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WESTERN SUDAN AGRICULTURAL RESEARCH PROJECT



RANGE AND LIVESTOCK RESEARCH  
REVIEW AND RECOMMENDATIONS

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THE GOVERNMENT OF SUDAN  
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WASHINGTON STATE UNIVERSITY

CONSULTING REPORT  
AUGUST 18 - SEPTEMBER 5, 1984  
RANGE AND LIVESTOCK RESEARCH  
REVIEW AND RECOMMENDATIONS

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RANGE MANAGEMENT AND LIVESTOCK PRODUCTION CONSULTANT

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CONSULTING REPORT

Western Sudan Agricultural Research Report

August 18 - September 5, 1984

Range and Livestock Research

Review and Recommendations

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Range Management and Livestock Production

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Western Sudan Agricultural Research Project  
Consulting Report on  
Range and Livestock Research--  
Review and Recommendations

Don D. Dwyer, Ph.D.  
Consultant

This report covers the period of time in Sudan--August 18-September 5, 1984. Time was spent in both Khartoum discussing the project with staff and reviewing pertinent reports and documents, and in Kadugli where I spent time in the field seeing all on-going activities and discussing the research with the scientists. During one morning the research on Striga was reviewed in Shambat with Drs. Faiz Bebawi, Hogrn and Riley.

Because of transport difficulties making aircraft unavailable more time was spent in Khartoum than originally planned and there was no time in El Obeid, Gazala Gawazet and El Fasher. Discussions were held with Kadugli animal and range scientists Fadlalla, Bunderson and Cook on the progress at those stations on range/livestock research and approaches to the research to be conducted there. cursory evaluations and discussions were held with the crops and socio-economic scientists.

The work of Ahmed El Wakeel was reviewed at Kadugli and the dissertation progress of Moustafa Rahama was discussed with him on three occasions in Khartoum.

#### Background and Philosophy

I have been involved in a consulting capacity with this project from 1979 when station locations were being finalized, to the present (1984) as the station construction is concluding and the research at Kadugli has

achieved significance. The range/livestock research is now well on its way to making real, measurable, positive impact on western Sudan. It must be understood that the original timing and expectations of the project were too ambitious for the circumstances and the project is far behind projections made in 1978-79. Notwithstanding, impressive progress has been made. The project as it was conceived is still valid and the approach to its implementation is sound.

As a matter of fact the timing of project implementation, though behind early projections, appears quite correct given the circumstances. It would have been impossible to have had all stations staffed and programs running effectively had construction been completed as first scheduled. Kadugli has very effectively served to develop a good model by which the stations at El Fasher and Gazala Gawazet can be patterned. With this Kadugli model programs at these two stations could be up and running effectively within one year.

#### Project Goals and Research Approach

The WSARP is designed in connection with Sudan's Agricultural Research Corporation to improve rainfed crop and livestock production in Kordofan and Darfur Provinces. These two provinces represent an enormous area (35% of Sudan) and contain 25% of Sudan's population.

The project's research approach has been to first understand the traditional crop and livestock systems through reconnaissance and diagnostic surveys and evaluations. With the help of producers constraints to production are then identified on which to do high priority research on-

farm, in-herd and on-station that is both producer-managed and researcher-managed. And finally, likely fruitful interventions will be identified and developed that can be adopted by the producer or pastoralist which will result in increased production at the producer level. This approach is sound and the early results appear to be working. The technical information gained thus far in both range/livestock and crops appears to be relevant, appropriate and applicable to the pastoralist and farmer.

In the case of range it was necessary to gather baseline ecological information on the status of the ecosystem. This has been done and has guided the research now being conducted in livestock production. There has been real value to having the diagnostic survey approach completed before the various research projects are firmly designed.

#### Review of Range and Livestock Research at the Kadugli Station

Range research was begun in March, 1981 by Dr. W. T. Bunderson with a reconnaissance survey of the study area around Kadugli. Numerous vegetation types were evaluated and ten were selected for further study within a 20 km radius of the research station. Grazing exclosures were constructed and protected against fire. Results of knowledge gained from these exclosures, other vegetation and soil studies and diagnostic surveys of sedentary and migratory herds have served as a partial basis for the range/livestock research which has been underway since approximately 1983. With Drs. Richard Cook's and Babo Fadlalla's arrival as livestock specialists considerable integrated research in range and livestock has been established by Bunderson, Cook and Fadlalla.

Most all of the ongoing research is quite well summarized in the annual report covering the 1983-84 research results at the WSARP Kadugli Research Station. I will not repeat material in that report but will comment on its contents.

The report is excellently done. It is thorough and complete and provides a sound basis for continuing research in range and livestock. I am impressed with the remarkably full integration of the research in range management and livestock nutrition and management. This is a credit to the scientists in the range/livestock section. The ongoing research in range/livestock is within the proper context of being rational and related to the constraints of the traditional producer. The work is being guided by the baseline data which was collected for range and livestock in 1981 and 1982. The work has been kept on target and is faithful to the workplans developed for each year. The value of the quantity and quality of the research now underway and planned by Drs. Fadlalla, Cook and Bunderson must be recognized and appreciated.

### Significant Findings

Some of the more important findings that have been observed and documented for South Kordofan are these:

1. The structure and composition of transhumant and sedentary herds have been identified and described.
2. The productive efficiency of these herds under traditional management has been established.
3. The natural forage production for all major vegetation and soil

types has been determined.

4. The relative native plant species composition and their contributions to grazing is now known.

5. Crude protein and energy content of key native forage species during the wet and dry seasons has been determined.

6. Preliminary information has been gained on lactation responses of transhumant breeding cows when sesame cake is used to provide supplemental protein.

7. A model of nutritive value of forage available and voluntary intake of cattle has been developed for the dry season in South Kordofan. This model, which uses known values from other similar locations of the world, clearly indicates the dry season forage for the region is very deficient in digestible protein and phosphorus. This information will guide the design of new research which will address the specific protein and phosphorus needs for livestock of South Kordofan.

8. A model similar to that described in 7 (above) has been developed for desert sheep grazing during the dry season in North Kordofan and Darfur. It is emphasized that these models have been constructed using "book values" but they will prove extremely useful in showing what kind of nutrition research should be given high priority. Excellent working papers for each of the two models have been prepared describing these two important livestock systems. The indication is that phosphorus is always deficient for cattle in South Kordofan and nearly always deficient (except for wet season) in the more arid regions of the north.

9. By protecting key areas (50 x 50 meters) from both grazing and

fire, it has been demonstrated that fire and not grazing is the major force in decreasing the quantity and nutritional quality of range forage in South Kordofan. Generally the finding is that perennial forage grasses have been killed and replaced with less desirable, fire tolerant annual grasses. Desirable forage shrubs have been reduced in number by the frequent fires and replaced with less desirable fire tolerant shrubs. In four years the protected exclosures have shown statistically significant vegetation changes favoring desirable perennial grasses and shrubs.

10. Screening of forage legumes has identified which of the local varieties as well as which of the exotic varieties show promise for livestock feed and for crop rotation schemes.

#### Future Research at Gazala Gawazet and El Fasher

There seems to be little doubt that development and research implementation should be continued at Gazala Gawazet (GG) and El Fasher (EF). Construction is near completion and the two regions the stations represent are important to the agricultural production of western Sudan. The best thing about their later than planned arrival on the scene is that experience has been gained at Kadugli and El Obeid which can now be effectively applied. Particularly with respect to range/livestock, an excellent model for research has been developed and implemented at Kadugli which should be used at all three of the other stations. That is that baseline data be gathered on the rangeland ecosystem which will determine its status ecologically and its productivity agriculturally. Structure, composition, productivity and traditional management strategies should be

identified with regard to livestock herds and flocks. It is clear that desert sheep and camels become much more important in the arid regions and thus research should emphasize these species to the level of their importance. The strict integration of range and livestock should be continued as well as the identification of crop residues which can be used to supplement the nutrition of livestock during the dry season.

Desertification is a problem of major proportions in EF and less so but still critical in GG and El Obeid. Research by the range scientists should clearly identify the causes of desertification, the extent to which it occurs annually and the nature and time required for its recovery when the causes are eliminated. It is now presumed that overgrazing and shifting cultivation are the main causes.

Based on knowledge gained thus far at Kadugli and the models developed from it, it would appear that low nutrient status during the dry season, particularly crude protein and phosphorus, would be important areas of early research. The role of these nutrients and minerals with regard to milk production and reproduction is critical and means to supplement deficiencies at an economic level must be investigated early.

#### Extension of the Project

The project appears to be moving along quite well at the present time. There is clear evidence that successes in research are occurring. The scientists for the most part are pursuing productive and likely fruitful studies. The "farming systems" approach is correct. It seems to me it would be a terrible waste of investment to quit now or even to reduce the

scope too drastically. It is a research project and all who have been involved with research administration understand why it takes a long time to get the support and infrastructure in place that scientists and science require.

Having followed the project closely for over five years there is no doubt in my mind that significant and permanent gains have been achieved and quite frankly the extent of the gains are not far from what experienced observers of similar situations might predict could have been accomplished. Criticism that more should have been achieved expresses disappointment but to say more could have been accomplished would be in error.

The Kadugli Research Station is quite successful and it is located in a key agricultural area where integration of crops, range and livestock is obviously needed. This station should continue to receive high priority with project extension. Next in priority of support should be El Obeid followed by El Fasher since EF represents the most arid as well as particularly fragile ecosystem. It seems important that the work in the EF area be guided more toward range and livestock but with some emphasis given to "desert cultivation." This means research on water harvesting and conservation techniques and attention to methods of halting desertification by reclaiming areas abandoned after cultivation. Least emphasis, in my opinion, should be given to GG if priorities must be set. My reasons have to do with the fact the area does not represent any ecological extreme and is relatively much more stable ecologically than EF. There is some work going on with cattle breeding and management and this should be improved upon and continued. Also because of the 20 square miles of pastures that

have been established for perhaps 25 years there should be some on-station grazing studies done using the station herd and a local herd as a comparison. Modest research efforts in variety and fertility trials of important crop species should be included.

#### Kadugli Sentinel Herds

The goal of setting up the migratory and sedentary sentinel herds in 1983 was to test the hypothesis that migratory cattle could be productive year-round on the cracking and noncracking clays. The traditional wisdom held that due to mud and biting flies during the wet season it was necessary to migrate north and not return until the commence of the dry season. Therefore the scientists constructed a sedentary herd purchased locally that represented the structure and composition of the migratory herds. The sedentary herd was kept on the Kadugli Station, grazed there year-round in the traditional fashion and did not receive any feed supplements. At least for that year and about half of the present wet season the sedentary herd has done well compared to the migratory herd.

The station owned migratory sentinel herd was placed with a pastoralist and managed by the pastoralist along with his own cattle. This sentinel migratory herd is used as a comparison with the sedentary station herd.

The question now is what should the next step be? My recommendations are these. The migratory sentinel herd should be maintained as it has been in the hands of pastoralist management and migratory status. The animals should continue to be measured and productivity evaluated. When

appropriate, comparison trials can be conducted on the sentinel migratory herd using phosphorus and/or crude protein supplement and compare responses with the pastoralist's own herd. The sedentary herd should now be developed as a Kadugli Station demonstration herd that receives the inputs considered to be economically rational.

Although the year-round test with no inputs has run for only two wet seasons it appears certain that sedentary herds can survive in the Kadugli region with few problems on a year-round basis. Now low level inputs should be used. For example, minimal levels of crude protein provided by forage legumes or sesame cake to help achieve minimum needs of breeding animals during the dry season. Effects of phosphorus supplement needs to be examined immediately. Culling and selection for replacement animals should be applied using criteria that are important to the traditional producer as well as good herd management.

Research trials both on-station and off-station with producer animals should be continued and used to evaluate inputs that might be applied to the station demonstration herd. Experience seems to indicate that 50 animals is an adequate size for a demonstration herd. This leaves plenty of station grazing land available for other research trials that need to be run. Using the sedentary herd as a demonstration herd to which research proven inputs are applied provides a real opportunity to use the "adaptive research" approach.

The sedentary and the migratory herds should continue to be closely monitored and production parameters measured. Records of cost of inputs must be maintained so that economic analyses can be run.

Later it might be considered whether a sentinel sedentary herd should be developed for the station from local sedentary cattle. This herd would receive no inputs except that it would be provided adequate forage and water by proper stocking. This herd would serve as the control to the Station Demonstration Herd with regard to economic and productivity comparisons. It would also be extremely useful for demonstration purposes to show the additive effects of various inputs and management interventions given the Kadugli Station Demonstration herd.

#### Role of Range and Livestock as a Part of Sudan's Total Rainfed Agricultural Strategy

Livestock will always be an important and critical part of Sudan agricultural whether it continues as a pastoralist transhumant system or tends gradually to become sedentarized with greater commercialization. In the North and West of Sudan range livestock will forever be the most important agricultural activity. This is true because crops that are climatically, ecologically, and edaphically suited extremely limited. For this reason it is critical that range and livestock be included as an important part of the overall rainfed agricultural strategy for Sudan. Even for the central Sudan semi-arid region in South Kordofan the primary agricultural production comes from livestock. Economic inputs required for livestock are quite small and returns are relatively large.

A rainfed strategy that emphasizes the integration of livestock and crops makes a lot of sense. Crop aftermath and forage legumes can serve to replace the grazing which is lost due to cultivation as well as increase livestock productivity by meeting maintenance needs. In the case of

legumes it seems quite probable that by using them in crop rotation the length of fallow on cropland can be eliminated or significantly reduced.

The role of milk in the total agricultural system is critical. Preliminary research at Kadugli indicates that .75 k of sesame cake per day for 90 days increased daily milk production over four times and lengthened lactation at this higher level of milk production about two times. This work needs further evaluation to be sure the work is repeatable but indications are the finding is significant and far reaching.

#### Progress of Sudanese Ph.D. Candidates in Range Science

The work of Ahmed El Wakeel was reviewed and progress evaluated. The fact that there was no rain through September 5th at his research location at El Obeid has resulted in elimination of that location from the study. Wakeel is now emphasizing the research on the leguminous, forage shrub Leucaena at the Kadugli Station and a second location about 90 km north of Kadugli. At these locations he is measuring establishment, survival, nodulation, nitrogen production, and impact of defoliation levels (0, 50, 100 percent), and is comparing direct seeding of Leucaena with transplants.

One of the big problems for him thus far is that rainfall at Kadugli has been far below normal and as a result the direct-seeded plants have had very poor germination and emergence. Overall however, El Wakeel is adapting to the circumstances and revising his research approach as necessary to accommodate the situation. He is making good progress and barring unforeseen disasters should produce adequate data for his dissertation. He will send a quarterly report to his committee at Utah

State University advising the members of his progress.

Regarding Moustafa Rahama I am not as optimistic. He visited with me on three occasions in Khartoum and presented some of his results and findings, described his work and responded to my questions. Presumably he has completed his field research and has commenced writing his dissertation. The material he presented to me is wholly inadequate to be used for a Ph.D. dissertation. We agreed that he would send a draft of his dissertation to his Utah State University advisory committee (through me) no later than November 30, 1984. This deadline was chosen by Moustafa. The committee will then make a judgment as to whether or not Moustafa will be admitted to candidacy. It must be noted that Moustafa has not once in 2-1/2 years corresponded or informed his committee of his progress. As far as Utah State University is concerned his file has been suspended and will not be reinstated until an acceptable dissertation draft is shown. November 30 is a firm and final deadline for this event.

#### Project Administration

I learned the scientists at Kadugli are pleased with the overall administration of the project. There have been some positive administrative changes and the people in the field recognize them. Sudanese and ex-patriot scientists feel their needs are being addressed and served in a timely fashion. They were complimentary of Dr. Dafalla's directorship and administration and felt that his decisions have been timely and fair.

Chief-of-Party LaMoyne Hogan has an excellent attitude and interest in the project. He is dedicated to the needs of the scientists and already in

his short tenure has helped to improve their morale considerably.

From my perspective project administration is the best it has been since the project started.

### Recommendations

The following recommendations result from this visit as well as the knowledge I have accumulated over the past five years.

#### General

1. Continue the integrated, farming systems approach to research. I was an early skeptic but am now convinced it is a proper manner in which to approach research in primitive agricultural systems. The traditional producers have learned a lot about their systems and their knowledge dare not be ignored.

2. The fact this is a research project and not a development project must continue to be emphasized. Development projects generally seek relatively quick solutions to obvious problems, frequently treating symptoms rather than causes. Research projects move much, much more slowly, particularly when institution building is involved. A foundation must be laid with buildings, people and processes. This takes at least five years. This project is now ready to produce results that are meaningful and applicable. The Kadugli model is ready to be adapted to other locations.

3. In my opinion the project should be extended to El Fasher and Gazala Gawazet in a prudent and thoughtful fashion emphasizing what is

important but following the integrated systems approach.

4. A forage agronomist is badly needed for the Kadugli Research Station. The research needed for forage legume testing and evaluation, and livestock feeding and crop rotation is more than enough to require such a scientist. The range scientist cannot add this project research need to his present assignment.

5. If the project is extended it should be amended to include an extension component. By that time there will be enough research to be extended. Perhaps this component should be located only at the Kadugli and El Obeid Stations at first.

6. There are a number of items of information being developed by the project that need to be made more broadly known. It would be in the best interest of the project to develop a periodic newsletter to which the research scientists contribute findings from their projects. The Chief-of-Party could take responsibility or assign responsibility to one of the project support staff to prepare the newsletter for distribution to USAID, ARC, World Bank, other organizations and other project scientists. This would serve as a valuable public relations document for WSARP.

### Research

1. Expand research on cattle feed supplementation to include influence of forage legumes, rates of feeding sesame cake and phosphorus on milk production, reproductive efficiency and increasing digestibility of sorghum fodder.

2. Conduct voluntary intake studies with cattle during various periods of the year. In more arid locations do intake studies with sheep.

3. Adaptability studies and trials with forage legumes are critical for both livestock and crops. The future role of dryland legumes appears to be quite significant as protein supplement for livestock and as a soil improvement factor in crop rotation schemes.

4. Market oriented research needs to be emphasized so that projections can be made as to if and how the market would react to increased productivity of livestock which will result from application of research findings in range and livestock. Also the role markets play in affecting livestock migration routes needs study.

5. Future range/livestock research at El Fasher should emphasize desert sheep and camels and at Gazala Gawazet should include desert sheep and camels along with emphasis on cattle. Both stations should examine impacts of shifting cultivation and its role in the desertification process.

6. Continue to emphasize the work on animal draft. Early information indicates there are potentially great advantages to using animal draft in land preparation, crop harvest, and storage and transport of livestock forage.

7. Work of Dr. Fadlalla is impressive and valuable. He should continue his planned research on voluntary intake of cattle grazing range, feeding trials using crop aftermath, digestibility studies, grazing behavior and plant selection.

8. Expand chemical analyses of forage plants to include phosphorus and major trace minerals.

9. Future work at Kadugli should include goats. This animal plays a

key role in human nutrition and its grazing behavior and nutrition there are unknown. Studies need to examine nutritional requirements and grazing behavior, productivity, milk production and other attributes of the goat. The goat is also playing a role in controlling bush while obviously attaining a diet much more nutritious for itself than cattle and sheep.

10. The idea of establishing a dry season grazing reserve in South Kordofan needs to be pushed. This appears to have real potential for increasing livestock productivity by providing water to a large area which is now unavailable for grazing in the dry season because water for livestock is absent. Preliminary discussions with Regional Government indicate its interest in collaborating in the effort. The study would be designed to focus on 1) strategic development of water resources, 2) the mechanisms for establishing land-use rights, 3) the initiation and implementation of clear land-use policies and 4) the development of grazing management systems.

#### Long Term Training

1. The education and training of the Sudanese to assume the role of research scientists should continue to be emphasized if the project is extended. People are the least developed resource in Sudan yet therein lies the greatest potential to develop the country and obviously is more important than the commodities which the project hopes to increase. This, however, requires a long term view which is often difficult to accept since the payoff is far away. The hope is that incremental gains in education now will result in exponential gains later in agricultural production.

2. When Sudanese graduate students return to Sudan to conduct their research on the project their research should, in as much as possible, be designed for conduct on the research station. This will minimize the support needs and mitigate against problems encountered off-station. This would suit agronomy, range and livestock graduate students.

#### Replacement of Range Scientist at Kadugli

1. Should the project be extended it will be necessary to replace the range scientist at Kadugli. Dr. Bunderson is presently planning to leave the project in May. This means his replacement should be recruited and on location by March 1 so there will be a two month overlap. The overlap is crucial to maintain the continuity and momentum in the range/livestock section. One of the major reasons this section has been productive is due to Dr. Bunderson's continuous role (over four years) in the project.

#### Conclusions

When this project was initiated its overall goal in research was to improve or increase the production and efficiency of the agricultural system while maintaining or improving the natural resource base. The research approach considered that livestock and crops were a system which could be integrated. It was thought important at the outset to know the behavioral processes associated with traditional cropping and livestock production and to learn where in those processes it might be possible to interject interventions that would be both appropriate and acceptable.

Especially the range and livestock scientists have stayed remarkably on target in identifying the most important constraints to production and

designing both on-station and in-herd research trials to solve them.

Based on experience with other similar projects, it seems to require at least three years to solve logistical problems of recruiting and locating teams in the field and another three years to find the right emphasis and design for the field organizations to pursue. From that point the working model should be ready to spread. It is not unusual that full benefits of a new approach are not visible for 10 years after project initiation and perhaps 15 years are required before the new program is sustainable in the local system. It is essential that sponsors of projects which seek to establish the buildings, infrastructure and process such as in this research project, recognize that long-term commitment of resources will be needed to insure success.

It is important to continue to expose the purposes and methods of WSARP to Sudanese scientists, Sudan government officials, programs and institutions through a program of workshops. Visibility nationally is essential for long term continuation of WSARP objectives and goals.