to developing the infrastructure necessary to support an applied research program, the WSARP has designed and implemented, at Kadugli and El Obeid, an integrated, production system research program. Because of the delays experienced in the construction program and consequent delays in the recruitment of staff and in the operation of facilities, the establishment of such a program at El Fasher and Ghazala Gawazet is behind schedule.

Research program development at both Kadugli and El Obeid has emphasized a "systems approach," with station activities focusing on the predominate production system(s) in the area being served by the station. The technological emphasis of these research programs has been on identifying applied technologies which: (1) have potential for overcoming the causes of major production constraints faced by producers; and (2) can be evaluated in adaptive, on-farm, in-herd trails. In those instances where policies, rather than technologies, are identified as the major obstacle to increasing productivity, alternative policies and programs are formulated and discussed with local, regional, and national policy-makers. Where technology development has been identified as necessary to overcome an important production constraint, and where such development is clearly outside the existing mandate of the Project, Project research staff have attempted to "farm-out" such development activities to other, more appropriate organizations.

According to original Project plans, applied research programs were to be initiated in the following area: (1) crop/livestock systems, (2) water/land-use management, and (3) range/livestock systems. Depending on the needs of the clientele of individual research stations, such research programs have been initiated at Kadugli and El Obeid. Research guidelines and tentative plans for

programs at El Fasher and Ghazala Gawazet have been formulated and discussed with the Regional Ministry of Agriculture in Darfur Region. Implementation of a research program at these stations is anticipated for mid-1986.

#### Kadugli Station Research Program

The Kadugli Research Station has focused its research program on the two predominate production systems in Southern Kordofan. The first of these is the traditional sedentary production system in the Nuba Mountains, and here research efforts have been directed at exploiting the potential of this system for the development of improved mixed-farming production practices. Consequently, an interdisciplinary research program was initiated, utilizing both on-station and on-farm trials which (1) tested new and improved varieties and identified improved cultural practices for sorghum, sesame, and cowpeas, the principal crops grown in the area; (2) tested new and improved varieties of dual-purpose legumes for incorporation into the existing cropping system; (3) examined the use of conserved forages, crop residues, and modified animal husbandry practices to improve livestock productivity; (4) initiated on-farm trials, in cooperation with the Nuba Mountain Rural Development Project, with draft oxen to exploit the potential for incorporating animal traction into the existing production system; and (5) provided socioeconomic data on traditional households and commodity price information for establishing guidelines for research program development and for evaluating the efficiency of local markets and producer marketing strategies.

The second major production system of the area is the Baggara, transhumant livestock production system. The research program addressing production constraints in this system focused on: (1) evaluating rangeland productivity and identifying potentially adoptable improvements in natural resource management practices; (2) evaluating the productivity and seasonal nutritional status of livestock under traditional management conditions and initiating in-herd/in-flock supplemental feeding trials; and (4) providing socioeconomic data to evaluate producer-market interactions, marketing

strategies, and elasticities for the output of cattle, sheep, goats, and various livestock products.

### 1984/1985 Research Results and Recommendations

The details of previous research activities and results have been documented elsewhere (refer to WSARP Reports, numbers 40, 41, 42, and 43). What follows is a general summary of research results achieved to date at the Kadugli research station, where I have spent my tenure on the Project. Also included are some general recommendations for future research activities.

#### Traditional Sedentary Production System, Nuba Mts.

1. Cultural practice trials: These have concentrated on using improved, short-maturing varieties of sorghum, specifically examining weeding practices, plant populations, seed dressing, fertilizer responses (nitrogen/phosphorus), and improved soil/water conservation practices. Results to date indicate that sorghum yields can be maximized (during years with below average rainfall) by using improved, short-maturing varieties (eg. Gadam El Hamam); weeding 2 and 4 weeks after plant emergence; using 20 cm between plants/60 cm between rows; and using phosphate fertilizer at the rate of 40 kg/ha. Mulching was shown to increase yields by almost 2.3 times over traditional practices, while economic analysis of the practice indicated that adaptations would have to be made to make it economically viable under producer conditions.

2. Variety screening trials: These have been substantially reduced in number during the past several years, with the present focus of screening trials concentrating on the most important crops grown in the area (sorghum, sesame, cowpeas), as well as several crops considered highly promising for introduction (eg. mungbeans and pigeonpeas). Selection for advancement to subsequent cropping seasons for most varieties have been based not only on yields but also on Striga resistance (sorghum); low pod shattering (sesame); bean/forage yield and nodulation (legumes).

3. On-farm trials: These have indicated that: (1) Hageen Dura 1 hybrid sorghum performed well under farmer-managed trials and

producers are willing to increase their acreage to this variety providing that seeds can be supplied in a timely manner; (2) improved, short-maturing varieties of sorghum, with seed dressing and fertilizer ( $P_2O_5$ ), out yielded all local varieties with traditional practices across all locations (1984); and (3) researcher-managed fertilizer trials with improved short-maturing varieties of sorghum showed rates of return to improved varieties with long-term average yields for South Kordofan ranged from 268% to 404%.

4. Legume trials: These have concentrated on those showing a high potential for grain production for household consumption and/or sale, as well as for forage production. In this regard cowpeas, mungbeans, pigeonpeas, and guar have shown high potential. On-farm trials with cowpeas (1984) indicated that the early planting (June 15-30) with plant spacings of 20 cm between plants and 50 cm between rows, could be expected to yield up to 2-3 tons of forage/ha with an effective rainfall of 350-500mm. Preliminary economic analysis showed that the highest benefit/cost ratios resulted when legumes were intercropped with sorghum. Crop rotations, are, however, considered a critical practice in traditional cropping systems to produce sustained increases in productivity.

5. On-farm livestock trials: These trials have concentrated on the introduction of animal draft and improving the dry season nutrition of cattle. Economic analysis of animal draft has indicated that benefit/cost ratios ranged from 1.15 to 3.45 over a five-year period when only rental benefits were considered and 4.92 to 11.24 over a similar period when welfare benefits were also included in the analysis. Feeding trials with harvested native grass hay were not successful because of the poor quality of the hay which resulted from problems in harvesting, curing, and storage. Similarly, feeding trials utilizing both a forage legume (peanut tops) and sorghum stover indicated that very little improvement in intake and digestibility of the stover was achieved even when substantial quantities of legume were ingested.

### Future Research Activities/Sedentary Production System

1. Expand researcher- and farmer-managed trials to examine the adoptability of; (1) introduction of improved varieties of sorghum (Gadam El Hamam, Hageen Dura #1), and (2) improved cultural practices. Both should be examined in relation to labor availability and alternatives for resource allocations.

2. Initiate researcher-managed, on-farm trials to evaluate the introduction of improved varieties of sorghum, sesame, and cowpeas on jubrakas (housegardens) to increase the availability of food for household consumption during the "hungry period."

3. Selected on-station variety screening trials, focusing on sorghum, sesame, cowpeas, mungbeans, guar, and pigeonpeas.

4. On-station development of improved soil/water management practices, including mulching, for both far-field and housegarden application.

5. Expand on-farm oxen draft activities to include a pilot study designed to assess the potential for development of village-level credit programs supported by draft cart rentals (1985).

6. In-herd/on-farm diagnostic studies will be continued to critically examine and evaluate the seasonal nutritional status of sedentary livestock and initiate strategic supplementation feeding trials focusing on both large and small ruminants and the incorporation of legumes in the supplement during the dry season and a mineral supplement including phosphorus during the rainy season.

### Baggara, Transhumant Livestock Production System

1. Rangeland productivity and utilization studies in the Nuba Mountains: These studies have shown that: (1) most rangelands are only in fair condition due to a dominance in the herb layer of tall coarse fast-maturing annual grasses of relatively low nutritional quality which is largely the result of inadequate grazing pressures during the growing season and the high incidence of burning during the dry season; (2) woody vegetation on most rangelands is declining in abundance and diversity in response to existing pressures from selective browsing, frequent burning, and a rising demand for land and wood products; (3) fires annually consume an estimated 25-30% of the

net primary production, and prevention of a 30% loss in herbage at the current utilization rate of unburnt forage by livestock (8.4% annually), would be sufficient to support a 43% increase in livestock biomass, an increase which during the dry season, would have very little impact on the composition of the herbaceous vegetation; and (4) only approximately 40% of the rangelands are utilized by livestock during the dry season due to the scarcity of permanent sources of water.

2. Inefficient utilization of the natural resource base is a fundamental problem for all livestock producers in Southern Kordofan. This is primarily the result of: (1) an inability/unwillingness to cope with the physical/disease factors associated with the rainy season use of the cracking clay plains; (2) widespread burning; (3) limited sources of water during the dry season; (4) land-use conflicts among producers groups over land and water resources; and (5) the absence of an effective land-use policy in the Region.

3. Monitoring studies with sentinel herds, have shown that cattle can be maintained year-round on the cracking clays at a level of productivity comparable with that commonly observed for the transhumant system providing that: (1) animals are given at least one year to adapt to climatic conditions; (2) year-round sources of forage and water are available within relatively close approximation to one another; and (3) the strategic control of ectoparasites is practiced.

4. In-herd studies of the seasonal nutritional status of transhumant cattle and sheep have shown that: (1) for cattle the phosphorus content of the grazing diet ranged from 0.05% to 0.13%, from dry season to rainy season; adult cattle are in a negative energy/nitrogen balance, with 95% of lactating cows being clinically deficient in phosphorus during the dry season, while during the rainy season the majority of lactating cows are in a positive energy/nitrogen balance but are clinically deficient in phosphorus; and (2) for sheep, energy and phosphorus appear to be the most limiting nutrients for pregnant ewes during the rainy season; energy/protein/phosphorus were limiting nutrients for lactating ewes during the early dry season, and energy was apparently the most limiting factor during the late dry season.

5. Researcher-managed, in-herd, dry season supplemental (sesame cake at maintenance crude protein levels) feeding trials with adult, female, transhumant cattle (1984/85) showed that supplemented cattle gained weight during the dry season supplemental period while unsupplemented cattle lost weight during the same period (1984). In 1985, however, both supplemented and unsupplemented groups lost weight when given the same level of supplement as that given in 1984. This was likely the result of the very poor grazing available during the 1985 dry season, the result of the 1984 drought. However, during both years, 1984 and 1985, supplemented cattle gave significantly more milk than unsupplemented controls, and their calves had significantly higher birth weights and growth rates for the first three months post-calving. However, during the subsequent rainy season (both 1984/85) there was no difference in milk production between groups. In 1984 unsupplemented animals gained significantly more weight than did animals which have been supplemented, such was not the case in 1985 where both groups gained weight at approximately the same rate. Calculation of marginal benefit/cost ratios for milk production showed that adoption of the practice was not cost/beneficial over a two-year period.

6. Researcher-managed, in-flock, dry season supplemental (sesame cake at 1/2 maintenance crude protein levels) feeding trial for breeding ewes (1985) showed that the level of supplementation had no significant effect on weight gains either for ewes or for suckling lambs. The lack of response to this trial was likely the result of an inadequate level of supplement to offset the very poor available grazing resulting from the 1984 drought. In addition 16% of all lambs died before weaning, the majority during the first three months of life as the result of respiratory infestation; ewe losses ranged from 12% to 20%, the highest occurring in unsupplemented, control animals and the lowest in animals supplemented with sesame cake/phosphorus. The majority of lactating ewes (early dry season) and maintenance ewes during the late dry season were clinically deficient in phosphorus as indicated from plasma phosphorus levels.

7. Livestock marketing studies indicated that producer strategy was quite complex, depending on rainfall patterns, commodity prices,

demand for liquidity, and scale of anticipated purchases. The rapid increase in the market price for sorghum during the 1985 dry season resulted in a price ratio of cattle:sack of sorghum of almost 1:1 as of May, 1985, and made the usual practice of selling small ruminants for most staple food purchase an impossible practice to follow.

8. Sociological studies have shown that Baggara women participate in herd management. Women have rights to milk and milk products and make decisions on how to allocate these products. Women usually do the milking and have the right to any cash earned from such sales. During the rainy season the sale of milk and milk products provides most of the cash for purchase of subsistence household requirements.

#### Future Research Activities/Baggara Transhumant System

1. Proposed feasibility study, in collaboration with the Regional Government (Kordofan) for introducing water on a limited basis to increase the availability of dry season grazing, accompanied by an evaluation of grazing management practices and strategically applied animal health control measures (control of ectoparasites).

2. Studies on the marketing of livestock by transhumant producers, milk production, consumption and sales, and contribution to transhumant household income.

3. Analysis of forage plants selected by grazing ruminants in relation to their seasonal nutritional status.

4. Implementation of improved management and husbandry practices for the research station's sedentary sentinel herd to assess potential productivity increases for traditional cattle maintained continuously on the southern ranges.

5. Phosphorus supplement trials for both transhumant cattle and sheep during the 1986 rainy season.

6. Phosphorus supplementation of pregnant ewes during the rainy season combined with early weaning and supplemental feeding of lambs during the dry season

## TECHNICAL PROGRAM - LIVESTOCK PRODUCTION

(A Perspective for Future Livestock Production Activities)

### Introduction

What is contained in this section is a brief discussion of the research strategy which has guided the development of the livestock production program for Southern Kordofan and how this strategy interfaced with the general trends and critical issues characterizing livestock production systems of the area. This section is followed by a series of recommendations for future research activities, based on the results of diagnostic survey, and in-herd trials.

In extensive livestock production systems, which are the predominant type found in Southern Kordofan, the inability of producers to control and manipulate their natural resource base, their mobile nature and consequent inaccessibility to many social services and infrastructural developments, their opportunity to readily accumulate livestock and the attractiveness of livestock for investment purposes, collectively define a production system with highly questionable long-term sustainability. This instability basically results from conditions which provide incentives for increasing the animal component and disincentives for managing the natural resource base. Long-term improvements in livestock production in the Region will only be realized if these fundamental issues are successfully addressed. The problems presented for livestock production activities are very complex, and cannot be realistically addressed if livestock production research is undertaken in isolation from other research programs, eg. socioeconomics and agronomy. The technical inputs commonly associated with improvements in livestock production, eg. improved nutrition, breeding practices, general husbandry and disease control, all lead to an increase in the number of livestock. Unless these activities are undertaken in collaboration with other disciplines so that concurrent improvements in the agronomic resource base and marketing opportunities for livestock and livestock products are achieved, the technical success of livestock production activities could, in reality, result in further stress on the production system and exacerbate already existing production

constraints, as well as providing new ones. Livestock production efforts must be closely integrated with those of range scientists, and crop, soil and water scientists to develop more efficient and rational uses of the natural resource base; of socio-economists to clearly identify producer production goals and objectives and to assist in the development and institutionalizing of marketing incentives for encouraging offtake; and finally, of regional policy-makers to design, implement, and enforce sound land-use policies. Unless this is done the objectives of measurably improving the welfare of traditional livestock producers (pastoralists) will not be achieved. In the specific case of Southern Kordofan, the ecology of the area rationally argues for long-term development efforts focusing on exploiting the potential for mixed-farming. Although transhumant production systems will persist for many years in Southern Kordofan, utilizing resources which are unavailable for sedentary producers, time will probably see this production system continually squeezed, constrained and restricted with regards to the available land resources which can be utilized for migratory livestock production activities. Sedentary farming, particularly on the cracking clay plains which predominate in Southern Kordofan, will likely increase and become more characteristic of integrated mixed-farming systems with livestock functioning in a complementary role with major crop production efforts.

#### Producer Orientation

The underlying technical objective of the livestock research program has been to improve the ability of producers to better manage their natural resources. Under existing land tenure systems and in the absence of definitive land-use policies, it has not been possible to directly address the resource management question. However, within a conservationally sound framework, the research program has focused on potentially solvable production constraints of practical importance to producers.

Diagnostic activities were part of an initial research effort to identify what production constraints were viewed by producers as most important and to assess their causes and what options were available for producers to circumvent or overcome them. Discussions with

producers greatly assisted in focusing the livestock research program, though in many cases the problems cited by producers as being the most serious and having the greatest impact on production were either not within the Project's mandate to address, eg. policy issues relating to land tenure, or could not be addressed with existing Project resources, eg. improving the supply of acaricides, antihelmentics, or mineral supplements in the marketplace for producer consumption. Once an addressable production constraint(s) was identified, however, a potential technology was selected for evaluation. Technology testing was prioritized for in-herd evaluation, if feasible and not preventing too great a production risk for the producer. Producers were considered to be partners with researchers in the establishment and implementation of field trials and accordingly, research program planning emphasized the necessity of working with producers and their animals as early in the research process as possible. As a consequence, early diagnostic activities concentrated on acquainting producers with the Project's goals and objectives and enlisting their assistance in identifying some practical ways to address some of their problems.

Initially, livestock production activities focused on the Baggara transhumants simply because: (1) the Baggara are the principal livestock owners and producers in Southern Kordofan; (2) many aspects of livestock production, and consequently production constraints, faced by the Baggara are similar to those for Nuba sedentary producers who raise cattle and therefore lessons learned from one group would likely be applicable to the other; and (3) land-use pressures and security problems associated with migrations and securing dry season forage and water supplies in southern areas appeared more critical for the Baggara than for Nuba cattle owners. It was also realized that research staff would initially find livestock producers reluctant to cooperate with them in initiating field activities utilizing their own animals. Therefore, to overcome this problem, and begin a process of education between producers and research staff, the concept of sentinel herds and flocks was introduced as a research tool for initiating field trials with livestock.

### Sentinel Herds/Flocks

The establishment of sentinel herds and flocks was one means successfully used by WSARP researchers to overcome some of the obstacles frequently faced in implementing a farming systems research program for pastoral systems. Because it was realized by staff that the design of production-increasing technologies by researchers and their adoption by producers required attention to both an identification of major production constraints and an understanding of how producers mobilized their resources to achieve their production objectives, initial diagnostic surveys focused on producer practices. Moreover, because adoption required that new technologies be demonstrated to be clearly superior to existing practices under producer conditions, in-herd testing was considered to be the most effective way of screening new technologies. An inherent problem in the diagnosis of livestock production constraints was the necessity of evaluating field data over extended periods of time, which invariably involved the handling and sampling of animals. Since pastoralists were generally reluctant or unwilling to have their animals handled or manipulated by research staff, alternative methods of field demonstration/evaluation had to be developed.

To overcome these problems, sentinel herds and flocks, owned by the research station, but similar in demographics and management to traditional groups of animals, provided WSARP scientists with an opportunity to: (1) initiate livestock diagnostic studies under simulated traditional management conditions; (2) plan, design, and implement researcher-managed trials; and (3) familiarize pastoralists with research methodologies and demonstrate that these do not have a significant negative impact on animal production. At the same time, this methodology familiarized research staff with some of the environmental factors with which pastoralists must deal in undertaking their production activities. These interactions between research station staff and producers facilitated the concurrent implementation of both applied and adaptive trails with producer animals.

Field trials with both a migratory and a sedentary sentinel herds attempted to clarify two basic issues for livestock producers in Southern Kordofan. The first was to better define what were the

actual problems in maintaining cattle year-round on the southern cracking clay plains (important in any consideration of increasing the utilization of these areas). The second was to quantitate the level of productivity and the main production constraints under traditional migratory conditions as commonly practiced in the area.

Results from range science studies (See Bunderson, WSARP publication number 43) examining the utilization of natural resources by traditional producers in Southern Kordofan suggested that on southern ranges an abundance of natural vegetation went unutilized each year. At the same time, many of the northern ranges were undergoing deterioration due to intense exploitation by both livestock and crop production, the former of particular importance during the early part of the rainy season. Thus, it was reasoned that if cattle, as well as small ruminants, could be maintained on the southern ranges for extended periods of time, then some of the grazing pressures on northern ranges, especially critical during the early rainy season, might be reduced. Accordingly, a sedentary herd was established on the research station farm at Kadugli and was maintained under husbandry conditions comparable to those of traditional producers. This herd, which has been monitored for the past three years, has shown that the maintenance of cattle year-round on these ranges in the South is possible, and offers a potential alternative to traditional migration during the early rainy season. Such sedentary husbandry practices should initially enable producers to maintain a level of productivity comparable to that found under traditional migratory conditions, while improvements in management would be expected to increase animal productivity over the long-term. These studies have clearly shown that the overriding factor limiting cattle productivity under both sedentary and migratory practices is poor nutrition, especially during the dry season and that improved utilization of forage resources on southern rangelands will require the future development of dry season sources of water and the control of grazing in the vicinity of these sources.

Ectoparasitic infestations were a problem for both sentinel herds, though to a greater extent for sedentary animals during the rainy season. The strategic application of acaricides is viewed as an

essential management tool to improve animal productivity by reducing the irritation and predisposition to secondary infections which are common for cattle in the area. A low intensity tick control program, focusing on the late dry and rainy seasons should result in significant improvements in animal productivity while maintaining the disease resistance characteristic of the indigenous livestock. Data also indicated that helminths may be an important factor increasing the nutritional stress on young stock during the late dry season, a consideration which could take on more importance with the adoption of sedentary husbandry practices. Oral antehelminth drenching of young stock early in the dry season, January/February, coupled with the rotation of calf enclosures could be important management tools to limit the helminth burdens and should be evaluated in future studies with the research station's sedentary herd.

The stress of late pregnancy and early lactation during the end of the dry season, was considered to be an important factor contributing to adult mortalities in both the sedentary and migratory herds. Under traditional husbandry practices, breeding is uncontrolled and generally takes place in August/September, when female animals come into estrus, following several months of lush grazing during the rainy season. Accordingly, the peak calving period occurs in May and June. Delaying conception until October, when the animals are still in good nutritional condition, would result in July calving, a time when there is generally an abundance of good quality forage on the southern ranges to support early lactation. The potential difficulties of having heavily pregnant animals commencing a northern trek, or calving during the trek, would not be a serious consideration for transhumants if they delayed their northerly trek until mid-July.

Though disease was a problem in both herds, the existence of an effective vaccination program in Southern Kordofan against the common endemic disease problems, should make disease control possible, and therefore not an insurmountable barrier to the rainy season utilization of southern ranges. Clearly management practices must try to control ecotoparasitic infestations and biting flies. Other factors, such as market availability, location of cheese factories

(now generally located in the North), etc. must be taken into account before recommendations for the year-round use of these southern areas can be finalized.

### Supplemental Feeding Trials

The primary objective of supplementary feeding trials with grazing ruminants (cattle and sheep) was to obtain the maximum benefits from natural pastures with a minimum investment in supplementary feed. To achieve this objective it was necessary to determine in what respects the available forage and browse were nutritionally deficient, on a seasonal basis, and how these deficiencies could best be provided. Range nutrition studies in southern Africa (Van Niekerk, 1978) have emphasized both the importance of supplying nutrients known to be deficient in the grazing ration and, conversely, the futility and economic wastefulness of feeding nutrients which are not demonstrated to be limiting animal performance.

Livestock production in Southern Kordofan, as is the case for most of Western Sudan, is largely dependent upon vast tracts of unimproved, open savannah, and the performance of livestock which are maintained under these extensive conditions is severely restricted by the extreme variation in the seasonal nutritive value of the grazing. Both the quantity and quality of the available grazing closely follow the yearly rainfall patterns, which are seasonal with a 3-4 month rainy season (mid-June through mid-October) and a 8-9 month dry season. The performance of animals grazing under such conditions shows a characteristic pattern of rapid gains during the rainy season followed by a period of weight loss, which may total, by the end of the dry season to as much as 30% of the peak rainy season weight. As a result of this pattern of weight gains, cattle usually take from 5-6 years to attain their maximum, mature body weight. From an economic standpoint this pattern of fluctuating body weight is problematic (Van Niekert, 1978) as cows are unable to maintain their body weight during the dry season and are not able to recover these losses during the immediate post-calving period. The net result is that cows tend to conceive on alternate years, only after having had an opportunity

to recover their lost body reserves. Limited growth rates and low calving percentages combine to contribute to low herd turnover rates which are characteristic of extensive cattle production in most of Sudan and the rest of Africa.

Considerable research effort has been expended during the past three years to identify nutrients, and other technical and management factors responsible for the poor performance of traditional grazing livestock in Southern Korodofan. Because of the seasonal variation in forage quality, and the difference in quality of different herbaceous communities between the northern and southern ranges, research has focused on relating both seasonal and locational factors to the quantity and quality of available forage and browse.

Accordingly, animals from the research station's sentinel herds, as well as animals from producer herds and flocks, have been used by research staff to concurrently undertake both diagnostic evaluations of forage availability and quality, as well as, implementation of supplemental feeding trials which provided, on the basis of preliminary evaluations, those nutrients which were considered to be most limiting animal performance. Preliminary nutritional evaluations indicated that energy and protein were most limiting during the dry season, while phosphorus, and possible other minerals (copper, zinc, selenium), deficiency appeared to be a problem throughout the year for both cattle and sheep. In these evaluations, the seasonal nutritional status of livestock was related to physiological state, the principal factor determining the animal's nutrient requirements.

#### Cattle

The technical details and results from in-herd supplemental feeding trials during the past two years have been documented elsewhere (See WSARP publications, numbers 41, and 43). In general, these trials have shown that the high cost of energy/protein supplements during the dry season resulted in a negative benefit/cost ratio when they were fed at a level that provided for a maintenance level of crude protein. The provision of phosphorus during this season had little impact on animal performance, a result which is consistent with that found for cattle maintained under similar

management conditions in southern Africa (Kotze, 1948; Shur, 1968; Ward, 1968). The absence of a phosphorus response during the dry season was likely due to the fact that energy and protein were more limiting. In fact, Van Niekert (1978) found that in South Africa, where bi-modal rainfall patterns predominate, marked responses (increases in weight gains) to phosphorus supplementation only occurred when animals were in a positive energy and protein balance. These studies also showed some carry-over effect to the rainy season, when phosphorus was supplemented during the previous dry season. WSARP studies did show slightly higher, though not statistically significant, plasma phosphorus levels in cattle supplemented during the previous dry season than in unsupplemented, control animals. Moreover, the rate of daily gain and the level of milk production were also not significantly different during the rainy season between groups which were or were not supplemented with phosphorus during the previous dry season. Plasma phosphorus data indicated that all animals were most deficient (lowest plasma phosphorus levels) during the rainy season (both 1984 and 1985), a time when weight gains and milk production were at their yearly high. Consequently, future supplementation trials with phosphorus should examine the effects of supplementation during the rainy season. Phosphorus supplements will likely exert their maximum effect on animal productivity during the rainy season when energy and protein are available in optimal amounts.

### Sheep

The impact of an energy/protein/phosphorus supplement on the productivity of transhumant sheep during the 1985 dry season was minimal. The major reason for this result was the low level of supplement fed (approximately 1/2 maintenance level of crude protein based on an estimation of forage intake from normal grazing). Due to the drought and limited sources of water during the later stages of the dry season, available grazing became very scarce, with the result that energy likely became the most limiting nutrient. Phosphorus deficiency, as evidenced from plasma phosphorus levels, was most pronounced in December/January/February. Improvements in the productivity of these animals might be achieved by the supplementation

of energy and protein during the end of the dry season thereby improving conception rates during the early rainy season and shifting the peak lambing season to the early, rather than late, dry season. Such a strategy would, however, probably require the early weaning of lambs so that ewes would not be additionally stressed during the last half of the dry season.

Because studies with cattle and sheep (ibid.) have shown that phosphorus shows its maximum effect on productivity when fed to animals with adequate energy and protein intakes, future phosphorus supplementation trials with transhumant sheep should concentrate on supplementaton during the rainy and early dry seasons, when transhumant sheep are at their peak periods of physiological stress (gestation, early lactation) and available energy and protein are at their highest available levels. In-flock trials with transhumant sheep have also shown the importance of disease control measures on flock productivity. During an 18 month survey the average mortality for lambs less than 4 months of age was between 16% and 20%, with death generally the result of respiratory disease. In addition, ectoparasitic infestations, especially ticks and lice, were very high during the latter stages of the dry season when animals were in their poorest condition. Future trials, in collaboration with the Veterinary Department, should examine potential strategic measures to overcome both these disease problems.

### Conclusions

One of the beneficial results from our studies with sentinel herds was the dialogue and interactions such activities generated between researchers and producers. On this basis alone, studies with sentinel herds should be continued, and their use further exploited for implementing demonstration trials for producers. The main purpose of the supplementation trials with transhumant cattle was to evaluate the economic feasibility of feeding sesame cake during the dry season. Preliminary findings indicated that supplementation, as carried out in our trials, was not economically viable. Though insufficient time has elapsed to accurately assess the impact of such supplementation on reproductive performance, it is unlikely that producers could, or

would supplement young, growing females with sesame cake to improve their subsequent breeding performance. Indications are that such supplementation would only improve performance by 20-30% (personal, unpublished data), reducing the calving interval from 21 months to 14-15 months. Under existing management conditions this would amount to only one additional calf per breeding lifetime for the average female animal. This additional benefit which would require several years of supplementation was not considered sufficient by producers to encourage adoption of yearly dry season supplementation. The conclusion from these trials was that traditional pastoralists need to better exploit, in a more conservationally sound fashion, the available natural forage resources on southern ranges, thereby minimizing the necessity for provision of purchased feed inputs .

In general, work with pastoralists over the past 3-1/2 years has indicated that very rational, economically sound decisions are made by households regarding the management of their livestock production enterprises. The low level of animal productivity commonly noted for extensive, pastoral systems, when compared to fenced ranching systems, the unsophisticated animal husbandry practices utilized by traditional producers, and the often conservationally unsound use of their natural resource base, are collectively a reflection of the political and economic environment in which pastoralists function. Substantial improvements in the productivity of pastoralists will be, in the first instance, predicated on the implementation and enforcement of sound land-use policies and changes in the marketing system where a kilogram of beef or litre of milk has a greater economic value to the producer than does the accumulation of large numbers of relatively unproductive livestock. Fundamental to engendering such a concept, is the adoption of land use policies which require sound land management practices in order to support and improve the productivity of the dependent livestock. Unless pastoralists appreciate the concept of finite natural resource base, one which must be managed in a sound technical fashion, little improvement in either livestock productivity or in natural resource management can be achieved. Moreover, producers must be provided with reasonable economic incentives to encourage off-take.

Bhenke (1984) cited several case studies in other African countries (Botswana and Libya) where livestock production has been seen to evolve from a purely traditional, pastoral system to a commercial one. Within this context, Bhenke (ibid.) cited several criteria which he considered necessary for such an evolutionary process. Included were the establishment of land-use policies, which involved the allocation of large tracts of land to individuals and/or groups for specific commercial purposes, and economic development on a national scale. Improvements in infrastructure, marketing, job opportunities, and in the general standard of living, were all considered essential driving forces for "modernizing" livestock production systems. In Western Sudan, where there the comparative advantage for development of the Region rests with the traditional agricultural sector, efforts should attempt to maximize production by stabilizing the natural resource base through the development of improved long-term crop rotation systems, instituting improved grazing management practices, and better integrating livestock production into improved mixed-farming systems. For pastoral systems, improvements in productivity will be very long-term in their realization; will require significant changes in land-use policies; and will be highly dependent on the success of regional and national development efforts. Research activities for pastoral systems often can only respond to these changes once they occur. Because of their scope of impact, research station models cannot duplicate actual conditions. Such is not strictly the case, at least to the same degree, for sedentary producers who exert greater control over natural resource management. Thus, short-term improvements in productivity leading to general and sustained economic development will more likely come from improvements in this production sub-sector. Therefore, future research activities should focus on improving livestock productivity for this system. Such activities could commence by utilizing the research station's sedentary sentinel herd (Kadugli) and examining improved management practices involving supplemental feeding with forage legume, strategic control of ectoparasites, improved breeding/culling programs, and improved calf management practices. The aim of these studies would be to evaluate what level of output is realistic with a given level of

input, and once established, how such interventions might be extended to consumer groups. These activities should clearly complement on-going agronomic programs and emphasize improved management practices such as the increased use of legume feed supplements, increased use of animal manure, use of animals for draft and traction, and improved husbandry practices for increasing milk production and the marketing of livestock products. Work by ILCA (1984) has shown that the financing of inputs for improving and stabilizing agronomic activities has frequently come from the sale of livestock and livestock products. For Southern Kordofan, where the ecological potential clearly favors crop production, livestock should assume a complementary and supportive role to such agronomic developments.

### RECOMMENDATIONS

(Issues for Future Consideration)

#### Training

The implementation and continuation of station research programs will be greatly dependent on the ability of the Project to recruit and keep qualified technicians. To date, a high quality of technical support has been recruited at the junior and senior technical level. However, most senior technicians have been provided employment on secondment basis, while many junior technicians have been hired on the basis of two-year contracts. The continuation of this "temporary" employment agreement with technical support staff will not meet either the long-term programmatic needs of the Project nor provide for career development opportunities which will encourage technical staff to continue with the Project.

Considerable effort has been devoted to discussing an incentive program for senior scientific staff, while very little attention has been given to formulating and implementing a similar program for technicians. At the Kadugli Research Station only three senior technicians have been given an opportunity to undertake non-degree specialization courses abroad. Efforts have been made to implement an "on-the-job" training program, however such training does not

substitute for degree and formal non-degree training opportunities in other institutions both in and out of country.

Training for Project maintenance and support staff is also a critical issue. In this regard, the maintenance of facilities, equipment, and the initiation of preventive maintenance programs are essential ingredients for the continuing successful operation of the Project. Three general areas need to be considered: (1) vehicles: while considerable progress has been made in securing spare-parts and providing a breakdown maintenance service, little progress has been made in instituting a preventive maintenance program for Project vehicles; (2) equipment maintenance: this applies to both laboratory and office equipment, and involves the implementation of a maintenance schedule for major pieces of equipment; and (3) building maintenance: implementation of a maintenance program focusing on structural and service functions.

#### Formation/Establishment of Information Networks

The Project is fundamentally a converter of information. Technical information flows into the Project from other research organizations, or is generated from its own research program. Information flows out of the research station to consumer and other research groups. Thus, information networks must operate at two basic levels: first at the technical scientific level to provide research staff with basic technological facts and interrelationships on which to base the selection of technologies appropriate for inclusion in an adaptive research program; and secondly, at the output end of the research chain, where successful adapted research results must be extended to consumers.

The WSARP has made significant progress in establishing some information channels at the technical input side of the research program process. The Senior Advisor to the Director General of the ARC was instrumental in establishing linkages with other research organizations, the Project has undertaken to establish an information network among research stations so as to coordinate programs and avoid duplication of research efforts. Future operational capabilities in Darfur Region will place additional strain on existing logistical

support/information networks, and these must be strengthened and maintained.

Establishing mechanisms for the dissemination of research information to consumer groups is critical to maximize the Project's impact on local and Regional production. This is an area which will require cooperation and collaboration among several agencies, eg. local/Region/extension service, communications media (radio, television) and other cooperating government agencies such as crop protection, range/pasture administration, veterinary services and animal production, etc. Establishing formal linkages between these agencies and the Project has been identified as one program area of the El Obeid Project headquarters. In addition WSARP production specialists, located at each of the Project's research stations will be charged with the responsibility of establishing linkages between local/regional consumer groups/technical staff, and the research station staff.

The long-term sustainability of the WSARP will be determined by its success in providing producers of the West with effective production-increasing technologies. As a result it is hoped that total productivity will be improved, and the West will develop a viable infrastructure and tax base to support and sustain regional development. More specifically, this success will be, in large measure, determined by the determination and commitment of qualified Sudanese scientists and technical and support staff for undertaking and maintaining relevant agricultural research programs in the rural West. At this stage in the development of a rainfed agricultural research infrastructure, donor agencies must not lose sight of the fact that considerable long-term assistance will be required to provide the operating resources necessary to establish such a research effort. Priorities for funding must address those constraints which threaten such efforts, such as the lack of monetary incentives for staff, poor social/medical services in Western rural areas, and limited career development and professional opportunities. While it can be argued that recurrent expenses for such a development project should be borne by host governments, for Sudan, such expectation under the present economic and political uncertainties is unreasonable and doomed to

disappointment. We need on the part of donor agencies and staff the same commitment for Project success that we expect and request of host country professionals and policy-makers.

#### REFERENCES

- Benke, R. 1984. personal communication.
- Kotze, J.J.J. 1948. Sheep Farming in Sour-Grass Veld Area. S. Afr. Dept. Pamphlet No. 24.
- Shur, S. 1968. Beef Cattle Response to Supplemental Trial. Modern Farm Management 4:25.
- Van Niekerk, B.D.H. 1978. Limiting Nutrients: Their Identification and Supplementation in Grazing Ruminants. In "Latin American Symposium on Mineral Nutrition Research with Grazing Ruminants." proc. of a conference in Belo Horizinte, Brazil, March 22-26, 1976, ed. Conrad and McDowell, Univ. of Florida, Gainsville, Fla, pages 194-200.
- Van Schalkwyk, A. and Lombard, P.E. 1969. The Influence of Phosphorus Supplementation on Body Function and Growth of Young Steers. Agroanimalia 1:45.
- Ward, H.K. 1968. Supplementation to Beef Cattle Grazing on Veld. Rhod. J. Agri. Res. 6:93.
- Winks, L. and Lang, A.R. 1972. Urea, Phosphorus, and Molasses Supplements for Grazing Beef Weaners. Proc. Aust. Soc. Anim. Prod. 9:253.

#### MEETINGS CONFERENCES AND WORKSHOPS

- |             |  |
|-------------|--|
| March, 1983 | Western Sudan Agricultural Research Project Farming Systems Workshop. Paper presented: "The Role of FSP in FSR," Khartoum, Sudan.  |
| April, 1983 | Western Sudan Agricultural Research Project Regional Meetings and Planning Workshops. Paper presented: "Nomadic Production Systems in Northern Kordofan - Reconnaissance Survey," El Obeid, Sudan. |
| May, 1983   | Planning Workshop, Ghazala Gawazet, Past, Present, and Future Activities. Khartoum, Sudan.   |
| May, 1983   | Field Trip to S. Darfur to examine areas for   |

potential collaboration with WSDC.

- May, 1984 Western Sudan Agricultural Research Project Regional Planning Workshop -- Management of Research Programs.
- December, 1984 Western Sudan Agricultural Research Project Regional Meetings with the Ministry of Agriculture, Darfur. Conference on program planning for research stations at El Fasher and Ghazala Gawazet.
- January, 1985 Western Sudan Agricultural Research Project and CIMMYT/East Africa, FSR Workshop, Wad Medani.
- March, 1985 FSR, sponsored by ICARDA/IDRC, "The Design and Implementation of Livestock On-farm Trials." Presented two papers, Production and Feeding of Conserved Forage to Traditional Cattle in the Nuba Mts., by Drs. W.T. Bunderson and R.H. Cook; Criteria in Evaluating Livestock On-farm Trials, by Dr. R.H. Cook.

#### ARTICLES/PUBLICATIONS

- Bunderson, W.T., Cook, R.H., and Fadlalla, B. 1983. Pastoral Systems in Arid and Semi-arid Africa: Basic Problems in Resource Management. Presented at the 2nd International Rangelands Congress, Adelaide, Australia, November, 1983.
- Cook, R.H., Bunderson, W.T., and Fadlalla, B. 1983. Application of Farming Systems Research and Development for Extensive Livestock Systems in Arid and Semi-arid Africa. A paper presented at FS Workshop, Kansas State University, August/September, 1983.
- Cook, R.H. and Fadlalla, B. 1985. Seasonal Disease Incidence in a Sedentary and Migratory Herd in South Kordofan, Sudan - Implications for a Change in Traditional Management Practices. (submitted to TAHP).
- Fadlalla, B. and Cook, R.H. 1985 Design and Implementation of In-Herd/On-Range Trials - The Use of Sentinel Herds. presented at a FS Workshop, ICARDA, Aleppo, Syria. IDRC (monograph), in press.
- Bunderson, W.T. and Cook, R.H. 1985. Production and Feeding of Conserved Forages to Traditional Cattle in the Nuba Mts., Sudan. Presented at a FS Workshop, ICARDA, Aleppo, Syria. IDRC (monograph).
- Cook, R.H. 1985. Criteria for Evaluating Livestock On-Farm Trials. Presented at a FS Workshop, ICARDA, Aleppo, Syria. IDRC (monograph).
- Cook, R.H. 1983. Dar Kababish - Exploratory Production System Survey, Report #2.

Cook, R.H., Fadlalla, B., and Bunderson, W.T. 1984. The Nutritional Status of Transhumant Cattle During the Dry Season - A First Approximation. Research Report #4.

Cook, R.H. and Bunderson, W.T. 1983. The Nutritional Status of Sudan Desert Sheep - A First Approximation. Research Report #3.

Cook, R.H. and Fadlalla, B. 1985. The Seasonal Phosphorus Status of Transhumant Sheep in South Kordofan, Sudan (in preparation).

Cook, R.H. and Fadlalla, B. 1985. The Seasonal Phosphorus Status of Transhumant Cattle: The Effect of a Dry Season Protein/Phosphorus Supplement on Plasma Phosphorus Levels and Productivity. (in preparation).

Cook, R.H. (ed.) 1985. Summary of Sedentary and Transhumant Production Systems Research Results 1984/85 - Kadugli Research Station. Western Sudan Agricultural Research Project, Khartoum, Sudan/Washington State University, Pullman, Washington, USA, WSARP Pub. #41.

Cook, R.H. (ed.) 1985. Summary of Transhumant Production System Research Results, Kadugli research Station, 1984/1985. Western Sudan Agricultural Research Project, Khartoum, Sudan, Sudan/Washington State University, Pullman, Washington, USA., WSARP Pub. #43.