

REPORT: USERS OF SEASONAL FORECASTS WORKSHOP
ARMOEDSVLAKTE, VRYBURG
5-6th October, 1999

Summary

A two day workshop was held in Vryburg, South Africa with scientists, climate forecasters, Department of Agriculture personnel and ranchers. The goal of the workshop was to: 1) present project plans and objectives to the local community; 2) generate stakeholder interest in the project, and 3) to solicit advice for modifying plans and methods and to incorporate into the project their concerns and information needs.

We found that the ranch community was interested in climate forecasts but generally unaware of them or how to use or access them. Forecasters explained how forecasts were made, their availability and how they were distributed. Much discussion occurred on climate forecasts and local needs. There was great effort among climate forecasters and local stakeholders to find common ground whereby ranchers could obtain useful forecasts. Issues such as having forecasts in simple terms, in the local language, and distributed by well informed extension officers, were issues that people agreed were important to address. A need was found for forecasts to be made available before winter (e.g., April/May); and for forecasts to be updated and modified throughout the season.

Stakeholders were also interested in the added value of the SAVANNA model output on forage condition and potential economic returns. There was much discussion on where the model would be housed and the best methods to get model output to the stakeholders.

The workshop was a success because it brought climate forecasters and ranchers together for the first time. However, the workshop was also seen as just the beginning of a long-term iterative process of getting appropriate forecasts (and model output) into the hands of the livestock producers in the region. The goal for the entire group was to make the livestock sector less vulnerable to high climate variability.

Project Workshop

Project Workshop

A very useful and informative workshop on users of seasonal forecasts was held at Armoedsvlakte, in Vryburg, South Africa on the 5th and 6th of October, 1999. The workshop was organized by Colorado State University and the University of the Witwatersrand as part of a National Oceanic and Atmospheric Administration (NOAA) funded research project on responses to climate variability and the utility of climate forecast information for the livestock sector in the arid and semi-arid zone of South Africa. The project explores effects of El Nino - Southern Oscillation (ENSO) events and the potential value of climate forecasting (long-term seasonal forecasts) to livestock ranchers and emerging ranchers in Vryburg and surrounding areas in the North - West Province of South Africa.

Informative Presentations

The workshop brought together various stakeholders as participants, including scientists, ranchers, and representatives from the Department of Agriculture, to discuss and debate goals and objectives of the workshop.



Figure 1. Workshop participants

Several presentations on the science underpinning the project opened the workshop:

Mr. Hennie Scholtz, Director of the Agricultural Field Services, in whose facilities the

workshop took place, opened with greetings. He emphasized that few of his constituents were using climate forecasts but stated that they were very interested in obtaining them. He stressed that the timing of climate forecasts was important in order for ranchers to use them appropriately.

Dr. Coleen Vogel, University of Witwatersrand, made a presentation on droughts, their impacts and lessons learned from work in South Africa and the North West Province. She highlighted the connections between climate, agricultural production and household food security.

Dr. Kathy Galvin, Colorado State University, introduced the project, outlined the aims and objectives of the research and provided some preliminary results on the modeling of drought and impacts in the study area. She explained that this project is exploring the effects of ENSO¹ events and the potential value of climate forecasting to livestock ranchers and pastoralists in a semi-arid shrub-savanna region in northern South Africa. This region, like other environmentally similar areas of central southern Africa, has experienced ENSO-induced losses of livestock production. In these regions, such losses and resultant decreased economic opportunities are major problems for both commercial ranchers and small-holder herdsmen. The project goals are to:

Determine how long-range climate forecasts (of El Nino events)² might enhance the welfare of commercial and emerging livestock ranchers in areas of high climate variability in southern Africa.

Determine how forecast information can be packaged and delivered to optimize human adaptation.

Project objectives include:

1. Assessing the effects of ENSO events on vegetation, livestock and people in the study area.
2. Identifying short-term, event-oriented tactics used by ranchers and pastoralists to cope with individual ENSO events.
3. Estimating how long term climate variability influences livestock production patterns and human coping strategies.
4. Determining the extent to which climate forecasting facilitates drought-coping tactics or could be modified to facilitate coping.
5. Using recent ENSO events (1992-93, severe, and 1997-98, mild) as part of a comparative research design.

We are currently conducting interviews and surveys with local livestock owners (see section by Jerry Hudson, below) to characterize the patterns of resource exploitation and land use employed by various types of livestock owners in the study area. Jerry is also determining how ranchers and

¹ ENSO, the interaction between El Nino and an atmospheric phenomenon known as the Southern Oscillation, influences rainfall and temperature patterns, especially in Southern Africa.

² El Nino (the Christ child in Spanish) is the name for the warming of the tropical Pacific Waters off the coast of South America. El Nino and its opposite counterpart, La Nina (when the waters cool), affect rainfall and temperature patterns around the world.

pastoralists cope with ENSO-induced events both for long term strategic management adjustments and short term tactical responses to ENSO events; determining the extent to which livestock owners now have access to and use climate forecast information, and ascertaining how forecast information could be best packaged and disseminated to maximize utility to livestock owners.

Field ecological surveys will be undertaken in April 2000 to ground truth vegetation maps and to identify regions of special concern within the study area. A spatial description of the ecosystem is now being developed through the acquisition and creation of geographic information system (GIS) data-bases representing the abiotic, biological/ecological, demographic, socioeconomic and sociopolitical attributes of the study area.

SAVANNA, a computer model that simulates various scenario outcomes resulting from variations in biotic and abiotic input factors, will be used (see section by Pete Weisberg, below) to assess the value and probable success of alternative coping strategies, including how alternative strategies influence ecosystem sustainability and economic viability under probable ENSO drought patterns. SAVANNA will also be used to explore the possible value of coupling model assessments of ENSO impacts with climate forecasts to provide information on ecological and economic impacts of ENSO events to livestock owners. We are currently developing a socio-economics model that will be linked to SAVANNA to assess the potential benefits of climate forecasting for human welfare, among different socioeconomic groups (see section by Philip Thornton, below).

Mr. Willem Landman, South African Weather Bureau (SAWB), gave a presentation on the compilation and content of seasonal forecasts. He stressed that the Long-Lead Forecasting group at the SAWB aspire to create useful climate forecasts. However, at this point their ENSO forecasts can only explain about 30% of rainfall variation in this region. This is partly due to the fact that forecasts must be made over a very large area and therefore have less predictive value at the local level. Forecasters at SAWB use multiple global circulation models to make probabilistic forecasts. The forecasts are made in the third week of each month and cover three months. The forecast is updated monthly. The forecast for January to March 1999 predicted that it would not be dry but precipitation was below normal. This variation was due to local weather phenomena that could not be predicted by seasonal forecasts. The forecast for February to April, in contrast, correctly predicted observed rainfall. New work for the climate forecasters is to build a nest of models, superimposing regional forecasts on a global circulation model in the hope of making more accurate forecasts.

Dr. Chris de Brouwer, Department of Agriculture, North West Province, provided inputs on various aspects of droughts, their impacts on the grazing conditions and livestock, and the modeling capabilities of these factors using GIS. He pointed out that there are approximately 1.3 million cattle in the region managed under two types of livestock systems, one commercial (intensive management) and the other subsistence (extensive management), each supporting about half of the region's livestock. Commercial businesses focus on profit and operate at various levels of intensification. Livestock carrying capacities have been established for different

areas in the region based on locally defined large stock units. The Department of Agriculture uses these units to determine ideal herd structure and sizes for localized areas and gives this information to ranchers.

He described two types of drought. Short-term drought occurs during a rainfall season whereas the long-term drought characterizes lack of rainfall throughout the rainfall season. The frequency of drought increases from east to west.

He described various types of livestock operations. The first, the weaner production operation, sells to feedlots calves that are at three months of age, seven months old, or nine to ten months of age. Being able to sell at 3 months is a relatively recent phenomenon and, from the producer's viewpoint, is advantageous, especially if short-term drought occurs. During long-term drought there is a decline in the condition, growth and conception rates of cattle. Prices of cattle are low but de-stocking occurs. Dr. de Brouwer stated that people are slow to react to drought. If forecasts are utilized by ranchers it would enable them to plan for destocking and/or to make arrangements for additional feed. He recommends fodder banks for this operation type and suggests that this system is most sensitive to climatic variability, because a great proportion of the breeding stock must be sold when drought occurs.

The second type of operation, Tollies, is characterized by selling cattle at the age of 15-18 months. During long-term drought people using this system usually slaughter their cattle. Forecasts could help these people make timely decisions to market animals early during drought years, and to establish fodder banks during favorable years.

The third operation type is the holding of oxen, where animals are sold at 30 or more months after castration. Very few farmers do this since older animals are classified as grade B, and sell for less. Of all types of livestock systems described, Chris believes the oxen system to be the least sensitive to drought conditions. During drought, larger animals are sold first, then smaller animals, so more area and forage are available for breeders. Since only 40% of total holdings are breeding stock, conception rates are not greatly reduced by most droughts, although animal condition is reduced. Timely and accurate prediction of drought occurrence would simplify decision-making about when to sell animals, and the utilization of fodder banks.

The fourth operation type Chris described as Holding which is characteristic of the communal areas. Household animal numbers are small, from around one to twelve. Commercial use of livestock is subordinate to other considerations and animals are sold as needed. In normal years, performance of the animals is usually low, often with calving rates of only 20% with annual offtake rates of 5%. In his view, overgrazing is common, especially around boreholes where water is accessible. During the El Nino drought of 91-92, animals were not sold because drought forecasters did not get information to this livestock sector and livestock losses were up to 80%. However, during the 97-98 El Nino event drought was predicted but it did not occur. A number of correct predictions will need to be made before people start believing in forecasts again.

Mr. Mahmood Randeree, Department of Agriculture, North West Province, Deputy Director of the Remote Sensing and GIS facilities, stated that data are available that could be used to assess the effects of drought through GIS. He stressed however, that there are great bureaucratic problems in getting the data and having adequately trained personnel to work with the data.

Mr. Theunis Meyer, Department of Agriculture, North West Province, discussed his research with evaluation of veld (range) conditions. He provided an overview of different vegetation types within the region, associated with different precipitation regimes. Assessment of range conditions is done through measurement of vegetation composition, basal cover and grass production. All three measures of range condition decline during drought. Some sites are more affected by drought than others. However, he also stressed that range management can have the same effect as do droughts, that is, decreasing the range condition. At some sites, carrying capacity for livestock is greatly reduced by shrub and tree competition. Therefore, management of the range prior to and during drought is important to long term recovery and sustainability of the rangeland.

Dr. Peter Weisberg, Colorado State University, outlined and described the SAVANNA ecosystem model, and its utility for this research. The SAVANNA model is designed to represent the long-term dynamics of grazing system processes in a spatially explicit manner, and has been applied to grassland, shrubland, savanna, and forested ecosystems on three continents. The model is composed of interacting submodels for weather, soils, carbon, nitrogen, water, light, fire, predators, and production and population dynamics for both vegetation and ungulates. The model: (1) couples grazing system simulation with GIS; (2) simulates seasonal and annual changes in vegetation quantity, quality, and distribution; (3) simulates herbivore distribution, forage utilization, and production in response to changes in vegetation; and (4) simulates demographic responses of herbivores to changes in vegetation. Components of SAVANNA that are sensitive to climatic variability include: (1) plant productivity, phenology, distribution, species composition, reproduction, and mortality; and (2) animal forage availability, forage distribution, forage quality, water availability, thermal requirements, reproduction, and mortality. This sensitivity makes the SAVANNA ecosystem model highly suitable for research of this kind, where ecosystem effects of drought are of primary interest. The model was also described by presenting results from two examples of its application: an elk population management application in northern Colorado, and an analysis of drought effects for the Ngorongoro Conservation Area of east Africa.

The model will be linked with a socioeconomic model (see Philip Thornton's section, below), and used to address such questions as:

- (1) What form of climate forecasts are most useful?
- (2) How far in advance do forecasts need to be, and when should they be delivered?
- (3) What are the economic costs of inaccurate forecasts?
- (4) What is the added value (to the rancher) of economic and ecological forecasts?
- (5) What may be optimal management practices for alternative climate scenarios?

Model data requirements were outlined, including GIS coverages as well as historical data on climate, livestock numbers, and range production and species composition.

Dr. Philip Thornton, ILRI, described model requirements and needs to develop a socio-economic model which could be used to complement the bio-physical SAVANNA model. The socio-economic model would include, for different operator types: cash flows and household expenditure decisions, livestock sale and purchase decisions, cropping decisions, and livestock herd dynamics. Model outputs would be represented as the proportion of years in which a profit was made.

Mr. Jannie van der Heever, ADC Ganyesa/Vryburg, provided valuable inputs and insights from the farmers/ranchers perspective on coping and adaptive measures to drought in the region. He discussed drought in Vryburg which is approximately 300 km by 300 km and has about 1500 commercial farmers. From east to west the rainfall gradient is about 550 mm to 280 mm and almost 50% of the years are drought ones. Furthermore rainfall distribution is extremely variable which makes the use of climate forecasts very difficult. The strategy taken by most people is a *Await and see* whereby people wait until the last minute during drought and do nothing until they feel forced to do something.

Many ranchers listen to weather forecasts then they wait and see. Their feeling is that next year will always be better. On the other hand, there are early adopters of climate forecasts and there are laggards. Unlike crop farmers who are at higher risk, ranchers feel they can beat the drought and next year will be better.

Mr. Jerry Hudson, Colorado State University, described and discussed his research findings to date on the role of drought in the area as well as the coping mechanisms people use and any mitigatory actions e.g. using forecasts to better manage droughts. He has found that all ranchers want more long-term weather information. They want to get it from their extension officers, through the radio and on the TV. Most ranchers do not get long-term information at this time; the exception was the 97-98 El Nino event. Figure 2. shows Jerry describing his research to the workshop participants.

The amount of resources available to the rancher determines management options. Soils are very poor in the region providing nutrient-deficient forage for livestock, especially in the dry season; thus supplementary feeds are used by all. This is especially the case during drought. However, water is not as limiting as vegetation because numerous boreholes are located throughout the region. Some ranchers feel it is a good adaptive strategy to overgraze as thin animals can then be sold to feedlots. One commercial rancher had adopted a successful strategy of understocking by 30% during normal years. He thus created a fodder bank that he exploited during drought years by purchasing cattle at low prices, or by selling fodder at high prices.

Termites were identified by farmers as a major competitor with cattle for aboveground biomass. Their effects were more noticeable during drought years, when range production was already reduced. Predation on livestock was highly variable over the study area, with cheetahs in the north, jackals in other areas, and cattle rustling a problem in certain specific locations. Different systems of land tenure applicable to communal farmers were then discussed.



Figure 2. Jerry Hudson describing his research findings.

Mr. Walter Mosobe, ADC Information Officer, told the group about the type of information his office collects from ranchers and others in the region. They have marketing information, and they also collect information on rainfall, farmer registration and livestock numbers.

Working Groups

Following the informative presentations two working groups were formed to discuss the following sets of questions from the various user perspectives and in terms of the project as a whole:

End users:

- Needs and constraints to utilization of forecast information
- Climate forecast needs: ranchers, extensions agents
- Constraints to forecasts utilization: ADC and organized agriculture

Information dissemination:

- Role of the meteorological services (forecasters)
- Role of the ADC and organized agriculture
- Role of farmer groups and other informal networks
- Role of system scientists
- Role of models and researchers

Guidance for the Project:

The following summary captures the discussions that emerged from the two groups. Figure 3. shows a break-out summary.



Figure 3. Peter Applegreen, Assistant Director, ADC Taung South, is rapporteur for this break-out session.

Group 1:

Needs of various users:

The group suggested that forecasts would be preferable before winter (e.g. April/May) so that various preparatory practices for the season could be made, e.g. culling. The information needs included temperature (moisture and soil); price of cattle (to assist in culling decisions); and a request for regular mid-season forecast updates. For the extension agents, information relating to poultry and other livestock would have to be more frequent. There was also a need expressed for some added information with the forecasts such as options of when to sell (in the case of a dry period) and other information such as fodder bank sources, etc.

Constraints of various end users:

Access to clients: In remote areas the forecasts were not well distributed; the radio was suggested as a useful dissemination mechanism. The TV was becoming a popular means of disseminating forecasts but there were complaints of the poor scheduling times of forecasts and other farming information (usually early on a Saturday morning). There were also needs for translation; at present the seasonal forecast issued by the weather bureau is only in English and Afrikaans. The language used in the forecasts should also be made more accessible to end users (several farmers still use terms such as »spade depth« and »inches« when referring to moisture). Members of the group stressed that avoiding acronyms (e.g. ENSO) would aid in understanding forecasts and strongly urged producers of information to be simple in their overall message (they also expressed concern about the technical level of some of the presentations in the workshop indicating that in some cases, these were inaccessible and difficult to understand).

Distribution of forecasts: For those linked to the Internet this provides a useful source of information. The group *strongly felt* that the forecast dissemination and uptake would take time and that the process would take at least a few years before ranchers were well informed, comfortable with using forecasts and perhaps adding the forecast to their more traditional decision-making practices. This process needs to be supported by necessary infrastructure and other technical support. To this end, the group felt that more could be made of extension officers' monthly meetings, and suggested that forecast information should be made a regular part of the meetings= proceedings. Farmer days and information days are also meeting points for forecast data and information to be distributed. The call for a package again emerged with the need perhaps for the Weather Bureau to produce a user-friendly video package that could be shown around the region at various meetings.

Model use and development: Although there was great interest in the group for a model, the overarching concern was one of capacity in being able to eventually use model outputs in the local context. While several ADC personnel had access to computers they were concerned about being able to readily engage with the model. The calls were therefore for a user-friendly model and possibly a package that accompanies the model so that ADCs could get the most added value from the model. The group also felt that the GIS facility in the region (Potchefstroom) could be

used as a launching point from which the model could be distributed via the ADC information officers to the farmers. There was also a call for information to flow back into the model from the end-users so that the model was being constantly validated.

Reflections on the workshop and the future of the project: The group felt that a more representative sample of farmers should have been at the workshop as well as extension officers (many were invited but did not attend). The workshop was also not very accessible to those present (too scientific and not practical enough). Some suggested that a packet sent to farmers and participants before the meeting may have assisted in familiarizing ranchers with the goals of the workshop and some of the science. The group also expressed the need for more workshops and the need for more forecast information.

Group 2:

Needs of various end users: As with the previous group the overwhelming need identified was for better mechanisms to ensure that forecasts reached the end users. While livestock farmers needed long-term information, there was also a need for information that could assist in tactical and strategic farm management decisions that needed to be made. Information therefore needs to be packaged in a variety of ways (e.g. rainfall distribution as well as onset); three, six, and nine month forecasts would be ideal with some indications attached to the forecasts of their reliability as well as regular mid-season updates. The group also noted that forecast information should be interpreted by a specialist before being distributed to end users in the line of transmission. Farmers would also possibly benefit from added information such as possible yields and forage conditions associated with climate forecast information.

Constraints of various end users: The group felt, like Group One, that the Internet was a useful means to distribute information but also felt the need for regular workshops by the Weather Bureau for those who did not have access to such services. While it was acknowledged that the forecasts were getting better there was also a growing need to increase information usage (e.g. needs to be demand-led).

Distribution of forecasts: The group also agreed (as did Group One) that there needed to be a central point for the distribution of the forecasts. The model and forecasts could be housed at the regional level (e.g. GIS/Potchefstroom) then sent via Field Service Units to farmers. Extension officers could also be more actively engaged and encouraged to feed information obtained from farmers back to forecast and model developers. Again, the conduits and links in the chain need to play a more active role in the process of information dissemination.

Model use and development: The group was clear on the role of models and scientists. They felt that the scientists play a necessary supportive role in farm management and risk management. They also felt the greater need for more accessible science and requested a training workshop and ways of overcoming the problems of technical presentation, etc.

Appendix 1: Workshop program and agenda

USERS OF SEASONAL FORECASTS WORKSHOP ARMOEDSVLAKTE, VRYBURG

5-6th October, 1999

Tuesday, 5th October, 1999

Session 1 Welcome, background and introduction to workshop

09:00-09:10	Introduction and welcome	Mr. Scholtz
09:10-09:30	Drought vulnerability in South Africa	Dr. Vogel
09:30-09:50	Goals of the workshop, description of project	Dr. Galvin
09:50-10:10	Climate forecasting: state of the art?	Mr. Landman
10:10-10:30	Discussion	
10:30-10:45	Tea and refreshments	

Session 2 Drought, Livestock and Modeling

10:45-11:05	Drought and livestock: problems and solutions	Dr. Brouwer
11:05-11:25	Drought and the effect on range condition	Mr. Meyer
11:25-11:45	The role of GIS and drought impacts in this region	Dr. Randeree
11:45-12:00	Discussion	
12:00-13:00	LUNCH	

**USERS OF SEASONAL FORECASTS WORKSHOP
ARMOEDSVLAKTE, VRYBURG**

5-6th October, 1999

Tuesday, 5th October, 1999

Session 3

**Managing livestock and rangelands in
Africa: constraints and opportunities**

13:00-13:30	Modeling of rangelands	Dr. Thornton
13:30-14:00	Modeling, GIS, and the project	Dr. Weisberg
14:00-14:15	Discussion	

**Managing livestock and rangelands in the North West
Province: constraints and opportunities**

14:15-14:35	ADC Ganyesa/Vryburg: Drought impacts and management	Mr. van der Heever
14:35-14:55	ADC Taung: Drought impacts and management	Mr. Dire
14:55-15:15	ADC Kudumane: Drought impacts and management	Mr. Khabele
15:15-15:30	TEA	
15:30-15:50	Drought and its effects on people's livelihoods Observations from the field	Mr. Hudson
15:50-16:10	Discussion and wrap up	

**USERS OF SEASONAL FORECASTS WORKSHOP
ARMOEDSVLAKTE, VRYBURG**

5-6th October, 1999

Wednesday, 6th October, 1999

Session 4 Drought experiences from the farmer's perspective

09:00-09:10	Welcome and outline for day's activities
09:10-09:35	Drought experiences of a commercial farmer (Ganeysa/Vryburg)
09:35-09:55	Drought experiences of an emerging farmer (Ganeysa/Vryburg)
09:55-10:15	Drought experiences of a commercial farmer (Taung)
10:15-10:35	Drought experiences of an emerging farmer (Taung)
10:35-10:45	Discussion
10:45-11:00	TEA

Session 4 Seasonal forecast user needs: farmers - modelers - forecasters

11:00-12:00	Break-away groups (constraints, needs and opportunities) Group 1 - farmers/end users Group 2 - providers of information (modelers and forecasters)
12:00-13:00	LUNCH
13:00-14:00	Break-away groups continue
14:00-15:00	Report backs
15:00-15:45	Issues to take forward and improve the research project
15:45-16:00	Closing and TEA

Appendix 2: List of participants at the workshop

PARTICIPANTS FROM THE DEPARTMENT OF AGRICULTURE

Name	Address	Phone/Fax
Hennie Scholtz (Director, Ag Field Services, Western Region)	Department of Agriculture North West province P.O. Box 50 Vryburg 8600	05391 71809 05391 72436 (fax)
John Dire (Deputy Director, ADC Taung)	Department of Agriculture North West province P.O. Box 50 Vryburg 8600	05391 72433
Jannie Van der Heever (Deputy Director, ADC Ganyesa/Vryburg)	Department of Agriculture P.O. Box 50 Vryburg 8600	05391 72431
Walter Mosobe (Information Officer, Western Region)	P.O. Box 112 Vryburg 8600	05391 71854
Chris Sebosong (Information Officer, Ganyesa/Vryburg)	Department of Agriculture P. Bag X518 Ganyesa 8613	05399 83343
Keletso Keupilwe (Information Officer Kudamane)	Department of Agriculture P.O. Box 1077 Kuruman 8460	05377 31232
A.J. Merementsi (Assistant Director ADC Seoding)	Department of Agriculture P.O. Box 264 Kuruman 8560	05377 31590
P. E. Applegreen (Assistant Director, ADC Taung South)	Department of Agriculture P.O. Box 937 Hartswater 8570	05399 41975

T.S. Tshekeng (Assistant Director, ADC Taung Central)	Department of Agriculture Taung Station 8580	05399 41816
N.N. Stock (Assistant Director, ADC Ganyesa)	Department of Agriculture P. Bag X518 Ganyesa 8613	05399 83343
Jerry M. Molefe (Assistant Director, ADC Taung North)	Department of Agriculture P. Bag X533 Taung 8580	05399 41816 05399 41684(fax)
B.J. Mookaneng (Assistant Director, ADC Glen Red)	Department of Agriculture P.O. Box 264, Kuruman 8460	05377 31981
Robert Gasealahwe (Assistant Director, ADC Pomfret)	Department of Agriculture P. Bag X518 Ganyesa 8613	05399 83343
G.E. Phutieauae (Assistant Director, ADC Vryburg)	Department of Agriculture P.O. Box 50 Vryburg 8600	05392 73971
Esther Makhwana (Agricultural Technician, Slough FSU)	Department of Agriculture P.O. Box 264 Kuruman 8460	05377 31982
S.P. Makwati (Agricultural Technician, Tlhakgameng FSU)	P.O. Box 20 Ganyesa 8613	08268 42236
Tebogo Phautudi (Agricultural Technician, ADC Taung)	Department of Agriculture P.O. Box 937 Hartswater 8570	05399 41975

PARTICIPANTS FROM POTCHEFSTROOM AND VARIOUS UNIVERSITIES AND OTHER INSTITUTIONS

Dr. Chris de Brouwer
Assistant Director: Animal Science
Department of Agriculture
North West Province
Private bag X804
Potchefstroom 2520 South Africa
vkcab@potch1.agric.za

Dr. Kathleen A. Galvin
Natural Resource Ecology Laboratory
Colorado State University
Fort Collins, CO 80523 USA
kathy@nrel.colostate.edu

Mr. Jerry Hudson
Research Assistant
Natural Resource Ecology Laboratory
Colorado State University
Fort Collins, CO 80523 USA
jhudson@nrel.colostate.edu

Mr. Willem Landman
LOGIC and Research Group for Seasonal Climate Studies
South African Weather Bureau
Private Bag X 097
Pretoria 0001 South Africa
willem@cirrus.sawb.gov.za

Dr. Theunis Meyer
Pasture Science: Department of Agriculture
North West Province
Private Bag X804
Potchefstroom 2520 South Africa
weitem@potch1.agric.za

Mr. Mahmood Randeree
Deputy Director: Remote Sensing (GIS)
Department of Agriculture
North West Province
Private Bag X804
Potchefstroom 2520 South Africa
mngmr@potch1.agric.za

Dr. Philip K. Thornton
Philip K Thornton
Project Co-ordinator, Systems Analysis & Impact Assessment
ILRI
PO Box 30709
Nairobi, Kenya
P.Thornton@cgiar.org

Dr. Coleen H. Vogel
Department of Geography and
Environmental Studies
University of Witwatersrand
Johannesburg, South Africa
017chv@cosmos.wits.ac.za

Dr. Peter Weisberg
Research Associate
Natural Resource Ecology Laboratory
Colorado State University
Fort Collins, CO 80523 USA
petew@nrel.colostate.edu