Title

Building Adaptive Capacity to Cope with Increasing Vulnerability Due to Climate Change

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ABSTRACT

The project objective was to develop educational curricula and research and extension competencies of present and future scientists to better assist farmers identify technology options that enhance their adaptive capacity to cope with risks and opportunities associated with climate change and variability. Research conducted by five PhD (two women) and four MPhils (one woman) students contributed to project outputs. Baseline data to describe cropping system and management under current climate variability and farmer perceptions about climate change across 4 districts of Zimbabwe and Zambia was collected and analysed. Indigenous knowledge of climate and indicators to seasonal conditions were also documented and compared with scientific forecasts. Seven workshops were held to educate farmers and extension agents on interpretation of the Seasonal Climate Forecast (SCF) and explore together its application in making cropping decisions. Management options in response to the SCF were then tested in participatory on-farm trials. Most smallholder farmers (at 3 of the 4 sites) were not aware of the existence of the SCF. However, in both seasons the farmers' prediction of seasonal climate was consistent with that from the meteorological department. Engaging smallholder farmers with SCF assists them in making investment decisions on crop management options and in particular, on-farm trial results showed that farmers could derive reliable and substantial benefit from the SCF in decisions related to fertility input levels. The project demonstrated that farmer uptake and use of SCF benefits from an extended participatory approach that provides timely access and interpretation of the SCF, experimentation, monitoring and a post mortem of results which enhances farmer ownership and adoption after the project.

***Keywords:** *Capacity building, Vulnerability, climate change and variability, smallholder farmers, Zimbabwe, Zambia*

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ACRONYMS

AGRITEX	Agricultural and Technical Extension Services
APSIM	Agricultural Production Systems Simulator
CCAA	Climate Change and Adaptation in Africa
CIDP	Community Information Dissemination Plan
CSIRO	Australian Commonwealth Scientific and Research Organization
CRMI	Climate Risk Management Information
DFID	Department for International Development
DMS	Department of Meteorological Services
FDG	Focus Group Discussion
GCM	General Circulation Models
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDRC	International Development Research Centre
MSU	Midlands State University
NGO	Non Governmental Organizations
SAT	Semi-Arid Tropics
SCF	Seasonal Climate Forecast
TSBF	Tropical and Soil Biology and Fertility Institute
UoFS	University of Free State
UNZA	University of Zambia
ZARI	Zambian Research Institute

1.0 THE RESEARCH PROBLEM

Both Zambia and Zimbabwe, target countries for this initiative, are signatories of the United Nations Conventions on Climate and Desertification, as both countries suffer from the adverse affects of climate change, that leads to poor and even negative growth in the agricultural sector, and subsequent degradation of the environment as rural households try and meet their livelihood needs. Drought relief is a common feature, almost every year, in the drier areas of both countries, as there appears to be an increasing trend towards a late start to the rainy season, prolonged mid-season droughts, and shorter growing seasons (Cooper et al., 2007; Love et al., 2006). Both countries are actively trying to address these problems, and mitigate the worst effects of climatic variability through breeding more drought tolerant short season crops, and the promotion of improved crop management practices such as precision application of available soil fertility amendments, conservation agriculture, and better weed control (Ncube et al., 2007; Twomlow et al., 2007; Zingore et al., 2008). Both countries support the Southern African Development Community (SADC) Regional Drought Monitoring Centre, based in Gaborone, Botswana, and receive updates on rainfall and the potential impacts on seasonal agricultural productivity on smallholder subsistence farmers for policy decision making purposes. The pilot initiative sought to provide some answers to the following Questions

Box 1: Research questions

- What competencies need to be developed in district and provincial planners for provision of improved early warning messages?
- How can an extension dissemination strategy be implemented for relaying messages to farmers on climate forecasting, based on previous experiences?
- What information and technical support do farmers need to improve their decision making to continually build their assets?
- What support do farmers need to adopt knowledge intensive systems for improved food security, increased income and sustainable natural resource management?
- How can participatory research approaches and decision support tools, using systems simulation modelling and optimization models, be integrated to develop improved productivity management options with farmers?
- Can existing decision support tools be used to (i) investigate the benefits and impacts of changing production enterprises; (ii) investigate how to optimally manage new enterprises, e.g., when to plant, how to fertilize with manures; (iii) explore the riskiness of new enterprises using long-term weather data; and (iv) conduct sensitivity analysis and determine implications of changes in macroeconomic and other policies applied?

The aim of the project was to bring together experiences from national and international research and extension institutions that are working in the drier regions of Zimbabwe and Zambia to build upon their existing skills, networks and field activities to strengthen regional capacities in linking simulation models, participatory on-farm research and climatic forecasting. This was meant to increase the competencies of smallholder farmers in coping with current climatic variability and adapting to potential climatic change and, thus, improve household food security, incomes and reduce environmental degradation through the further intensification of the production systems.

This project sought to improve incentives and opportunities for households to cope with and adapt to the increasing vagaries of climate by investing in improved crop production practices (inorganic fertilizers, conservation agriculture, alternative crops such as forages for livestock) of more practical value to diverse groups of small-scale farmers. The project stimulated the adoption of these options by linking their dissemination with complementary investments in climate forecasting, and building linkages to other projects that have either a humanitarian relief focus, or are involved in the development of input and product markets. The linkage of public investments in technology design with private investments in market development improves the sustainability of these efforts.

The focus of the project 's technical inputs were areas in southern Zambia and south-western Zimbabwe with an annual rainfall of less than 700 mm per year, and a growing season of 90 to 150 days. Adoptions/adaptation of project outputs in these areas should reduce the need for continued extensification of cropping systems, which results in the opening up of new lands at marginal sites, often at the expense of grazing areas and woodlands.

2.0 OBJECTIVES

The main objective of the project was to build adaptive capacity to cope with increasing vulnerability due to climate change in southern Zambia and south western Zimbabwe. The proposed strategy builds on participatory approaches and capitalizes on farmers', scientists' and development workers' knowledge, products and experiences in agricultural research for development to bring out positive changes in people's livelihoods. The specific objectives of the project are highlighted in box 2.

Box 2: Objectives of the project

1. Establish the existing preconceptions of drought risk by poor smallholder farmers that can be used by change agents and meteorological services to better target their interventions

2. Determine how rural communities have coped with existing climate variability and extremes and develop appropriate strategies for adapting to future climatic change
3. Build capacity and competency within Zambian and Zimbabwean institutions to use simulation and climatic forecasting tools for predicting climate variability in order to facilitate rural communities in developing and evaluating improved coping strategies
4. Use farmer participatory research approaches linked with simulation and climate forecasting methods to develop and evaluate scenarios with farmers that enable adaptation of their agricultural production systems to climate variability
5. Develop, test and disseminate climatic risk communication materials and appropriate delivery interventions to all stakeholders

3.0 METHODOLOGY

3.1 Site selection

The project was conducted in Monze and Sinazongwe districts in semi-arid southern Zambia and Lupane and Gweru districts in south western Zimbabwe. Project activities were initiated at a start-up workshop involving all stakeholders (Midlands State University, Zambia Agricultural Research Institute, Zambian Meteorological Services, ICRISAT, CIAT, CSIRO) in June 2008 (Annex 1).

3.2 User participation

Two main beneficiary groups were targeted in this project – those of an institutional nature and the farmers themselves. The institutional partners in this project have all contributed in different planning and writing, meetings as well as via email in implementing the project, using their experiences in existing projects and through working with farmer groups. Partners implemented the project with their existing farmer groups and farmer association partners.

3.2 Participatory diagnosis

Participatory diagnoses were conducted in the study districts to establish the baseline on climate risk and coping strategies used by smallholder farmers in the target communities. This involved use of participatory methodologies such as PRAs and FGDs, and other methods such as individual farmer interviews for in-depth case studies on investment decisions and household survey questionnaires (Annex 3) for broad-based information on farmer coping strategies. A questionnaire survey was administered to 720 households in Zambia and Zimbabwe (360 in each country). Tools such as resource mapping (used to demarcate resource availability, abundance and accessibility by gender and other marginalised groups such as minority ethnic groups), historical trend analysis (used to establish trends in climate variability and change over 30 years and related occurrences), participatory impact diagramming (used to understand from farmers' perspectives impacts emanating from the changes and variability that they highlighted in historical trends, particularly on farming systems and livelihoods), seasonal calendars by gender (used to establish gender roles and how these vary by specific seasons), visioning by using the river code (a mime used to capture the current situation with regards to farming systems and livelihoods and to build scenarios and plan for specific activities to deal with current vulnerabilities emanating from climate variability and change and other stressors), matrix scoring and ranking (used to understand farmer priorities with regards to their farming systems and also priority challenges that heighten farmers' vulnerability) were used as part of the data collection.

3.3 Capacity and competency building within Zambian and Zimbabwean institutions of higher learning

Two under-graduate courses/modules on (a) Climatic Change and Adaptation and (b) Crop Simulation Modelling have been developed and have been approved by the Deans' committee on Academic Regulations and finally by the academic board at the Midlands State University (Annex 2). Module lectures commenced in September 2008. Aspects of climate change and adaptation have been incorporated in the University of Zambia's (UNZA) existing courses and teaching of the revised courses started in 2008.

A climatic change and adaptation and Agronomic Modelling Teaching laboratory with 13 computers and 2 printers was established at MSU in 2008.

Five PhD students and four MPhil students have been supported by the project. Four of the PhD students have registered with the University of the Free State (South Africa) while one has registered with the University of Pretoria (South Africa). Three PhD and two MSc students were trained in the application of the APSIM model for cropping systems analysis. All lecturers involved in the project were trained on aspects of the project and other lecturers in the faculty were made aware of project activities. Agricultural and meteorological extension personnel working in the project areas were trained in aspects of how to relate the seasonal forecast to farming decision making such as variety choice, tillage systems to use and the amount of fertilizer to use.

3.4 Participatory Action Research

Farmer participatory research approaches were linked with crop simulation and climate forecasting methods to develop and evaluate scenarios with farmers that enable adaptation of their agricultural production systems to climate variability.

A major project activity was to raise the knowledge and use of seasonal climate forecasting (SCF) by smallholder farmers and extension officers in farm management decision making. The project adopted an innovative action research approach involving farmer information and planning meetings coupled with on-farm experimentation testing management responses to the SCF. This was implemented using a multi-disciplinary team of meteorologists, agro-meteorologists, agronomists, system modellers and extension officers interacting with farmers to describe and interpret SCF's and explore implications for farm management decisions.

About 400 farmers were informed of the downscaled seasonal climate forecast for the 4 project sites, over 3 seasons. The farmers were educated on how to interpret the probabilistic forecasts using visioning exercises and crop management responses to the forecasts were explored through farmer-researcher dialogue.

The farmer-researcher interactions on SCF helped design the experimental treatments of on-farm trials conducted in Zimbabwe and Zambia over two seasons. As part of these interactions, the project also tested the use of crop simulation modelling to benchmark local yield variability with farmers and as an information source in discussions with farmers about crop management choices.

The project used on-farm trial results to evaluate and calibrate the performance of APSIM to simulate observed treatment responses (to tillage, variety, weeding and fertility inputs) and apply the calibrated model to analyze the impacts of various climate change scenarios on crop productivity. Various management adaptation strategies for coping with future climate change were evaluated using crop simulation and the outputs subject to farmer assessment.

The project established a detailed baseline on cropping systems and management by smallholder farmers in 2 districts in Zimbabwe. For APSIM applications, long term climate data records for the 4 target districts have been constructed. The baseline data on farmer perceptions about climate change (Objective 1&2 output) across the 4 project districts have been compared with trends evident in the climate data parameters.

3.5 Development, testing and dissemination of climatic risk communication materials

A desk study was undertaken to investigate the dissemination pathways from internet, regional project experts and agricultural extension officers, farmer to farmer and from farmers through FGDs, questionnaires and face to face interviews. The role of the media was also investigated using semi structured interviews.

The project developed multi-dissemination approach (Chikuni vernacular radio, vernacular radio listening clubs, agricultural extension, agrometeorological extension, field experiments (learning by doing), field days, driving through (in a particular period of calendar) participatory agricultural and agrometeorological extension strategies.

4.0 RESEARCH FINDINGS

4.1 Key results

4.1.1 Participatory diagnosis

Farmers' perceptions relate more to climate variability than to climate change. It emerged through group discussions and in-depth case studies that while farmers report changes in local climatic conditions consistent with climate change, there is a problem in assigning contribution of climate change and other factors to observed negative impacts on the agricultural and socio-economic system. While farmers are able to recognize changes in climate and to explain low agricultural performance and low well-being in terms of climate variability, when there are political, social and economic problems in a country, farmers may not be able to disentangle contribution of each factor to observed outcomes. Farmers try to make sense of what is happening in their environment based on the socio-cultural framework in which they operate. In addition, with wider and a complexity of challenges to deal with, small-scale farmers may be less inclined to notice changes in climate parameters.

Analysis of baseline data revealed that climate variability and perceived changes in climate are major factors that farmers are aware of and respond to in farm management decision making. Ranking of livelihood stress factors revealed climate variability and change as a high priority. There was consensus from farmers' reports in group discussions to the effect that while there are a multiplicity of challenges that they have to contend with, farmers still find that most of these challenges emanate from the recent changes and variability of climate. In all the districts, climate variability was scored in the range 18 to 20 out of 20 points. Farmers suggested that constraints such as lack of capital to buy food and agricultural inputs, shortage of draught power, imposed and low livestock prices and pests and diseases for crops and livestock, among others, are linked to climate variability and change. Essentially, while there is a multiplicity of stressors that confront farmers, climate variability and change remain the most critical and exacerbate livelihood insecurity for those farmers with higher levels of vulnerability to these stressors.

Impacts from climate variability and change have been categorised into four themes emerging from farmers' responses in the various data collection exercises, namely, crop yield, health, water and the socio-economic context. Farmers' perceptions of negative impacts that are dominant are on crop yield (above 33%) and livestock well being (above 30%). In both countries, the major consequence of a reduction in crop yield during this period was food insecurity. It is interesting that baseline data showed that farmers in the wetter sites of Monze (48%) and Lower Gweru (40%) were more aware of the impacts of climate variability and change on their crop performance as compared to farmers at the drier sites of Sinazongwe (35%) and Lupane (28%). This is attributable to differences in farming systems, for instance the relative importance of livestock as a production unit in Sinazongwe and Lupane.

Coping strategies for climate-induced stresses were found to be more agriculture based, as opposed to off-farm options. This is expected given their farming occupation, but also reflects poor opportunity for off-farm income generation due to isolation of the communities from commercial activity centres. The main coping strategies revolve around changes to tillage system, crop and variety choice, planting strategies (dry sow, avoid certain field types) and fertilizer and manure use. Adoption of conservation methods such as crop rotation, use of crop residues, ripping and potholing, among others, is a dominant response to drought conditions. While adoption of conservation methods is somewhat maintained during flood periods in Monze (29%) and Sinazongwe (19%) (emphasising that this activity has been ingrained in these farmers' usual farming activities), it is intensified in Lupane (76%) and Lower Gweru (53%) during heavy rains, largely with the making of contours in Lower Gweru. Off farm strategies include mainly, migration, gold panning, handicraft, petty trade and gardening especially in Lupane.

Farmers are now knowledgeable of issues pertaining to coping and adaptation strategies which farmers were highly involved during the project implementation. All the participating farmers have implemented adaptive strategies while more than 200 farmers in both Zimbabwe and Zambia have adopted one form or the other of adaptive strategies in the following years.

4.1.2 Development, testing and dissemination of climatic risk communication materials

Significantly more farmers in Zambia (79.7%) have access to weather forecast information than their Zimbabwean counterparts (43%). In addition, significantly more male headed than female headed households have access to weather information in both countries. This has negative implications for Zimbabwe and female headed farmers as access to weather information is critical for the planning of farmers' crop management practices (Srivastava and Jaffe, 1992). The radio, followed by fellow farmers and extension personnel are the major sources of weather information in Zimbabwe and Zambia. A significant percentage of farmers rely on information from fellow farmers, more so in Zimbabwe than in Zambia. This suggests that farmers do not rely entirely on conventional ways of acquiring weather information but also on other such as farmers' indigenous knowledge. Zimbabwean farmers indicated that they rely less on conventional weather forecasts than Zambia farmers.

In addition, farmers in both countries rate the weather information that they receive as ranging from being poor to average, more so in Zimbabwe than in Zambia. Although there is a diversity of weather information provided in Zambia, weather forecasts in Zimbabwe are predominantly on rainfall and scanty on temperatures and non-existent on other parameters such as dry spells and floods.

The lack of access to weather forecasts gives an indication of the significant complementary role that indigenous knowledge on weather forecasts can play in mitigating the vulnerability to climate variability that farmers may use. In this regard, most farmers reported that they rely on indigenous weather forecast to predict the weather. A significant total percentage of 88.8% indicated that they are aware of and rely on traditional indicators for climate variability and change. In contrast, negligible (11.2%) farmers indicated that they do not know of any indicators for climate change, with the greater proportion of 7.1 % coming from Zimbabwe and 4.1% from Zambia. This gives an indication that reliance on traditional indicators in the study areas is widespread. It was established that traditional indicators could replace modern ones, considering that illiteracy may reduce the level of efficiency of the modern methods of weather forecasting. For instance, illiteracy in Sinazongwe district was higher than in Monze district, hence use of literature in seasonal climate forecast dissemination had limited impact in Sinazongwe.

There is evidence of diversity of pathways, but some are not suitable for target/ particular communities (e.g., radio and printed media was in English). Media was broadcasting inappropriate/technical information for these people to understand. The media was not fully involved and utilized in the dissemination of the information. More people (example 174 in 2007/08 season and 193 in 2009/10 for Nkabika village which is 18% and 20% respectively) listening to the vernacular radio program.

The group discussions undertaken on SCF provided individual farmers with an increased understanding and enhanced farmer to farmer interaction on SCFs. The project developed a community information dissemination plan used for testing the possibility of developing a participatory agro-meteorological extension strategy.

Smallholder farmers, in feedback, indicated through drama sketches and oral presentations that they had learnt various lessons (effectiveness of SCF in decision making [field, crop varieties and tillage practices selection]) from the participatory agro-meteorological extension strategy over the three years period.

The met services of both countries participated in the research and were the ones who gave the SCF to the farmers and explained what it means and a little bit on how it is obtained. The met services of both countries have got a advisory section that advices farmers on how to respond to the SCF. However, they have not been able to demonstrate to the farmers how their advice would work. The project gave the met services personnel the hands on experience on how SCF would be used in the field to respond to their forecasts.

In Zambia the meteorogical office is planning to return to the project site to provide a feedback to the farmers of the overall project lessons. The Met office requested the district officers responsible for disseminating SCF in the project area to ensure there was continued interaction with the farmers. A replication to other provinces is being considered for next season with the IDRC project as model of success and justification for more resources and need for up scaling.

4.1.3 Comparison of the meteorological records with farmers' assessment of climate change

The trends reported by farmers matched the data from the met services. Above ninety percent of farmers in Zambia and Zimbabwe noticed significant changes in weather patterns. Farmers in Zambia indicated 1992/3, 1995/6, 2002/3 as drought years while in Zimbabwe farmers indicated 1992/3, 2002/3, 2005/6 as drought years. Southern Africa experienced droughts at differing scales during the years 1991/2; 2001/2; 2002/03; 2003/04 hence there is a relationship between those years farmers claim to be dry years and records from the meteorological offices. The historical rainfall trends, for example, showed a reduction with time while the met data analysis showed the same scenario with an erratic performance of some high and low extremes from the late 1990s to 2006.

Comparison of the meteorological records with farmers' assessment of climate change (from baseline surveys) showed a large disparity, with few of the stated changes being evident in the long term record. For example, 57% of farmers in Zimbabwe and 75% in Zambia claimed that the rains were starting late and finishing early. Analysis of the rainfall record showed that starting rains (20 mm in 2 days) have been later by 5 to 10 days in the last five years compared to the 1980-2008 period at Monze and Lupane sites but, for the other 2 sites, it actually started earlier, by 9 days (Table 4.1). And at no site was there evidence that the rain season was finishing earlier (Table 4.2). Data on dry spells shows that there was an increase in the number of dry spells in both Zimbabwean districts while there were decreases in dry spells in the two Zambian districts (Table 4.3).

This suggests that farmers have a poor understanding of the rainfall variability over the longer term, and given their almost non-existent measurement of rainfall, this is not an unexpected result. However, the result does highlight the need to cross-check (with measured data) farmer derived information about perceived climate change.

Table 4.1: Rainfall starting dates at study sites in the last 5 years and between 1980 and 2008

(Median dates)	Gweru	Lupane	Monze	Sinazongwe
1980-2008	Nov 14	Nov 12	Nov 19	Nov 25
Last 5 years	Nov 5	Nov 22	Nov 24	Nov 16

Table 4.2: Rainfall ending dates at study sites in the last 5 years and between 1980 and 2008

(Median dates)	Gweru	Lupane	Monze	Sinazongwe
1980-2008	Feb 22	Feb 9	Mar 17	Mar 23

Last 5 years	Mar 1	Mar 25	Mar 14	Mar 31

Table 4.3: Dry Spells at study sites in the last 5 years and between 1980 and 2008

Max Length Dry Spells (Dec 1 to Mar 31)	Gweru	Lupane	Monze	Sinazongwe
1980-2008	16	18	14	12
Last 5 years	20	20	13	10

Farmers use a variety of indigenous knowledge systems in predicting weather. Table 4.4 shows the various indicators used to predict the quality of the coming season for Zambia and Zimbabwe. These indicators from the two districts in a country are almost similar but there are some differences between Zambia and Zimbabwe.

Table 4.4: shows the indicators that farmers use predict the quality of a season.

Country	**Wet year**	**Drought year**
Zambia	• Prevalence of certain types of birds/insects, mist in hills during dry season • Plenty of wild fruits • Abundance of leaves on fig trees • Too many girl children • High temperatures • Frost around end of	• Less wild fruits • Sparse leaves in fig trees • Too many boy children • Very cold winters between May and August • Heavy October rainfall

	year • Dark and heavy clouds • Strong winds coming from lake kariba	
Zimbabwe	• Rhus Lancea and *Lannea discolor* trees produces lots of fruits • Azanza garikeana do not fruit well • Heat wave experienced • Early hazeness soon after winter • North easterly winds • Frogs turning brownish • Water birds making a lot of noise • Butterflies seen hovering in the air from north to south starting in October	• Rhus Lancea trees produces fewfruits • Lannea discolor produces fruits but aborts them before the rains • Extended winter period • North easterly winds dominant • White frogs appear in trees • Lots of thunderstorm without rains • Early rains starting from early October

There was impressive consistency between farmer predictions on seasonal rainfall using indigenous knowledge of environmental indicators and the meteorological-based SCF. For example, the farmer predictions at Monze, Sinazongwe, Gweru and Lupane were in accordance with the favourable 2008/09 SCF. Conversely, the SCF in 2009/10 predicted normal to below normal rainfall, and the farmers at Lower Gweru and Lupane also forecast a poor season using local indicators. Across the two seasons however, the forecasts were correct in 2008/09, but only partially correct in 2009/10 as this season eventually had very good rains in February and March.

4.1.4 Participatory Action Research

Investigation of management responses with farmers in an extended participatory mode (i.e. from farmer meetings on SCF and design of experiments to review of on-farm trial results) proved an effective means of adding value to the seasonal climate forecasts (SCF). It became a major dissemination pathway of seasonal forecasts within the project and presented a more practical and participatory approach in communicating SCF information to smallholder farmers. However, as its information and impact reach is limited (reaching only 400 farmers in this study), the approach is most suited to the development of farmer-based information that can add value to the SCF in its wider dissemination.

From the discussions held with the farmers and the nature of experiments proposed by the farmers in response to the seasonal forecast (both modern and indigenous knowledge), it was evident that farming decisions are influenced by rainfall expectations. These included choice of crop and variety, tillage systems to use, planting date, fertilizer amounts to use and when and how to weed.

Changes to input levels of fertilizer in response to SCF proved reliable over two seasons and enabled farmers to improve their management of investment risk in relation to fertilizer inputs. For example, high, recommended rates of fertilizer (59 kg/ha of nitrogen) tested in on-farm trials provided high rates of return on investment in the favourable forecast season of 2008/09 when between 800 and 1100 mm of rainfall was received (3.0 tons/ha compared to 2.14 tons/ha where lower rates were applied) (Table 4.5). For the poorer forecast in 2009/10, lower rates of fertilizer (24 kg N /ha) were chosen for testing and it proved efficient (1.23 tons/ha for lower rates of fertilisers compared to 0.79 tons per ha where there was zero fertilisers in the 2009/10 season). Weeding treatments imposed in this season also gave significant yield increases in two of the three sites tested (Table 4.6). In contrast, across the 2 seasons and the 4 districts, varying management options for either tillage or variety choice (Table 4.7) in response to the SCF provided limited or no yield advantage.

Figure 4.5: Effect of fertiliser levels on maize yields during the 2008/9 and 2009/10 seasons in Zimbabwe

	Daluka		Menyezwa	Nyama		Mudubiwa	
	2008/9	2009/10	2008/9	2008/9	2009/10	2008/9	2009/10
Treatment							
Recommended fertilisers	4.06^{a}		2.58^{a}	1.60^{a}		3.82^{a}	
Low fertilisers	3.34^{ab}	1.446^{a}	2.55^{a}	0.873^{b}	1.900^{a}	2.78^{b}	0.331^{a}
Manure	2.760^{b}		2.20^{a}	0.641^{bc}		1.50^{c}	
Zero	2.140^{b}	0.975^{b}	1.14^{b}	0.414^{c}	1.242^{b}	1.13^{c}	0.164^{b}
LSD	0.898	0.297	0.610	0.319	0.390	0.595	0.101

Figure 4.6: Effect of weeding times on maize yields during the 2009/10 season in Zimbabwe

	Daluka	Nyama	Mudubiwa
Treatment	2009/10	2009/10	2009/10
Weed 1	1.033^{a}	1.567^{a}	0.193^{a}
Weed 2	1.388^{b}	1.583^{a}	0.252^{b}
LSD	0.297	0.390	0.101

Figure 4.7: Effect of varieties on maize yields during the 2008/9 and 2009/10 seasons in Zimbabwe.

	Daluka		Menyezwa	Nyama		Mudubiwa	
Treatment	2008/9	2009/10	2008/9	2008/9	2009/10	2008/9	2009/10
SC403	3.4^{a}	1.23^{a}	2.57^{a}	0.905^{a}	1.858^{a}	2.54^{a}	0.253^{a}
SC510	2.73^{a}	1.2^{a}	2.29^{a}	0.880^{a}	1.283^{b}	2.16^{a}	0.242^{a}
OPV	3.1^{a}		1.47^{b}	0.861^{a}		2.22^{a}	
LSD	0.660	0.297	0.320	0.276	0.390	0.515	0.101

The baby trials (within a Mother/Baby trial approach) proved to be a good strategy for encouraging farmer involvement in the project activity as well as an aid to farmer learning about varying management options in response to SCF. Further, the dialogue on SCF with farmers proved effective in designing experimental treatments and therefore enhanced ownership of the on-farm trials.

4.1.5 Modelling crop yields under different climate and agronomic scenarios

The APSIM model was run under different climate scenarios (A2 and A1F1) using historical data from Lower Gweru. The benchmark simulations represent the expected yields for the Lupane and Lower Gweru district. Figure 4.1 represents the effect of temperature increases (+0.5, +1.5, +2.5, +3.5 °C) on maize yields at 420 ppm carbon dioxide while figure 4.4 shows the combined effect of increases in temperature and changes in rainfall (-20%, -10% and +5%). The general trend for all the scenarios is the same for both graphs. The probability of not exceeding yields of 1000 and 2000 kg/ha increases as you increase temperature from baseline to 3.5°C indicating that climate change will have an effect on maize yields in the study areas. High temperature increases (+3.5°C) combined with a 20% decrease in rainfall will result in a big difference in yield between the baseline. The probability of getting a yield increase of more than 1000 kg/ha is 65% under baseline while it is 50% for a increase (+3.5°C) in temperature and decrease in rainfall of 20%.

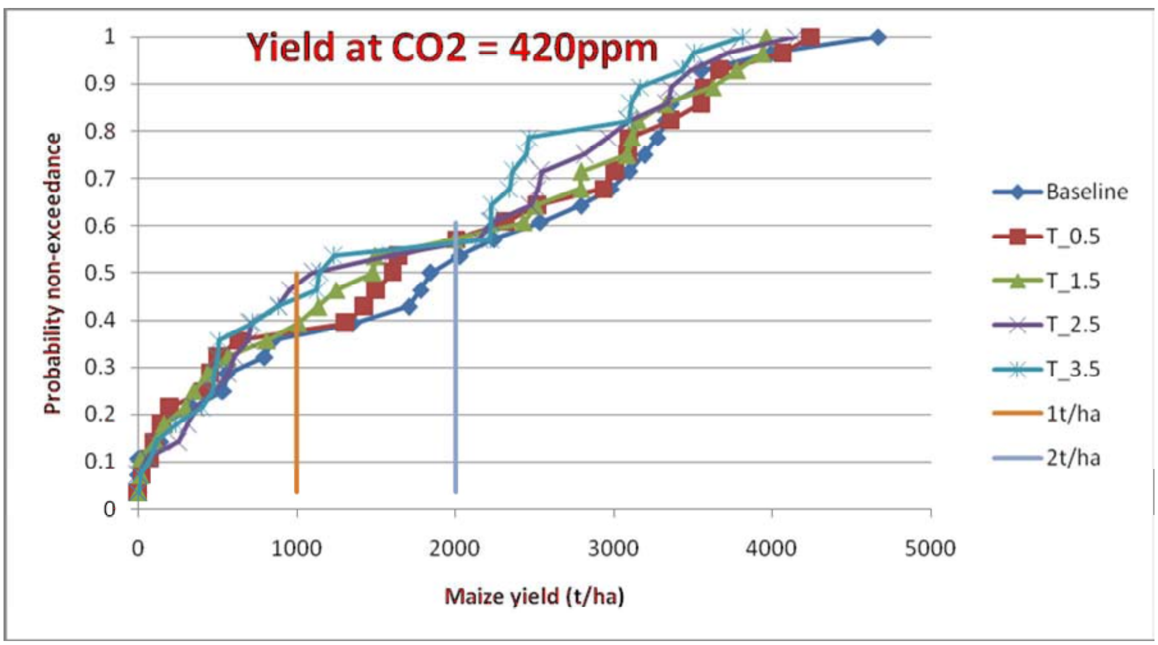


Figure 4.1: Effect of temperature on maize yields

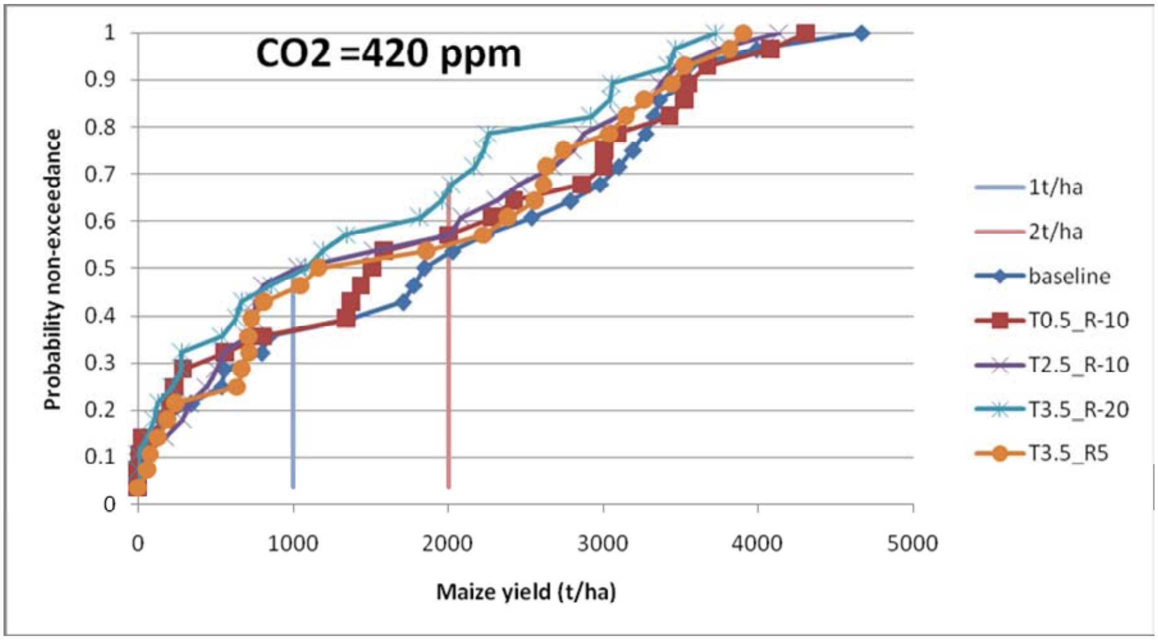
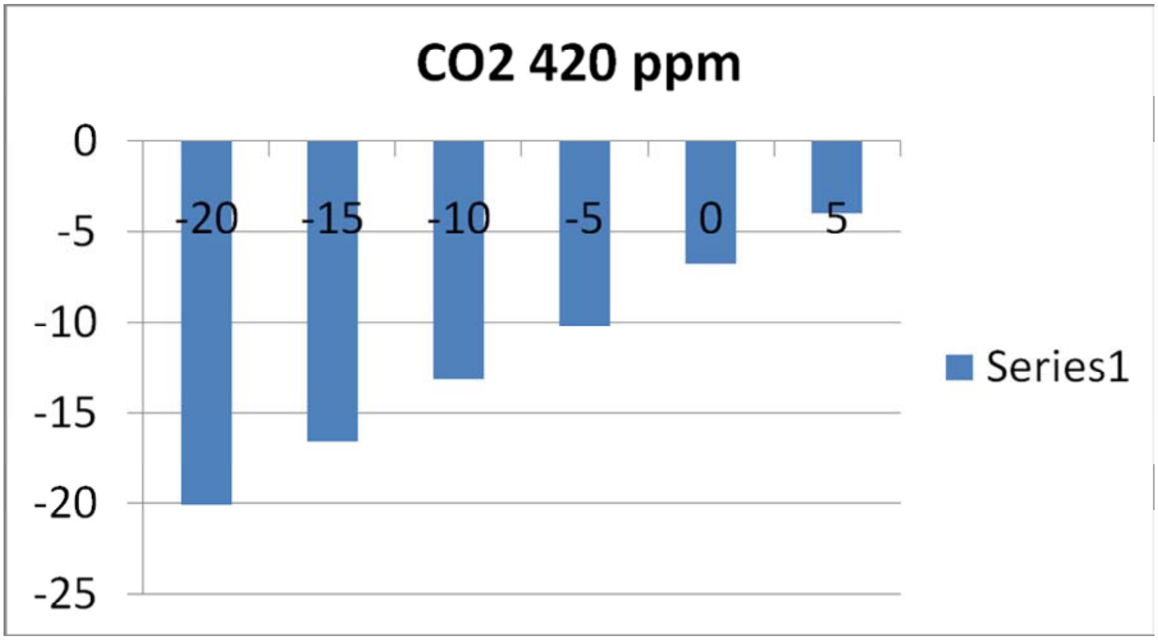
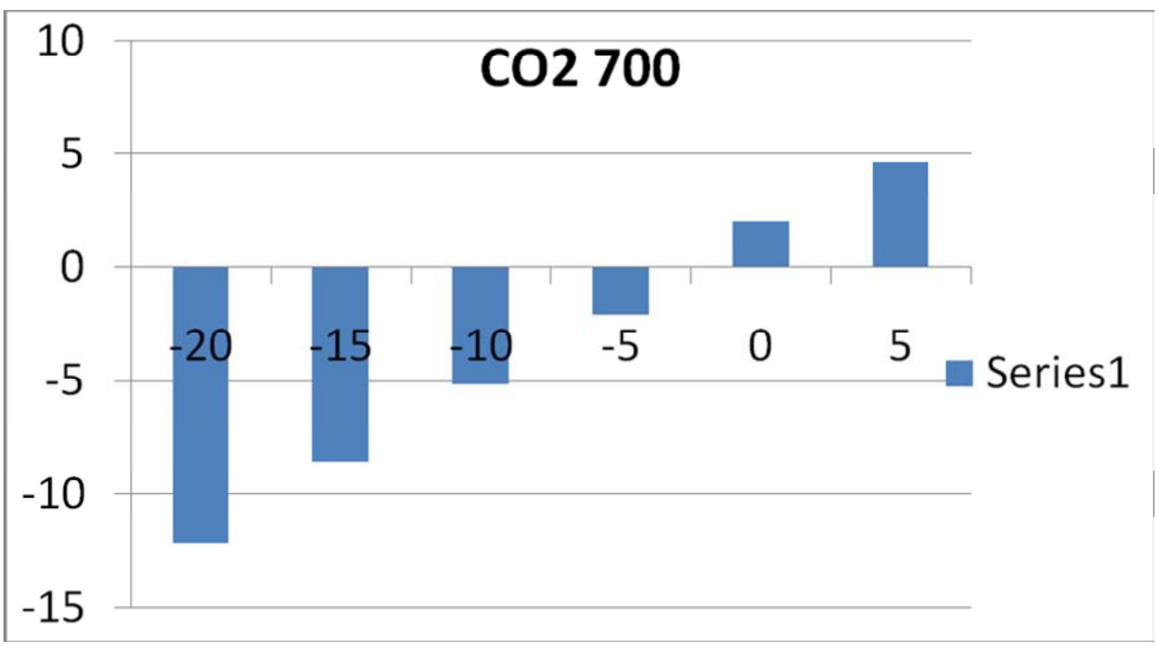


Figure 4.2: Effect of climate change on maize on yield

Figures 4.3 and 4.4 below shows that climate change will result in reduced yields even when the rainfall increases by 5% at 420 ppm CO_2 while at 700ppm yields will be reduced (-5% to -20%) while yield increases will be expected to increase if rainfall increases to 5% at 700 pmm CO_2. This is consistent with work carried out by Dimes et al (2009).



4.3: Effect of rainfall changes on maize yield at 420 ppm CO_2



4.4: Effect of rainfall change on maize yields at 700 ppm CO_2

4.2 Major noticeable achievements

4.2.1 Participatory diagnosis

Farmer typologies and perceptions on climate variability and change for the 4 target communities have been documented by the project. Two African women scientists have achieved higher qualifications as a result of this work to the level of PhD and a Master of Philosophy. Approximately 400 smallholder farmers across the 4 districts have been sensitized to climate change as an emerging management issue at the local level.

The project was implemented in two districts each in Zimbabwe and Zambia. Six wards were chosen in each of the district and five farmers in each ward directly participated in the project. 120 farmers directly participated in the project while more than 300 farmers indirectly participated in the district by attending field days where demonstration experiments showing best practices for a given seasonal climate forecast. About 100 farmers have gone ahead to use SCF information to change their management practices in their fields depending on the predicted quality of rainfall. The project has capacitated the ability of farmers to give farmers advice based on some field experience.

4.2.2 Introduction of climate change and adaptation courses at MSU and UNZA

Seven students at PhD and MSc level have been trained on climate change and adaptation and will further train undergraduate students thereby increasing the pool of trained personnel on climate change and adaptation who will later be working with farmers as extension agents. This is likely to improve farmers' access and use of seasonal climate forecast information.

4.2.3 Use of crop simulation models

Decision support tools (crop simulation models) were used to; (i) investigate the benefits and impacts of changing production enterprises (ii) investigate how to optimally manage new enterprises e.g. when to plant, how to fertilise with manures (iii) explore the riskiness of new enterprises using long-term weather data and (iv) conduct sensitivity analyses and determine implications of changes in macroeconomic and other applied policies.

4.2.4 Participatory Action Research

Most SCF interventions inform farmers what the forecast is, with limited or no opportunity for dialogue on its interpretation and application in farm management. This study has pursued a highly participatory approach, engaging farmers from release of the forecast, its interpretation, making decisions, participatory experimentation, monitoring and evaluation of the interventions through to doing a post mortem of results. The comprehensive approach has achieved high levels of learning and strong appreciation of the SCF by farmers for crop management decision making. It also demonstrated that the SCF has high benefits in decision making with regard to fertility input levels.

Implementation of an effective multi-disciplinary approach to on-farm research, proved to be highly beneficial to all parties concerned: (i) farmers learnt how to interpret the SCF and use it effectively in crop management decision making, (ii) the Met Department saw increased demand and appreciation of the SCF by farmers and promised to work closely with farmers so that they have access to SCF in the following years and (iii) extension agents and agronomist greatly enhanced their effectiveness in promoting crop improvement technologies to farmers.

Farmers have been empowered as a result of this project, clearly stating that they want the SCF information made available as early as possible (September rather than October).

The training and uptake of systems modelling in this project has extended the evaluation and application of APSIM in African farming systems and expanded the skills base amongst African scientists.

4.2.5 Development, testing and dissemination of climatic risk communication materials

Planting earlier from November (or immediately after receiving planting rains) as opposed to planting from December proved to be beneficial. This was an informed decision based on facts such as average planting dates, crop variety maturity period and average length of the growing season. Some changes were in the planting times. More people (about 30 farmers) started planting maize with the start of the planting rains in November as opposed to their usual practice of starting in December (PRA analysis result). Planting of maize varieties in the planting window (longer maturing planted at the start of the season while the shorter varieties are planted towards the end of the planting window). Farmers used to plant maize at any time in the planting window regardless of the variety. 27 farmers reported this as a lesson learnt. Yield increases of between 30 and 80% were recorded depending on season and the technology chosen by the farmers. The introduced Sun Hemp legume for nitrogen fixing which stated with 4 farmers had 26 it adopted by project end in Zambia.

There was an increased acknowledgement of climatic information and participation (76 to 87 farmers in 2007 and 2008 respectively) to SCF meetings. They found it relevant in agricultural decision making especially.

No demands for SCF were made from the project communities prior to the project but 55 calls for SCF were received during the 2008/09 season.

4.3 Expectations, lessons learnt

4.3.1 Participatory diagnosis

The high ranking of climate variability as a livelihood stress factor points to seasonal climate forecasting as having high value to smallholder farmers.

Project staff learnt that smallholder farmers have a high appreciation of their climate environment and the changes occurring therein and already have extensive coping strategies for the various climate scenarios.

However, it also became apparent that attribution in assessing climate change perceptions of farmers is an important issue with implications in designing questionnaires and conducting farmer interviews. Care is needed in establishing the true meaning of farmer's answers on climate change impacts as it was observed that social, political, cultural and economic issues influenced their responses. Also farmers can attribute change in aspects of rainfall patterns that are part of the natural background variability.

4.3.2 Participatory Action Research

Based on experience with this project, the project farmers will be able to adjust investment decisions in response to the SCF information leading to improved crop productivity and climate risk management.

SCF information coupled with on-farm participatory trials that test management responses to the forecast greatly enhances farmer learning about the value of the SCF.

We expect that farmer to farmer communications on their learning about SCF will broaden the benefits of this project. Similarly, strong interest in the project activity by high level management of the Zambian Met Dept has the potential to dramatically extend the message of this project to benefit many more farmers.

Even though the probabilistic SCF is difficult to interpret, a SCF (be it meteorological- or indigenous-based) has been shown to be an ideal entry topic for extension (and research) to enter into more meaningful dialogue with farmers about crop management decision making.

The use of crop modelling outputs to benchmark local yield variability with farmers proved to be highly effective in helping farmers better understand the impact of rainfall variability, in particular its with-in season distribution, on the yield response to crop improvement technologies. This assisted them in thinking about treatments for experimentation (eg an extra weeding was suggested as a treatment at the Gweru site) and that manure and fertiliser inputs can be relied upon to increase crop yield, irrespective of the season type.

4.3.3 Development, testing and dissemination of climatic risk communication materials

The following need to be known before implementation of the project:

Repeating a forecast more than three times at a public meeting increases farmer understanding of SCF. Continued interaction with smallholder farmers on SCF enhanced farmer understanding

A multi-climatic information dissemination approach enhanced farmer understanding and utilization of SCF information (including indigenous season climate forecasts).

5.0 PROJECT OUTPUT AND DISSEMINATION

5.1 Project reports

Several project reports on the various project activities were produced during the project implementation period and these include those that are listed in Annex 1 to 10. A

Handbook for Agro-meteorological Participatory Extension was produced. The aim of this guide is to build the capacity of the agro-meteorological extension officers in using agro-meteorological participatory extension strategies. After a formal training, the new agro-meteorological officers need an additional guide in the field. This guide is meant to be as their reference.

5.2 Capacity building

5.2.1 Postgraduate students

There were 5 students who registered for PhD and 4 for MPhil. Of the PhD students, two have completed her studies and graduated on the 16th of September 2010. The other is submitting his thesis in November 2010 for graduation in April 2011. The third one is finalising her write up and will submit her thesis by May 2011 for graduation in September 2011. The fourth is still working on his thesis. One of the PhD students passed away in early 2010. As for the MPhil students, one has submitted her thesis and is graduating in April 2011. The rest are at different levels of thesis writing. One MPhil passed away in 2009.

Table 1: Project postgraduate students, university where registered, thesis title and status of thesis.

Student name	Programme	University	Title of thesis	Status of thesis
Mubaya, C	PhD (Development Studies)	University of the Free State	Farmer strategies towards climate variability and change in Zimbabwe and Zambia	Graduated
Nanja, D.H.	PhD	University of the Free State	Dissemination of climate information to small-holder farmers: A case study for mujika area, zambia	Submitted in November 2010
Makuvaro, V	PhD	University of the Free State	Impact of climate change on smallholder farming in	Submitting in May 2011

			Zimbabwe, using a modelling approach	
Murewi, C	PhD	University of Pretoria	Climate variability and change over central southern Africa: downscaling for uptake/use by smallholder farmers	In progress
Gondwe, P.	PhD	University of the Free State	Cropping Decisions Under Variable Climate for Small-Scale Farmers in Zambia	Passed away
Mutswangwa, E	MPhil (Agricultural Economics)	University of the Free State	An Economic Assessment of Smallholder Farmers' Adaptive Capacity to Climate Change in Zimbabwe	Awaiting graduation in May 2011
Chagonda, I	MPhil	MSU	Seasonal climate forecasting and participatory field experimentation as options to improved crop productivity in semi arid Zimbabwe	In progress
Masere, P	MPhil	MSU	The applicability of the APSIM model to decision-making in small-scale, resource-constrained farming systems: a case study in the lower Gweru Communal area, Zimbabwe	In progress
Mukhata, A	MPhil	UNZA		Passed away

The trained staff will be teaching courses on climate change and adaptation at both Midlands State University and the University of Zambia. Participating staff members are now in a better position to develop proposals jointly or independently. For example the MSU team was awarded funds (£70 000) by Development Partnership in Higher Education (DelPHE) for their project proposal "Strengthening environmental education through revision of current module/courses, use of decision support systems and field experimentation at a University in Zimbabwe" in 2008 which is being implemented in Chivi.

5.2.2 Undergraduate students

Forty five MSU students registered for the Crop Simulation Modelling course between 2008 and 2011 and they have all passed the course. The course is now part of the Faculty of Agriculture's curricula. At UNZA all the students have passed the revised courses.

5.2.3 Project members training

Four scientists were trained in APSIM applications on cropping systems analysis (Annex 4) and 2 were trained in the use of STARDEX for climate trend analysis. Eight other students were exposed to APSIM capabilities at a training workshop at the University of Free States conducted by CSIRO-Australia in Dec 2009. All project scientists were exposed to APSIM's cropping systems capabilities and participatory modelling techniques during the project.

5.2.3 Extension personnel

Sixty agricultural and meteorological personnel have been trained on how to interpret and respond to the SCF to come up with appropriate crop management practices that respond to climate change and variability.

5.2.4 Publications

Eleven papers have been produced from the project which three been published, four submitted and four are under preparation (Box 1). Five papers have been presented at various workshops. Four presentations have been made to IDRC/CCCA organized meetings throughout Africa, and contributed to curricular development material on climate change courses for universities at the COP in Copenhagen, Dec 2009.

Box 1: Paper produced on the project

Box 1: Publications

1. Mubaya,C.P, Njuki,J., Liwenga,E., Mutsvangwa, E.P and Mugabe, F.T. 2010. Perceived Impacts of Climate Related Parameters on Smallholder Farmers in Zambia and Zimbabwe. *International Journal of Sustainable Development in Africa*, 12(5): 170-186

2. Mugabe, F.T., Mubaya, C. P., Nanja, D. H., Gondwe, P., Munodawafa, A. Mutswangwa, E., Chagonda, I., Masere, P, Dimes, J. And Murewi, C. 2010. Using indigenous knowledge for climate forecasting and adaptation in Southern Zambia and south western Zimbabwe. *Zimbabwe Journal of Technological Sciences, 1: 24-39.*

3. Twomlow, S., Mugabe, F.T., Mwale, M., Delve, R., Nanja, D., Carberry, P. and Howden, M. (2008) Building adaptive capacity to cope with increasing vulnerability due to climate change- A new approach. *Chemistry and Physics of the Earth*, 33: 780-787.

4. Mugabe, F.T., Dimes, J., Nanja, D., Gondwe, P., Chagonda, I., Masere, P., Murewi, C. and Munodawafa, A. Engaging smallholder farmers with seasonal climate forecasts to design crop management options: Experience from southern Zambia and north western Zimbabwe. *Submitted to Current Science.*

5. Mubaya,C.P., Njuki,J., Liwenga,E., Mutsvangwa, E.P. and Mugabe, F.T. Perceived Impacts of Climate Related Parameters on Smallholder Farmers in Zambia and Zimbabwe. *Accepted by the International journal of sustainable development in Africa.*

6. Mubaya,C.P. Njuki,J., Mutsvangwa,E.P., Mugabe,F.T., Nanja,D., Murewi,C., Dimes,J., Makuvaro, V. and Munodawafa, A. Climate variability and change or multiple stressors? Farmer perceptions

regarding threats to livelihoods in Zimbabwe and Zambia. *Submitted to Environmental management.*

7. Crimp, S.J., Hargreaves, J., Dimes, J. Makuvaro, V. Bupe, V. and Walker S. An Assessment of Climate Change Impacts on Maize production in Zimbabwe and Zambia. *Submitted to Experimental Agriculture*

8. Murewi, C., Nanja, D., Munodawafa, A. Mubaya, C. Mutsvangwa, E. Evidence of climate change in Zimbabwe and Zambia : comparison of farmers' perceptions and meteorological data. *Submitted to Experimental Agriculture*

9. Mubaya,C.P., Njuki,J., Chamunorwa,A., Mutsvangwa, E.P., Mugabe, F.T and Nanja, D. How do households transition from Coping with Impacts of Climate Change to Adapting to Climate Change? Lessons from Zambia and Zimbabwe. *In preparation*

10. Mubaya,C.P., Njuki,J., Mutsvangwa,E.P., Mugabe, F.T and Liwenga, E. A Gender Analysis of Vulnerability to Climate Variability and Change Impacts on Smallholder Farming Communities in Zimbabwe. *In preparation*

11. Mubaya,C.P., Njuki,J., Mutsvangwa,E.P., and Mugabe, F.P. Smallholder farmer coping and adaptation strategies towards climate variability and change in Zimbabwe and Zambia. *Submitted to Southern African Studies?*

12. Mubaya,C.P., Njuki,J., Mutsvangwa,E.P., and Mugabe, F.P. An overview of current agronomic practices and coping/adaptation strategies of smallholder *farmers in semi-arid central and weste*rn Zimbabwe. *In preparation*

<u>Conference papers</u>

1.0 Dimes, J., Cooper, P., Rao, K.P.C., 2009. Climate change impact on crop productivity in the semi-arid tropics of Zimbabwe in the 21st Century. CGIAR Challenge Program on Water and Food Theme I Conference paper

2.0 Makuvaro, V, Murewi, C., Crimp, S and Walker, S. Evidence of climate change from rainfall data in Semi-arid Zimbabwe. WATERNET symposium that is scheduled for 27-29 October 2010 in Victoria Falls, Zimbabwe.

3.0 Nanja, D.H., 2010 Improving livelihoods in a changing climate: Participatory agrometeorological extension services a major link to improved agriculture decision making - the Zambian experience. Presented at the International Colloquium on Adaptation to Climate Change, Senegal

4.0 Nanja, D.H., 2009. Major challenges affecting the dissemination of climatic risk management information: The Mujika experience: Liu, N., Wang, S. and Tang, G. (Eds) Proceeding of International Disaster and Risk Conference, Chengdu 2009 IDRC, Qunyan Press Pp 201-214

5.0 Munodawafa, A., Makuvaro, V., Dimes, Mugabe, F.T., Masere, P., Murewi, C and Chagonda, I. Developing farmers' coping and adaptation strategies to climatic variability and change in semi-arid areas of Zimbabwe. Presented at the International Colloquium on Adaptation to Climate Change

Makuvaro, V. 2010. Using a crop model to evaluate climate change impact on smallholder farmers in Zimbabwe. Young Researchers Seminars, Montpellier, France, March 2010

5.2.5 Participatory action research

Seven SCF and experimental planning meetings with farmers were conducted in Zimbabwe (4) and Zambia (3). Thirteen researcher-managed, on-farm Mother Trials at 4 sites and over 3 seasons were implemented. It supported 60 farmer-managed baby trials over the same period.

6.0 PROJECT OUTCOMES AND IMPACTS

6.1 Participatory diagnosis

Project team and stakeholders were informed on the role of climate variability in farmer decision making. In-depth case studies unravelled that while farmers do have a multiplicity of factors that they consider when they make decisions on how to invest into farming in each season, climate variability plays a major role in this process, based on both indigenous indicators and weather forecasts.

Baseline information enhanced design and implementation of other project activities. The baseline report specifically informed activities for the selection of farmers to be engaged in trials in both countries and also for the selection of in-depth case studies that were conducted to collect data on farmers' investment decisions and coping strategies, among other factors.

Local farmers were sensitized to issues of emerging climate change. While farmers might have been aware that there are changes and variability in climate, engagement of these farmers in discussion surrounding the subject sharpened their awareness and views with regards to high priority stressors and responses.

Farmer's appreciation of and responsiveness to other project activities was enhanced as indicated by the number (about 100) of farmers who have asked for seasonal climate forecast from the extension workers after the project had completed (2010/11 season). This baseline provided a basis for farmers to understand the importance of the project and the direction it was taking right from the onset so much that by the time they were engaged on other project activities that include case studies and trials, they were well prepared.

6.2 Capacity and competency building within Zambian and Zimbabwean institutions of higher learning

The PhD and MPhil students have gained enough experience on climate variability and change issues will be teaching relevant modules. Approximately 30 % of the trained students (future change agents) from the faculty of Agriculture have joined AGRITEX. Thus of the 30, about 10 are expected to join AGRITEX and are expected to support small holder communities in adapting their agricultural practices to current climate variability and change. Agricultural and Meteorological personnel are now disseminating farmer-demand driven forecasts and are helping farmers in deciding best agricultural options. Farmers have changed their behaviour (are now demanding the forecast as well as responding to it) and they have become more proactive in making forecast driven decisions like the weeding frequencies to use, tillage type to use, varieties to use as well as amount of fertilizer to use.

The establishment of courses on climate change and adaptation at MSU and UNZA for 'Future Change Agents', will ensure subsequently support to smallholder communities in adapting their agricultural practices to current climate variability and is the first step in building adaptive capacity to cope with future climate change.

6.3 Participatory Action Research

The project resulted in increased farmer demand for SCF information and its timely availability and also increased the application and skills base of African scientists in system modelling research. Farmer understanding of the interpretation of SCF and its use in crop management decision making was increased and the research and reporting skills of four scientists was improved. The ability of local extension officers to interpret and advise farmers of the SCF was improved. There has been an enhanced communication of climate information from the Meteorological Department to extension officers and farmers are more able to interpret and apply SCF information.

6.4 Networking

CCAA organised seven workshops of which project members participated in. This resulted in the formation of workable networks. For example MSU and Sokoine University of Agriculture (SUA) developed a proposal that was funded by DelPHE from the networks that were formed during these meetings. The team leader was tasked by Food, Agriculture and Natural Resources Polity Analysis Network (FANRPAN) to write a country paper "Assessing the vulnerability of agriculture to climate change in Zimbabwe: Strategies for adapting to climate change in rural Sub-Saharan Africa-targeting the most vulnerable" as a result of knowledge gained during the implementation of the CCAA and the associated networking. The team leader was also appointed visiting Professor at Chancellor College in Malawi through networking with one of the project members that was funded by CCAA.

7.0 RECOMMENDATIONS

Results of this study show that socio-economic factors determine whether farmers cope with or adapt to both climate and non-climate factors. The results have a number of implications for strategies to build farmers adaptive capacity to deal with the vagaries of climate variability and change. First, there is need to strengthen farmers' social and human capital as it was found that social and human capital characteristics are an important determinant of farmers' adaptive capacity. Farmers with some level of education and engaging in training and group activities are more likely to adapt than those who are not.

Second, there is need to provide appropriate and timely information on future climate changes to farmers to alert them to take appropriate action in time, given that access to weather information and farmer perceptions of climate variability have a positive and significant relationship with adaptation.

Third, there is need for governments and other stakeholders to create a conducive environment for farmers to build an asset base from which they can draw in times of stress as results show that the more resources farmers own, the higher their chances of adaptation.

Fourth, there is need to guard against making generalisations regarding coping with climate variability by farmers by understanding the stages that farmers take from coping, to both coping and adapting and finally to adaptation. It is also important to understand the differences within the discourse of adaptation by distinguishing between coping and adaptation.

Finally, farmers' perceptions are critical in adaptation processes. If farmers are conscious of weather changes and they have a positive outlook of themselves, they will be in a position to adapt to long term and future changes and variability in climate. This is drawn from the findings that farmers are aware of climate changes and are more likely to adapt than if they are less aware of climate changes.

Engaging farmers from release of the seasonal climate forecast through experimentation, monitoring, evaluation to harvesting makes farmers judge better the benefits of seasonal climate forecast in making decisions that respond to the given seasonal climate forecast.

New courses of climate change and adaptation were introduced on the project and six PhD and five MSc students were trained on the subject with a view that they would continue teaching the courses at the Midlands State University and University of Zambia. The current salary levels in Zimbabwe may fail to retain the trained staff to continue the teaching of system modelling and climate analysis courses. However, we recommend that climate change and adaptation courses should be introduced to agricultural colleges and Universities so that students can better advise farmers when they join the extension service.

Involving policy makers in the research work can lead to increased adoption of our recommendations both in time and space as was the case in Zambia where the Minister of Agriculture tasked the Met personnel to ensure that our work be scalled up to all districts at a field day in Monze.

REFERENCES

Cooper, P., Singh, P., Traore, P.C.S., Dimes, J., Rao, K.P.C, Gerard, B., Alumira, J., Shiferaw, B., Twomlow, S., 2007. New Tools, Methods and pproaches in Natural Resource Management. ICRISAT, Patancheru 502 324, Andhra Pradesh, India, 68pp.

Dimes, J., Cooper, P., Rao, K.P.C., 2009. Climate change impact on crop productivity in the semi-arid tropics of Zimbabwe in the 21st Century. CGIAR Challenge Program on Water and Food Theme I Conference paper

Love, D., Twomlow, S., Mupangwa, W., van der Zaag, P., Gumbo, B., Nyabeze, W., 2006. Implementing the millennium development food security goals – challenges of the southern African context. Physics and Chemistry of the Earth 31, 731–737.

Ncube, B., Dimes, J., Twomlow, S., Mupangwa, W., Giller, K., 2007. Raising the productivity of smallholder farms under semi-arid conditions by use of small doses of manure and nitrogen: a case of participatory research. Nutrient Cycling in Agro-ecosystems 77, 53–67.

Srivastava, J., Jaffe, S. (1992) Seed systems development: The appropriate roles of public and private sectors. World Bank Discussion Paper Number 167. Washington D. C. The World Bank

Twomlow, S., Mugabe, F.T**.,** Mwale, M., Delve, R., Nanja, D., Carberry, P. and Howden, M. 2008. Building adaptive capacity to cope with increasing vulnerability due to climate change- A new approach. *Chemistry and Physics of the Earth*, 33: 780-787

Twomlow, S., Rohrbach, D., Rusike, J., Mupangwa, W., Dimes, J., NCUBE, B., 2007. Spreading the word on fertilizer in Zimbabwe. In: Mapiki, A., Nhira, C. (Eds.), Land and Water Management for Sustainable Agriculture. Proceedings of the EU/SADC Land and Water Management Applied Research and Training Programme's Inaugural Scientific Symposium, Malawi Institute Management, Lilongwe, Malawi, 14–16 February 2006, Paper 6.21 (Chapter 19).

Zingore, S., Murwira, H.K., Delve, R., Giller, K.E., 2008. Variable grain legume yields, responses to phosphorus and rotational effects on maize across soil fertility gradients on African smallholder farms. Nutrient Cycling in Agro-ecosystems 80 (1). doi:10.1007/s10705-007-9117-3.

Annex 1: Inception workshop report 97 – 8 June 2007)

Building Adaptive Capacity to Cope with Increasing Vulnerability Due to Climate Change

I. Introduction

The inception workshop to launch the IDRC-funded project on 'Building adaptive capacity to cope with increasing vulnerability due to climate change' was held at ICRISAT-Bulawayo on 7–8 June 2007. Participants included officials from universities, meteorological offices, and extension services from Zambia and Zimbabwe, as well as scientists from various international organizations (for a full list of participants see Annex 1).

The objectives of the workshop were to:

- understand the significance of climate change and adaptation
- familiarize participants with the farmers' perceptions of climate change and current work on adaptation to climate change/extremes in Zambia and Zimbabwe
- revisit the activities and assign tasks and timeframes
- initiate a project monitoring and evaluation protocol
- create a community of practice with other IDRC climate change projects

This document summarizes the presentations and discussions at the meeting (see Annex 2 for the schedule of the meeting).

II. Presentations on Day One

Dr Steve Twomlow (on behalf of Dr Isaac Minde, ICRISAT Country Representative) as well as Mr Joe Sikosana, Head of Matopos Research Station, welcomed the participants.

A series of presentations that described climate change in Zimbabwe and Zambia as well as an update of the most recent projects on climate change and vulnerability followed.

Opening address (Professor Francis Mugabe, Principal Investigator)

Prof. Mugabe presented the workshop objectives as well as the Climate Change Adaptation in Africa (CCAA) objectives, which included various goals such as strengthening the capacity of African scientists, organizations and decision makers, generating better shared understanding of the findings of research, and informing policymakers with high-quality science-based knowledge.

Some of the issues discussed at the IDRC inception workshop held in Ethiopia included ways of promoting regional cooperation in facing shared challenges; sharing knowledge of climatic risks and adaptation to policymakers, researchers as well as those at risk; and strengthening communication within projects.

Table 1 shows the IDRC training workshop schedule. Each of the commissioned IDRC-CCCA projects is allowed to send one project participant and one policymaker to each of the four workshops.

Table 1. IDRC training workshop schedule.

Title	Venue	Dates
Integrated risk assessment	Nairobi	16–19 July
Research methodological training (PAR & gender analysis)	Dakar	6–11 August
Training in research and project management	Cairo	27–31 August
Research to policy linkages	Johannesburg	September

It was decided that the terminology that this project uses must be the same as the Intergovernmental Panel on Climate Change (IPCC) to avoid confusion. For example, 'mitigation' and 'adaptation' are not interchangeable terms. 'Mitigation' involves practices that reduce greenhouse gas emissions; in other words, managing risk by avoiding climate variability. Mitigation is often outside the scope of most projects. 'Adaptation' is the management of risk through activities in response to climate variability. 'Coping strategies' are practices that people are already carrying out. 'Adaptive strategies' are how people's behavior changes over a long period of time.

Climate change in Zimbabwe (Mr Washington Zhakata, Climate Change Office, Zimbabwe)

The surface temperature in Africa has increased over the past century with a sharp rise in the last 10 years (Figure 1). Human activities have changed the composition of the atmosphere since the pre-industrial era. The use of fossil fuel currently accounts for 80–85% of the carbon dioxide being added to the atmosphere. Land use changes such as clearing land for logging, ranching, and agriculture account for a further 15–20% of current carbon dioxide emissions. If current trends continue, the amount of carbon dioxide in the atmosphere will double during the 21st century.

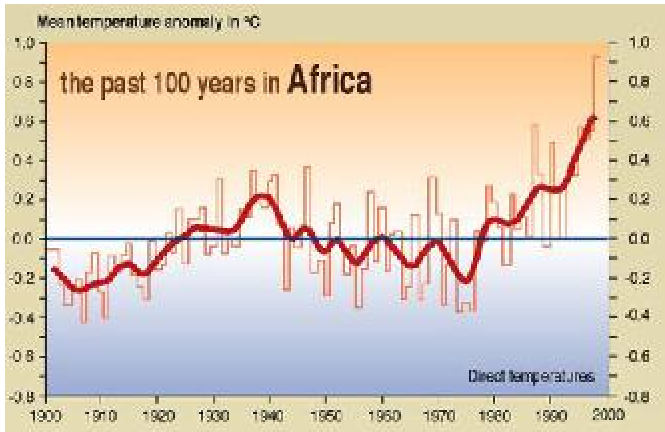


Figure 1. Surface temperatures in Africa over the last century.

The implications of this are serious for Zimbabwe. The number of years with below average rainfall is increasing (Figure 2). There are signs of a gradual warming in both summer and winter temperatures. Models suggest that Bulawayo will experience a minimum rise in daily temperatures of 2.7°C. There may be more rain in northern Mozambique, Namibia, Botswana, southwest Angola and western South Africa. However, the predictions are that the rest of the region will experience a decline in rainfall.

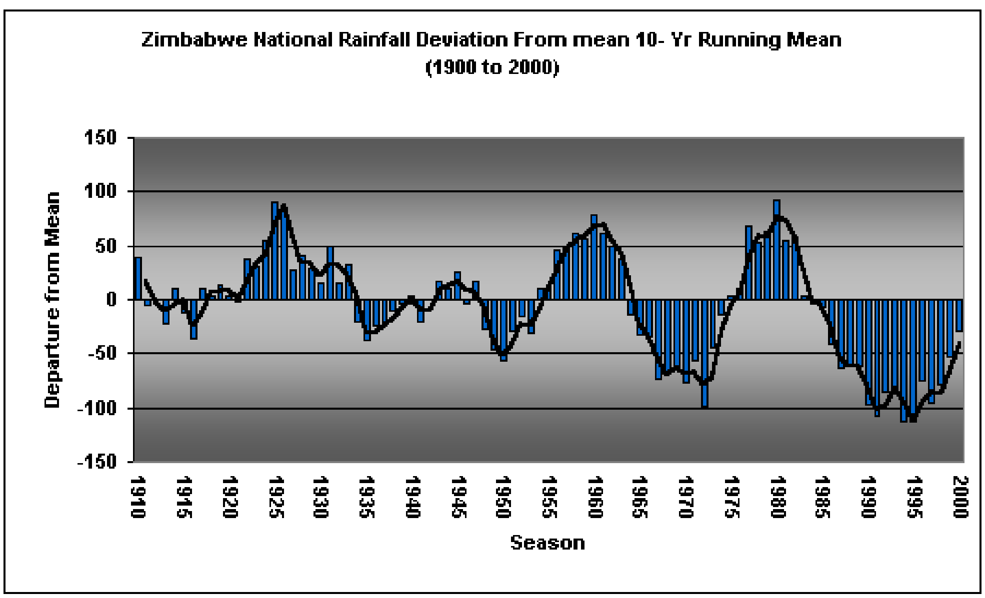


Figure 2. Zimbabwe's national rainfall deviation from the mean from 1900 to 2000.

To show its commitment to addressing the challenges of climate change, Zimbabwe was one of the first countries to sign and ratify the United Nations Framework Convention on Climate Change in Rio de Janeiro in June 1992. Established in 1996, responsibilities for the Climate Change Office in Zimbabwe include coordinating all climate change related issues in the country and assisting the government with establishing appropriate policies to address climate change. The office also coordinates and conducts research on climate change impact analysis and vulnerability assessments. For example, the Climate Change Office's has been working on a project in the Zambezi Valley's flood-prone area attempting to use digital recorders to ensure that people are evacuated when the river rises beyond a certain point. They have also worked on a project in the Limpopo River basin in Botswana, Mozambique, South Africa, and Zimbabwe to assess the vulnerability of the communities along the river.

Farmers' perceptions of climate change in Zimbabwe (Mr Dave Masendike, Agricultural Research and Extension Services (AREX), Zimbabwe)

This presentation tries to answer three questions:

- Are farmers aware of changes in the climate?
- What are their observations?
- What do farmers think causes climate change?

1. The answer to the first question is simple: yes, farmers are aware of climate change.

2. What changes are they seeing? Farmers have noticed changes in the quantity, quality and efficacy of rainfall. There is a general decline in the amount of rainfall, which is more pronounced in the semi-arid tropics (SAT). In terms of quality, they have noticed differences in distribution as well as more erratic rainfall events. The dry spells appear to be increasing in duration and frequency and this is also more pronounced in SAT. There is an increased incidence of drought. Farmers have also noticed that the rainfall is less effective now than before. The rainfall is heavy and infrequent causing more runoff and soil erosion.

Farmers have also noticed certain environmental changes such as the drying up of wetlands, ponds, pans, and riverbeds. Certain grass species that are associated with the wetlands are disappearing as are some small insect species.

There are also certain changes in season length. The end of the rainy season used to be in March/April but now it is as early as February. SR52, the first late maturing maize hybrid used to be grown in Tsholotsho and Gwanda, when it was first released in the 1960s, but now its offspring cannot be grown in these areas.

Farmers are also finding that they can no longer rely on their traditional signs, such as the flowering of certain tree species, or a halo around the sun or moon signifying rain, to predict the weather.

3. What are the causes of climate change? Some farmers mentioned deforestation. Others say that it rains at commercial farms because they have trees that catch the rain clouds.

Others believe that the rains are failing because traditional customs are no longer observed. Some commercial farmers say that global warming is the cause of climate change.

The information for this presentation is from surveys that asked farmers what indicators they use to predict rainfall as well as 20 years of experience working with farmers. The surveys did not specifically look at ways that farmers were adapting their behavior in response to these observations.

Agromet information dissemination to farmers in Zimbabwe (Mr C. Murewi, Midlands State University, Zimbabwe)

The main sources of agromet information are the Zimbabwe Meteorological Services and the National Early Warning Unit. Their main products include: seasonal forecasts, rainfall maps, specialized forecasts and warnings such as frost occurrence and severity. The Met service also produces the fortnight crop and livestock reports for both policymakers and the general public.

The Met service tries to target the needs of the small-scale farmer who has less flexibility in applying forecasts in the face of climate variability as well as the commercial farmer who has more flexibility and a better resource base.

The presentation also included a list of challenges for the users of the information, such as having to pay for it or not completely understanding the information and how to use it. The discussion on the presentation raised questions about the reliability and timeliness of the information as well as the adequacy of the resources available to the Met service.

Group Activity

Following the presentations, each of the participants identified various gaps in knowledge, resources or capacity that the project could begin to address. These were then sorted into four categories:

1. Community adaptation and current coping strategies

2. Data quality and availability: Met office – reliability, end-user dissemination strategies

3. Quality of forecast and reliability of it (risk and adaptive strategies – communication and dissemination)

4. Existing climate records and their use (what databases need to be in place for this project?)

Farmers' current coping strategies (Dr John Dimes, ICRISAT, Zimbabwe)

Risk detection and risk avoidance are emotional decisions.

Some examples of crop management coping strategies include:

- short-duration germplasm
- early sowing
- multiple sowing dates across fields
- drought-tolerant crops
- intercropping – variation on multiple sowing
- extensive rather than intensive farming

Farmers do not invest in soil fertility as a way of coping with climate variability.

Some water management technologies include tied ridges and dead-level contours. These strategies may not be so widely or actively pursued. Conservation agriculture is largely dependent on fertility packages.

We know that farmers prefer to use short-season cultivars rather than long-season cultivars, but the other thing to notice is that the yields are still low. It is only when we invest in fertilizer do we see crop production gains.

Is there any evidence of climate change? There does not appear to be a strong trend in rainfall data. The maximum length of time without rainfall in a season is 50 days. The minimum time is 15 days.

Models provide a different way from the perception of risk. How do we close this gap?

Climate change: The role of modeling to assess adaptation options (Mark Howden, CSIRO)

Preconditions of adaptation:

- Capacity to manage existing climate risks
- Confidence that climate changes are real and will continue
- Motivated to avoid risks and use opportunities
- Demonstrated technical and other options available and implementation issues understood
- Support for transitions to new locations, land uses and practices (policy level issues)
- New storage and transport infrastructure
- Monitoring for continuing improvements in adaptation

With only few exceptions, most of globe has warmed. This cannot be explained without taking human actions into account. The warming is not just on land. Sea surface temperatures have also risen, influencing ocean currents, storm patterns etc.

Current carbon dioxide levels are unprecedented in the entire history of our species (Figure 3). This is a fundamental change in the system. Experiments studying increases in carbon dioxide show significant changes in species composition. For example, FACE experiments have shown a 36% increase in aboveground net primary production. The response to carbon dioxide varies with the type of year. The response is strongest in moderately dry years rather than in very wet years or very dry years.

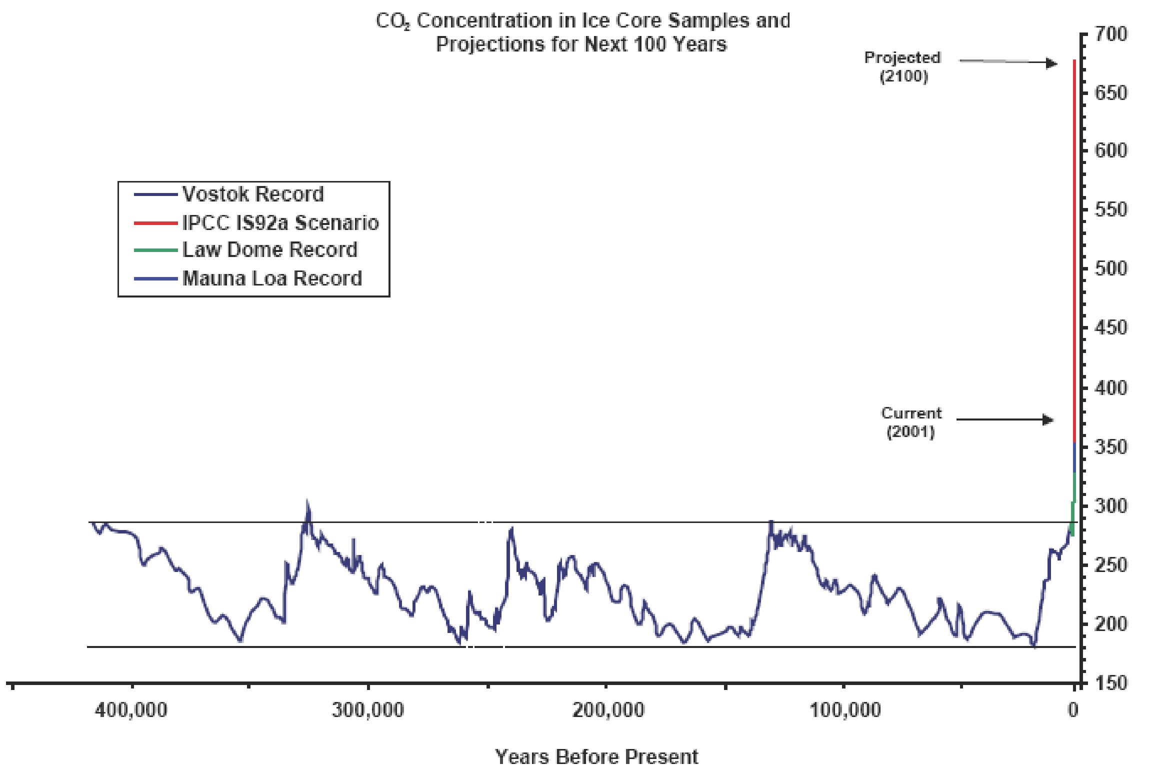


Figure 3. Carbon dioxide concentration in ice core samples and projections for the next 100 years.

Climate change can be seen as an operational concern now, NOT as a strategic planning exercise. Climate variability used to be the entry point for climate change. Now climate change is the entry point for assessing broader climate risk management.

Rainfall projections are highly uncertain, but decreases are likely in most subtropical land regions, continuing observed patterns in recent trends (Figure 4). Winter rainfall is more likely to be less than summer rainfall.

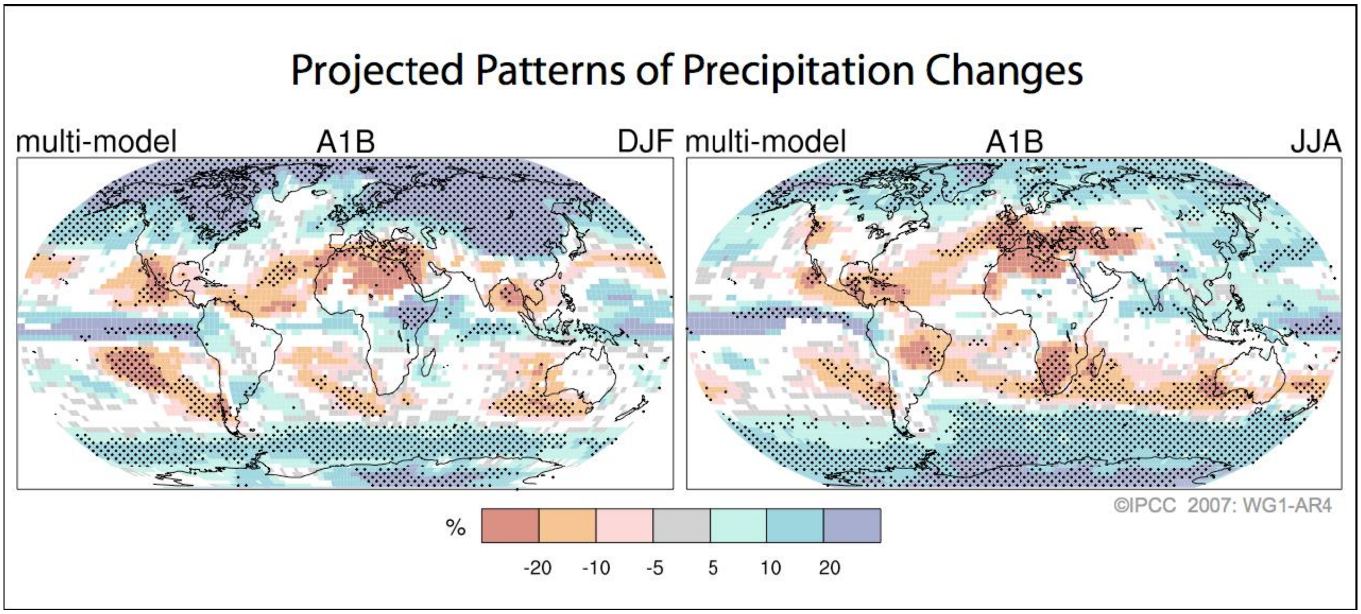


Figure 4. Projected patterns of precipitation changes.

Other climate changes include: increases in temperatures (1.1 to 6°C), possible reduction in frost, increases in rainfall intensity and dry spell length, changes in seasonality of rainfall, increases in evaporation, and possibly more frequent, intense and southerly tropical cyclones.

We need to be able to assess the things that are most likely to change such as climate and atmospheric changes (temperature means and extremes; rainfall mean, seasonality, intensity; carbon dioxide effects); management responses and other variables of interest such as productivity, production risk, farm economics, rural livelihoods, natural resource condition.

Some guiding principles:

- The choice of model should fit the needs of the project. Make the method fit the project, not the other way around. This means you need to have a clarity of who the clients are and a well-defined scope.
- Deal with the things that need to be varied in a balanced way. There is no point in having incredible precision on one area such as carbon dioxide levels if you do not have precision in rainfall data.
- The analysis needs to fit the scale of the decision.

- Confidence vs. precision (it is better to be roughly right rather than precisely wrong).
- Assessment of relative effectiveness and acceptability of options – neither optimization nor absolute measurement.

Different climate adaptation analysis methods are available. These include historical data analysis for variation which tends to ignore a lot of issues, expert opinion, time for space substitution, simulation pathways such as APSIM, mixed models, agent-based models, livelihoods analysis (social and natural capital).

The aim is to make adaptations more effective and efficient in the face of climate change. Trial and success rather than trial and error.

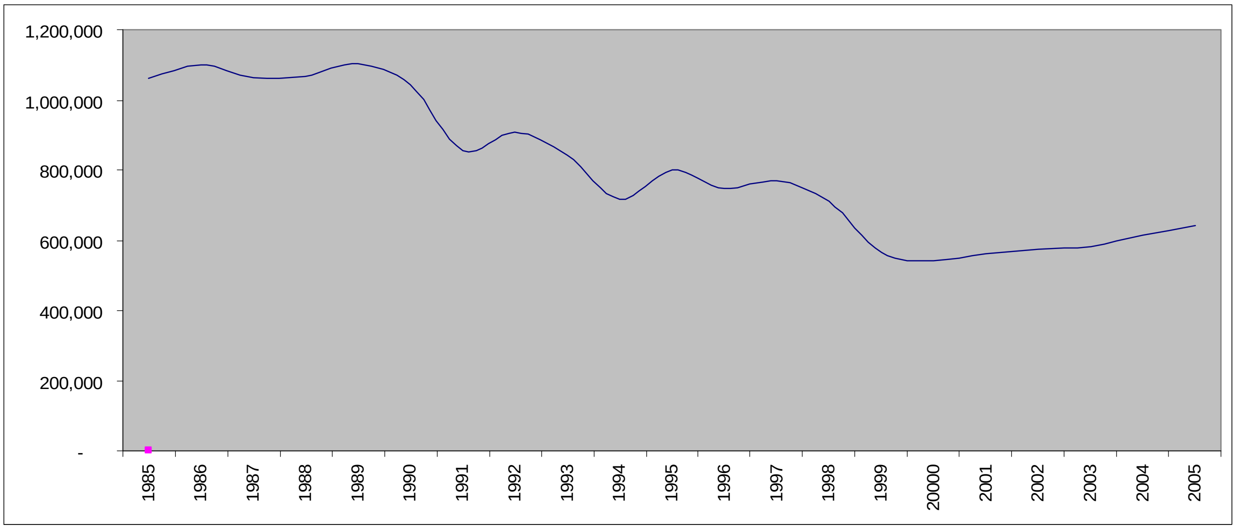
Some suggested steps:

- Establish the real and perceived climate risk
- Determine how farmers have coped in the past
- Explore improvements in these coping strategies via simulation analyses in a participatory way
- Identify projected change in climate variables
- Quantify impacts of these changes on the existing agricultural systems
- Explore adaptations to these impacts (which may include opportunities) with farmers
- Assess the institutional and other barriers/synergies to these adaptations
- Identify the capacity building needs and implement further training
- Adopt an effective communication strategy

The role of modeling in participatory systems (Peter Carberry, CSIRO)

The key message from this presentation is that the promised improvements in agricultural systems productivity as a result of participatory research approaches are still not fulfilled. Out of 400 examples of articles on models reviewed by Mathews only 11 are examples of models having impact. We need to use the model in the real world and engage with farmers using our models and tools.

III. Presentations on Day Two



Dr Twomlow provided a brief summary of the events of the previous day and stated that the two key questions that the project aims to address are:

- Do farmers have the capacity to respond to forecasts and the climate (capacity can vary with wealth and scale of farmer)?
- Do change agents have the capacity to respond and do they have flexible messages that take climate change into account?

Farmers' perception of climate change in Zambia (Brighton Miyanze, Ministry of Agriculture and Cooperatives)

The southern province of Zambia has 235,1444 households with 24% of them being female headed. The total area of the province is 85.283 square kilometers. Rainfall fluctuates every year and as a result so does crop production. Rainfall also affects animal health with the shortage of water leading to changes in pastures.

Effects of climate change in the southern province include a decline in crop production, as well as low water levels in natural reservoirs. It also includes a decline in the cattle population between 1985 and 2005, which could be linked to a decline in rainfall (Figures 5 and 6).

Figure 5. Cattle population in the Southern Province, Zambia, from 1985 to 2005.

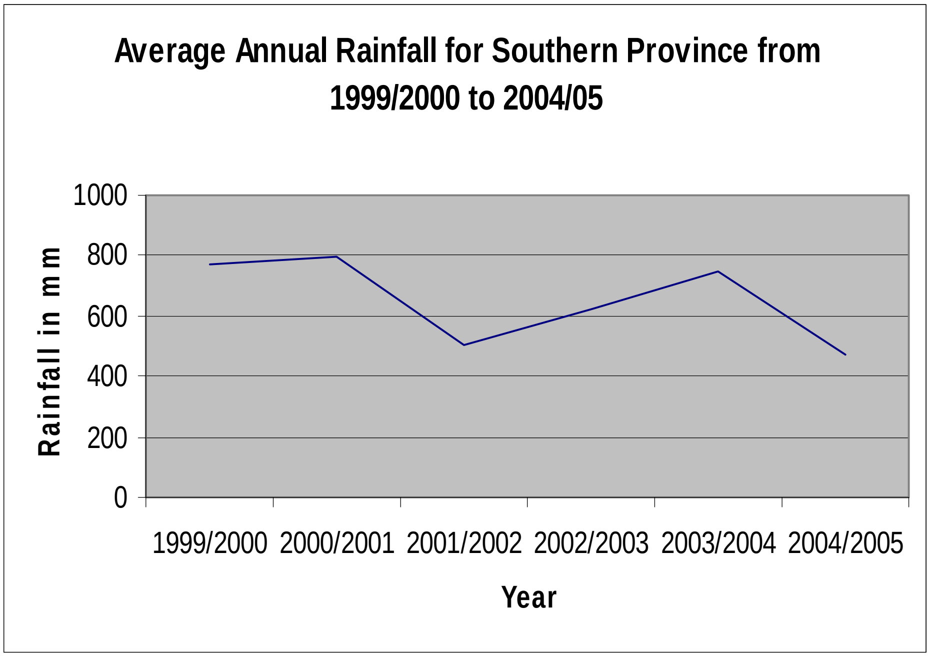


Figure 6. Average annual rainfall for the Southern Province, Zambia, from 1999/2000 to 2004/2005.

Drought mitigation strategies practiced by farmers include:

- crop diversification
- soil fertility
- erosion control structures
- supplementary feeding
- nursery establishment and tree plantation
- conservation tillage

Farmers fall back on sorghum and/or plant both sorghum and maize as sorghum is more drought resistant. They also plant sweet potatoes and legumes. Farmers in Gwenbe and Sinazongwe have switched to growing cotton and prefer to buy rather than grow maize. Small stock such as goats are also common in these districts.

In order to mitigate the effects of reduced water and loss of fertility, the Ministry of Agriculture and Cooperatives along with other ministries and cooperatives, have promoted the certain technologies including: crop residue management, mulching and crop covers, and composting.

Agromet information dissemination to farmers in Zambia (Elijah Phiri/Durton Nanja, Zambian Meteorological Office)

The presentation provided the reasons for the establishment of Agromet services in Zambia and the problems that clientele face when using them. These include a lack of ability to understand raw data and its interpretation for the relevant action; language technicalities; lack of awareness of the importance of the Agromet information; lack of timeliness to respond to early warnings; problems associated with technological advances such as poor telephone infrastructure and internet facilities.

The information dissemination targets are policymakers, intermediaries (NGOs, change agencies,) and other stakeholders. Communication pathways include radio, extension services, vernacular literature, and crop weather bulletins. The following questions frame effective communication: Relevance for decisions? Credibility of sources? Compatibility?

The Zambian Met Department releases a crop weather bulletin at the provincial level and is trying to determine how best this can be used by people on the ground. It may be necessary to narrow down the forecast to the local area. The Met Department does not have the capacity to marry soil conditions with weather predictions, so certain recommendations may apply to a certain farm but not another.

Maize yields in Zambia average 1.2 metric tons. Every time there is a within season fluctuation, there is a drop in yield. There are no feedback mechanisms in place to assess how the Met forecasts are used. The government must be sensitized to meteorological issues, so that the feedback mechanisms, which are key for understanding the lessons that emerge, are implemented and funded. There is also a need to assess whether farmer perception matches with the reality.

The presentation also included a few words from Agnes Hamabuyu, a Zambian farmer who attended the workshop: When you talk to us in your language most people do not understand. You should talk to us in our language. You should use farmer groups to communicate with farmers. We need inputs to enhance productivity. We need to understand what is the government strategy and then most farmers are willing to listen to recommendations.

Group activity

Following the presentations the participants divided into four groups to determine whether the gaps identified the previous day were adequately covered in the project objectives. Each group then presented their results.

1. Gaps in community adaptation and current coping strategies

The group felt that most of the issues were covered under Objectives 1 and 2. The objectives are listed as surveys and so the surveys need to be disaggregrated between risk avoidance vs. coping and adaptation strategies.

The idea of impact or quantifying the impact of climate change on communities is missing from the objectives. There is also the issue of attribution: how do we tell that the changes that are being seen are as a result of climate change and not as a result of the general economic situation in Zimbabwe for example. This is a methodological issue and must be addressed so that when conducting surveys there is an adequate attribution mechanism.

There were two gaps that were beyond the scope of the project: 'Inclusion of all agro-ecological areas as sites to compare climate change' and 'Establishing mitigation measures at the community level'.

2. Data quality and availability; Met office – reliability, end-user dissemination strategies

The group felt that all the gaps were covered by the objectives especially Objective 2. Some of the issues that need to be looked at are: a review of previous project outputs such as RAINMAN; the quality of available data from met offices; access and downloads from IPCC datasets and prognoses; a decision on which climate variables are to be looked at (temperature, rainfall, wind, solar radiation etc.); identifying seasonal forecast indicators and testing their role in climate change; NCEP reanalysis data.

The group also discussed climate data resources that are required to carry out the project and methods of obtaining access to them.

They also discussed the choices of project sites and decided that some of the questions that need to be answered include: what data do we have about those locations? What are the prognoses for those locations? Should we be linking with all 16 projects in terms of downscaling?

3. Quality and reliability of forecast (risk and adaptive strategies – communication and dissemination)

What is the reliability of the met data?

How can farmers access weather forecasts/information? (Objective 5)

Need for capacity building in the interpretation of weather information at all levels? (Objective 3)

How effective are the indicators – traditional and otherwise? (Objective 1)

Currently the met offices are blind broadcasting; they need to target the user appropriately.

4. Existing climate records and their use (what databases need to be in place for this project?)

The cards developed at the previous group session mostly addressed Objectives 1 and 4. There is still a need to determine farmer indicators and use them as tools to evaluate the situation. Also, the various types of indicators – environmental, vulnerability, climate, livelihoods, traditional/indigenous – need to be looked at closer.

The role of evaluation in a successful project (Dr Steve Twomlow, ICRISAT)

Monitoring and evaluation is a prime objective of the project. Evaluation is a broad concept and can be defined as the systematic assessment of a situation at a given point in time. Evaluation occurs at the institutional/systems level as well as project/individual level.

As our approach to solving agricultural and environmental problems changes, so should our approach to evaluation change. There are many reasons for not conducting an evaluation such as thinking that this project is different from others or it would cost too much or there is not enough time.

An evaluation will look at the all aspects of the impact chain and determine who are the beneficiaries of the impacts (Figure 7). Never switch your mind off to the opportunities to interact with all the stakeholders. Evaluation is only of value for the identified audience.

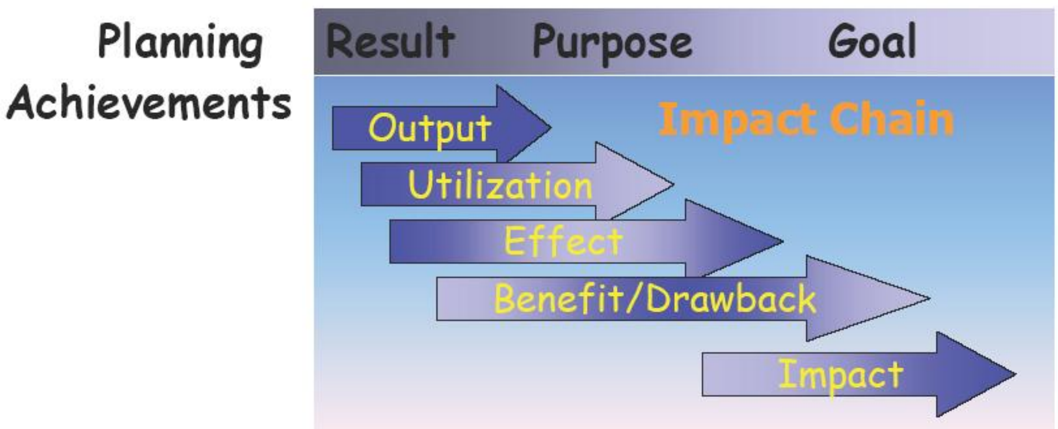


Figure 7. Diagrammatic representation of an impact chain.

Participatory Monitoring and Evaluation (Dr Jemimah Njuki, CIAT)

The project needs to develop monitoring and evaluation (M&E) protocols and determine what the protocols must capture. M&E is not about coming back at the end and determining what happened. M&E has to be occurring throughout the project.

PM&E is a culture. There should be no action without plans, no activities without records, no records without analysis, no analysis without sharing, no sharing without learning, and no learning without action. PM&E has to involve all the stakeholders.

PM&E has many goals/purposes:

- accountability
- tracking progress
- generating knowledge
- improved decision making
- learning

Some key questions to ask when developing M&E protocols are:

- What do we want to monitor and evaluate?
- Why? For what purposes?
- What methods?
- Who will do it; who will be involved?
- What is the process, system, arrangements of monitoring?
- How will we use the results?

We assume that positive projects have positive impacts. But this might not always be the case. PM&E can occur at different levels. It can occur at the activity level where the successful implementation of each of the project activities is evaluated. There is process monitoring, which looks at the processes that occur during the implementation process such as stakeholder participation and farmer involvement. It can occur at the output level where technology outputs such as new varieties or process outputs such as increased capacity are evaluated. PM&E can also take place at the outcome level and evaluate technology outcomes such as technology adoption/adaptation as well as process outcomes such as institutional change and changes in behavior. PM&E can also include impact assessments.

The project has to develop indicators for M&E. There are different types of indicators such as scientific and local, qualitative, quantitative and these have to be gender sensitive.

The budget for M&E should be no less than 10% of the total. However, it is important to remember that PM&E is part and parcel of the activities. We've always seen PM&E as separate to the rest of the project activities. This has to stop.

It is important to use PM&E for reflection, change and institutional learning. How do you reflect on the information from PM&E? The International Center for Tropical Agriculture (CIAT) uses an indicator-based participatory system. This is what we wanted, this is what happened, why did it happen, do we need to change it, etc.… Have you met your target, have the processes to your satisfaction, how happy are the farmers and what do they feel? This is usually a facilitated process. It is difficult to do it otherwise.

We need to ask ourselves what are the results we expect from this project. Once we identify those results we need to determine what the indicators are that we are going to use to assess whether or not we are achieving those results. If you are not clear what the results are then you are not going to be clear what you are trying to monitor. The first step is to define the results, then go back and think of activities for each objective.

We need to critically look at the objectives and the activities that are in the project proposal. We should define what the expected results are going to be and develop at least two indicators that will say determine whether or not each result will be achieved. The target must also be time-bound. The milestones for each activity are vague; so for each activity it is important to develop a milestone with figures and numbers as well as assign responsibility to someone for each.

Group activity: Assessing the objectives

The participants were then split into five groups based on the five objectives and were requested to fill out the following two tables for each objective.

Table 2: Expected results and indicators

Objective	Expected results	Indicators	Target	Information to be collected
		Indicator 1		
		Indicator 2		
		Indicator 3		

Table 3: Activities, milestones and data collection requirements

Activities	Milestones	By when?	Who?	What information do we need to collect?

The results of this exercise are presented below.

Table 4: Objective 1: Expected results and indicators.

Objective	**Expected results**	**Indicators**	**Target**	**Information to be collected**
Establish smallholder farmers' perceptions on risks associated with climate change in the project areas	Case studies of existing knowledge	Review report	Review report produced by Aug 2007	Case studies on how communities have been affected by climatic change/extreme and their adaptation strategies
	Baseline information on what farmers know about climatic change and risks associated with it	Baseline report	Baseline report produced by Oct 2007	Farmer knowledge on risks associated with climate change Vulnerability context

	Historical met data profiled for the project areas	Climatic data profiles	Climatic data profiles produced by Nov 2007	Rainfall, temperature, radiation, wind speed, humidity data
	Historical profiling of drought years and impact on crop yields and livestock performance	Baseline report	Baseline report produced by Oct 2007	Yields trends and livestock population trends from CSO Available opportunities and challenges

Table 5. Objective 1: Activities, milestones and data collection requirements.

	Activity	Milestones	**By when**	**By who**	**Information to collect**
1.1	Start-up workshop	Workplan developed/ workshop report	June 2007	Mugabe, Twomlow, Nanja	Who to do what and when in the project
1.2	Develop survey instruments	Survey tools developed and tested	July 2007	**Munodawafa**, Mugabe, Nanja, Met, Masendeke, Shirichena, Mwale, Phiri, Hungwe	
1.3	Review case studies of existing knowledge and perceptions	Report on case study of existing knowledge	Aug 2007	**Munodawafa**, F.T. Mugabe, Nanja, Twomlow	

1.4	Parcipatory baseline surveys	Baseline report	Oct 2007	**Munodawafa**, Mugabe, Nanja, Met, Masendeke, Shirichena, Mwale, Phiri, Hungwe	
1.5	Correlate historical climate data to those years farmers claim were dry years	Report	Nov 2007	**MSU, ZMO, AREX, ZARI, ICRISAT, CIAT**	
1.6	Data analysis and documentation	Data analysis for paper completed	Dec 2007	**Munodawafa**, Hungwe	
1.7	Feedback workshops	Workshop report	Nov/Dec 2007	Munodawafa	
1.8	Develop a paper on farmers' perceptions of drought in the four districts of Zimbabwe and Zambia	Draft paper Paper submitted	Jan 2008 March 2008	**MSU, ZMO, AREX, ZARI, ICRISAT, CIAT**	None

Table 6.Objective 2: Expected results and indicators.

Objective	**Expected result**	**Indicators**	**Target**	**Information to be collected**

Determine how rural communities have coped with existing climate variability and extremes and develop appropriate strategies for adapting to future climatic change	Synthesis and documentation of key practices farmers have adapted to cope with climate change	Number of documents compiled Type of practices identified Number of farmers practicing the different coping mechanisms	One report compiled by end of year 1	Type of existing coping mechanisms Desegregation of farmers based on gender and type of mechanisms adapted Socioeconomic information on the contribution of these coping mechanisms to community resilience in relation to food security and climate change
	Identify promising coping mechanisms to recommend for scaling out	Publishing of simple-to-read policy briefs on respective coping mechanisms	Five policy papers/briefs	Geographical prevalence and potential of coping mechanisms General weather/climate information

	Active involvement and support of policymakers (traditional leadership, government leaders, NGOs, donor community) in implementing appropriate coping mechanisms for climate change	Increased participation of policymakers in programs pertaining to climate change		Number of meetings/visits in which policymakers participate Type of organizations actively involved in climate change mitigation programs

Table 7. Objective 2: Activities, milestones and data collection requirements.

Activity	**Milestones**	**By when?**	**Who?**	**What information do we need to collect**
Activity 2.1 Identify attitudes to risk and vulnerability and farmers' perceptions of climate change and coping strategies to meet their livelihood goals using participatory diagnosis and visioning tools				
2.1.1 Undertake a baseline survey to carry out an inventory of coping mechanisms in the project sites	Baseline survey starts by September 2007 Data analysis and report writing completed by December 2007	By December 2007	Agric dept, Zambia ZARI AREX Met Dept MSU Farmers CIAT	Type of existing coping mechanisms and farmer practices Desegregation of farmers based on gender and type of mechanisms adapted

				Socioeconomic information on the contribution of these coping mechanisms to community resilience in relation to food security and climate change
2.1.2 Identifying and training of support staff to assist in data collection	Training of support staff conducted by end of August 2007	August 2007	AREX ZARI Agric. Dept UNZA MSU CIAT	Number of support staff to target for the training Resources to be used for the training
2.1.3 Presentation of baseline information on coping mechanisms	National stakeholders' workshop held by December 2007 to present preliminary survey findings	December 2007	AREX ZARI Agric. Dept UNZA MSU CIAT	Draft survey report Inventory of key partners
2.1.4 Publication of final baseline report	Final report produced by end of January 2008	January 2008	AREX ZARI Agric. Dept UNZA MSU CIAT	Draft survey report

Activity 2.2: Identify, characterize, and disaggregate indigenous and innovative adaptations to climate change by gender, social capital and resource endowment				
2.2.1 Conduct focus group discussions to develop criteria for wealth ranking	Criteria for wealth ranking developed	February 2008	CIAT MSU	What are the criteria for measuring wealth?
2.2.2 Develop an index for social capital using questions/variables from baseline data	Social capital index and paper developed	May 2008	CIAT MSU	Indicators of social capital Information for all indicators from households during baseline survey
2.2.3 Analyze data categorizing coping strategies by gender, wealth and social capital index	Data analysis for papers completed	April 2008		Coping and adaptation strategies Gender of head of household Social capital indicators
2.2.4 Develop two papers on the role of resource endowment, gender and social capital in influencing farmer coping and adaptation to	Two draft papers completed Papers submitted to	June 2008 September 2008		None

climate change	journal			
Activity 2.3: Quantify the biophysical, resource and economic thresholds that affect farmers' adaptive capacity to climate change though focus group discussions, interviews and participatory diagnosis tools, such as, participatory budgeting				
2.3.1 Identify PhD student				
2.3.2 Develop PhD proposal and data collection tools		September 2008	PHD student/ Free state/CIAT	
2.3.3 Develop tools and collect data on resource and economic thresholds affecting farmers adaptive capacity	Data collection and analysis completed	June 2009	PHD student CIAT	Farmer resource endowment Natural, financial capital of different households Measures of adaptive capacity
2.3.4 Draft and final thesis	Draft thesis Final thesis	December 2009 June 2010	PhD student CIAT	
2.3.6 Draft papers for publication	Paper on economic and resource thresholds that affect farmers adaptive capacity to climate change	December 2009	PhD student CIAT	Economic and resource thresholds of different farmers vs. their adaptive capacity to climate change

Table 8. Objective 3: Expected results and indicators.

	Expected output	**Indicators**	**Target**	**Information to collect**
Build capacity and competency within Zambian and Zimbabwean institutions to use simulation and climatic forecasting tools for predicting climatic variability	Undergraduate students training	Number of students	30 (MSU), 40 (UNZA)	Attendance list
	Extension staff training	Number of participants	15 (ZIM), 15 (ZAM)	Attendance list
	APSIM training	Number of participants	15 (ZIM), 15 (ZAM)	Attendance list
	IDRC/CCAA training	Number of participants	6 (ZIM), 6 (ZAM)	Attendance list
	Post-graduate training	Number of participants	6 (ZIM), 3 (ZAM)	Attendance list
	Undergraduate attachment	Number of participants	6 (ZIM), 15 (ZAM)	Attendance list

Table 9. Objective 3. Activities, milestones and data collection requirements.

	Activity	**Milestones**	**By when**	**By who**	**Information to collect**

3.1	Develop and conduct training courses and lectures Conduct needs assessment for public sector, private sector and undergraduate students Develop and conduct training courses for extension staff Develop and conduct courses for undergraduate students on agronomic modeling and climatic change and adaptation	Reports on: Course outline Course materials Module being taught	30 July 2007 31 Aug 2007 29 Feb 2008	Mugabe/ Phiri	Level of education Computer literature and skills IPCC documents and other sources
3.2	Explore and strengthen synergies between public and private sector institutions Invitation of public and private participants to a	5 public and 5 private sector participants	August 2007	ICRISAT	APSIM materials

	climate change modeling course	At least 50 participants attend course	January 31, 2008		
3.3	Provide support to MSU and UNZA in the use of simulation models Organized training conducted by ICRISAT	Reports Number of participants	Every 12 months starting September 2007	ICRISAT	Identification of participants Nominations for the course
3.4	Train lecturers from MSU and UNZA on aspects of the project during inception phases Train project team members	Reports Attendance at IDRC/CCAA workshops	Dec 2007	Mugabe/Mwal e	Identification of participants Nominations for the course
3.5	Train postgraduate students (3 PhD & 4 MSc/MPhil under MSU and 3 PhD under ZARI/DMS/UNZA Post graduate	Progress reports Identification of candidates Registration	June 07 July 07	MSU/UOVS/ ZARI/DMS/St udents	Identification of participants Nominations for training Draft copies Receipts

	training Identify PhD students Develop PhD proposal and data collection tools	PhD proposal Annual reports, peer reviewed articles	Dec 07		

Table 10. Objective 4: Expected results and indicators.

Objective	**Expected results**	**Indicators**	**Target**	**Information to be collected**
Use farmer participatory research approaches linked with simulation and climate forecasting methods to develop and evaluate scenarios with farmers that enable adaptation to climate variability and change within the	Adaptation strategies/measures to reduce farmers' vulnerability to climate change and variability	Knowledgeable and understanding farmer (on adjusting cropping activities according to climate forecasts)	Farmer	Farmers' initial expectations versus final perceptions
		Localized climate and crop forecasts	Farmer, scientist, extension officers	Historical climatic and crop records; expected changes in climatic variables.
		Stabilized agricultural yields	Farmer	Agricultural yields

agricultural systems		Appropriate extension messages formulated and disseminated to the smallholder farmer	Farmer, scientist, extension officers	Initial farmer expectations versus final perceptions
		Training programs (farmers, extension staff, researchers/scientists)	Farmer, scientist, extension officers	Numbers trained

Table 11. Objective 4: Activities, milestones and data collection requirements.

Activity	Milestones	By when?	Who?	What information do we need to collect?
Baseline survey (Agronomic survey to identify: options for the crop simulation models; adaptation strategies to climatic change and variability)	Research questions developed and tested Survey conducted	Aug 2007 Oct 2007	Njuki/PhD student	Current agronomic practices and systems, constraints to agricultural production Perceptions on climate change and variability Current coping strategies to climate change and variability
Training smallholder farmers on the concept of climatic forecasts and their usefulness in making decisions for cropping and livestock	Production of training course materials Hold training workshops with farmers Pre and post season	Aug 2007 Oct 2007	Murewi to lead Durton	Number of farmer groups and group sizes from each project site. Literacy levels and languages of the target group. Current seasonal forecasts.

activities	workshops (present current forecast and review previous season)	Oct 2008 & 2009.		Feedback from farmers on previous season outcome (rainfall patterns, crop performance)
Collection and analysis of historical climatic, crop yields, soil types, location specific (geographical coordinates, altitudes, topography) data for project sites	Climate record for project sites Crop yields record for project sites Geographical coordinates, altitudes, topography Establish relationships/trends among variables (climate, yields)	Aug 2007 Aug 2007 Aug 2007 Dec 2007	Makuvaro to lead Gondwe	Rainfall, maximum temperature, minimum temperature, solar radiation; evaporation, wind speed and direction, and humidity Crop yields for three major crops for each site Geographical coordinates, altitudes, topography
Generating climate forecasts and climate change scenarios (downscaling) for project sites	**Climate forecasts from GCMs and RCMs** Climate scenarios from GCMs and RCMs Localised climate	Sept 2007 Sept 2007	Murewi to lead Durton	Climate outputs from GCMs and RCMs; regional and national seasonal forecasts

	change scenarios Localised climate variability scenarios (seasonal forecasts)	Nov 2007 Sept 2008 Sept and Oct 2007, 2008, 2009		
Participatory crop simulation modelling	Simulated crop yields under current agronomic practices/systems and current climate Simulated crop yields under current agronomic practices/systems and climate change scenarios Simulated crop yields under identified agronomic adaptive strategies and climate change scenarios Likelihood of adoption tested (farmers'	Oct 2007 Oct 2007 Oct 2007 April	Dimes to lead	Climate change scenarios. Identified coping strategies Current agronomic practises/systems Farmers' views on adoption of adaptive strategies Agronomic input costs; Crop commodity prices

	perspectives) Economic analysis carried out	2008 April 2008		
Participatory establishment and evaluation of on-farm trials	Field experiments established in the project areas Field experiments evaluated	Oct 2008 & Oct 2009 May 2009 & Apr 2010	Twomlow to lead	Input requirements (seed, fertilizers, pesticides) Crop yields Farmers' views on crop performance and nature of cropping season
Policy workshops in each country	Outreach program for administrative personnel from agriculture, meteorology at national and provincial levels; political leadership developed	Mar 2010	Mugabe to lead	Project results

Table 12. Objective 5: Expected results and indicators.

Objective	**Expected results**	**Indicators**	**Target**	**Information to be collected**
Develop, test and disseminate climate risk communication materials and appropriate delivery mechanisms	Quality and accessible climatic data and analyzed for use in climate change and variability	Quality controlled data Analysis of climatic variability and change completed	Farmers	
	Effective climate dissemination services of critical information for users		Scientists, extensionist and farmers	
	A globally recognized conference on adaptation to climatic change	A global conference	Scientists	

Table 13. Objective 5. Activities, milestones and data collection requirements.

Activity	**Milestones**	**By when?**	**By who?**	**What information do we need to collect?**
Establishment of a community of practice with climate change consortium for	Agreement on common downscaling methods across	September 2007	Mugabe to lead	Needs of existing projects What are the

Africa	projects			viable downscaling methods Assessment against data availability
Review of existing dissemination strategies and materials	Complete the review and pass it to other project components Publish a review	End of September 2007 February 2008	Nanja Zhakata	Dissemination strategies and materials
Develop and test an existing strategy and adaptation measures	Develop and test a draft extension and dissemination approach Develop a final extension and dissemination approach	End of October 2007 Assess it at the end of May 2008 and reviewed each season after that. Final strategy delivered end 2010	Mugabe to lead	Staff levels matching information dissemination with available resources Review of methods used in other parts of the world and an assessment of the feasibility for Zimbabwe and Zambia
Develop and disseminate information packages on climate change	Document the information	End of 2010	Swathi and Mugabe	Compiled information from other projects and processing it to make it suitable for

				continental level decision makers and for rural community in Zambia and Zimbabwe
Continental conference	Additional funding US$100,000	April 2009	Mugabe	Contribution of other IDRC projects to the conference Contact detail for potential funders
Climate data collection and analyses	Quality control data for each site Analysis undertaken for climate variation in relation to seasonal or other climate predictors and for climate trends	April 2008	Durton Zhakata	Long-term quality climate date Climate predictors

IV. Workshop Closing

Mr Durton Nanja closed the workshop and thanked the participants for their presence and comments. He said that the workshop has left the participants with a clear understanding of the objectives and the enthusiasm to move forward and carry out the activities.

Annex 2: New Modules/Courses introduced in the Faculty of Natural Resources Management and Agriculture at MSU

Annex 2.1: LWR 216 Climatic change and adaptation

Scope of the module:

The world community faces many risks from climate change and the scenarios generally indicate higher temperatures and more erratic rainfall in Africa. Predictions for southern Africa suggest a general decrease in total seasonal rainfall, accompanied by more frequent in season dry spells that will significantly impact crop and livestock production, and hence economic growth in the region. The hardest hit will be the rural poor in the drier areas, where crop failure due to drought is already common and chronic food emergencies afflict the region in most years. This has a bearing on food production especially for the poor who are located in SSA. Their adaptive capacity is very low hence the need to train them and the extension agents to be able to better off adapt in a changing climate.

1.0 Climatic change drivers

- Radiative forcing (negative and positive) and climate including anthropogenic
- Emissions (sources and trajectories)
- sinks

2.0 Climate

- Historical climate
- Projected climate

3.0 General circulation models and Regional Climate Models

- General Circulation Models (GCMs)
- Regional Climate Models (RCM)
- Local Climate Models
- Downscaling techniques (dynamic and statistical approaches)

4.0 Impacts

- Direct or indirect effects of climatic change on crop production
- Description of main tools available for studying the impact of climatic change on crop productivity
- Cropping systems (different crops in different places etc.)
- Livestock systems (effects on pasture growth, effects on animals, impacts on fire and shrubs
- Crop-livestock systems
- Natural resources management and biodiversity/ecosystems
- Hydrological cycle/water resources

5.0 Adaptation

- Types of adaptation (i.e. short and long term, autonomous and planned etc.)
- Purpose of adaptation
- Climate change adaptation analysis methods
- Barrier and synergies to adaptation

6.0 Policy

- Integrated assessment – its roles and issues
- Engagement process
- Mainstreaming climatic change
- Dealing with uncertainty

7.0 Communication

- Techniques (e.g. for media, farmer groups etc.)
- Participatory approaches and their role

Annex 2.2: AGRO 210: Crop simulation modeling

Students will analyse biological and environmental aspects of crop production using models; evaluate the behavior and environmental aspects of crop production using simulation models; evaluate the behavior and results of computer models for crop production; and use computer models to make management decisions.

1.0 Why crop simulation modelling?

- Introduction to systems analysis and simulation models
- Role in scientific research and resource management
- Testing hypothesis
- Data extrapolation and synthesis
- Prediction of the effects of future climatic change/extremes on crop production
- Cost effective for complex crop systems
- Coming up with adaptation measures/strategies

2.0 Terminology

- Model, modelling simulation
- System and system boundary
- Inputs and outputs
- Parameter and state variables

3.0 Classification of models:

- By approach of model development – material models vs mathematic models
- By mathematical equations - deterministic vs stochastic; process, physically based vs empirically based, regression models
- By model structure- lumped (homogeneous) vs distributed model (compartmental model).
- Agricultural models (APSIM, DSAT);
- By emphasis of physical processes- vegetation models; soil hydrological models (SWIM); surface hydrological models; ground water hydrological models (MODFLOW); mixed hydrological models (ACRU, TOPMODEL); water quality models; forest hydrological models; urban models

4.0 Procedures for model development

- statement of objectives, hypothesis
- defining system, initial and boundary conditions
- literature review and data analysis to select appropriate existing models and model components
- mathematical equation formulation
- Basics of programming/computer implementation – programming that translates mathematical equations into computer codes using computer language e.g. BASIC, FORTRAN, PASCAL, C/C++, Visual basic;

- Model evaluation (Stability, sensitivity, precision, validation, optimization)

5.0 Numerical integration of constituent processes. Selection of mathematical equations to represent the different processes

- rainfall interception
- evapotranspiration modelling, potential ET, actual ET,
- description of soil water movement (Darcy's law), general equations for water movement (Green-Ampt, Philip, Horton's equation)

6.0 Sub-routines (Modules)

- Genetic co-efficients
- Water balance module
- weather modules
- Fertility modules
- Management modules

7.0 Limitations of Crop Simulation Models

- Difficulty of providing input data
- Stochastic nature of this input data in a temporally and spatially continuous environment
- Difficulty of representing complex situations numerically

PRACTICALS IN THE CCAA-MSU COMPUTER LABORATORY

Application of crop simulation models - Use of models as decision support systems in developing adaptation measures (Development of 'what if scenarios')

- Use of computers and spreadsheet programs
- Use of agronomic models (APSIM, SPACTeach; PARCH; DSSAT)
- Structured tutorial questions to investigate crop growth and yield in highly variable environments.
- The impact of climate change on agricultural food production (investigating the effect of changes in CO_2 and precipitation on crop yields).
- Use of models to come up with mitigation strategies
- Analysis and generation of environmental data on computer
- Model validation using field data
- Model sensitivity analysis

Annex 3: Survey tool

Building adaptive capacity to cope with increasing vulnerability due to climatic change

Questionnaire for Baseline Data Collection

SECTION A: GENERAL INFORMATION

Enumerator ____________________________Date _______________________

1. Country: 1=Zimbabwe 2=Zambia
2. District: 1 = Monze, 2 = Sinazongwe 3= Lupane 4= Lower Gweru
3. Agricultural Camp: 1 = Njoola, 2 = Kaumba, 3 = Sinazeze, 4 = Sinamalima For Zimbabwe put Wards
4. Village: ____________________________
5. Location Latitude :_____________ Location Longitude: ________________
6. Name of household head (HH)____

SECTION B: AGRICULTURAL PRODUCTION

7. How much land do you own and cultivate?

Is the five yeas really enough or we can go beyond that to capture what was done before since most of the decrease in rainfall started two decades ago?

	Last year	**5 years ago**	**If there is a change, reasons for the change**	Tillage method commonly used ***1=Manual with hoe 2= Animal traction 3= Tractor tillage***

How much land do/did you own (Ha/Acres)				
How much land do/did you cultivate (Ha/Acres)				
Area not being utilized (Ha/Acres)				
Do/did you hire additional land / plots *(1=yes; 0=No)*				
If yes, how many acres?				
How much land on irrigation (Ha/acres)				

8. What are the priority crops grown now and five years ago?

Crops grown currently		Crops grown five years ago		
Crops grown now	How important is the crop for food security (see codes below)	Crops grown five years ago	How important was the crop for food security (see codes below)	If there is a change in priority of crop, why?

Codes for importance of crop 1=Very importance 2=Moderate importance 3=Not important

9. a) What are the indicators of a good crop production year?

Indicator (e.g rainfall)	Description

b) In the last 10 years, which years would you consider as having been good?
……………………………………………………………………………………………

10. a) What are the indicators of a poor crop production year?

Indicator (e.g rainfall)	Description

b) In the last 10 years, which years would you consider as having been poor?
……………………………………………………………………………………………

11. What are the average yields for the following major crops in a good crop production year and a poor crop production year?

Crop	Amount (in Kg)/ acre in a good crop production year.	Amount (in kg) / acre in a bad crop production year?

	Scotchcarts/ha or acre buckets/ha or acre	Scotchcarts/ha or acre buckets/ha or acre
Maize		
Millet		
Sorghum		

12. What areas did you plant and how much did you harvest for these crops in the last 3 seasons?

	2006/07 season *Your perception of this season 1=Good 2=Bad*		2005/06 season *Your perception of this season 1=Good 2=Bad*		2004/05 season *Your perception of this season 1=Good 2=Bad*	
Crop	Area planted (acres/ha)	Amount harvested (in kg), scotchcarts/buckets	Area planted (acres/ha)	Amount harvested (in kg)/scotchcarts	Area planted (acres/ha)	Amount harvested (in kg) scotchcarts
Maize						
Sorghum						
Millet						

13. In the last 5 years, what has been the change in production of the following crops? Important crops grown in each ward

Crop	What has been the change in production? ***1=Increased*** ***2=remained relatively the same*** ***3=Reduced***	What have been the reasons for the change?

14. How would you rank the changes you have mentioned above in terms of their contribution to change in agricultural productivity?

Causes of decline in crop production **(NB-Enumerator to transfer causes from the table above)**	Rank these factors (starting with 1=most important, 2= second most important, etc)

15. What improved or local technologies are you currently using in crop production and what are the objectives of using them?

Technologies being used (if local names are given, please describe the technology)	On what crops are you using them?	When did you start using them?	What are the objectives for using them or what problems are you trying to address by using the technologies?

16. What are the main changes that you have made in the way you farm in the last ten years? Are we not limiting them to only ten years why not go beyond

Changes	When did you make the changes?	Why did you make the changes?

17. What livestock do you own?

Assets	Do you own? ***1= yes*** ***2=no***	If yes, how many?	Source: ***1=bought, 2=gift, 3=inheritance, 4=other source***	Purpose for keeping ***1=Mainly for food*** ***2=Mainly for cash*** ***3=Equally for cash and food*** ***4=For asset accumulation / prestige etc***
a. Cattle				
b. Goats/ Sheep				
c. Poultry (chickens, guinea fowls)				
d. Donkey				

Other 1 (specify)………………				
Other 2 (specify)………………				

SECTION C. HOUSEHOLD INCOME AND CAPITAL ASSETS

18. What are your main sources of income in the past month and how important are these sources to your livelihood?

Income Source	Yes/No (a)	Priority
Sale of crops		
Sale of livestock		
Informal work *(maricho)*		
Formal employment		
Remittances		
Old age pension		
Pension fund from work		
Gifts received in kind		
No income at all		
Others (specify)		

19. What major agricultural assets/implements do you have?

Assets	**Do you own** **1= yes** **2=no**	**Number**	**Source:** 1=bought, 2=gift, 3=inheritance, 4=other source
a. Ox-drawn plough			
b. Oxcart			
c. Harrow			
d. Ridging plough			
e. Cultivator			
f. Irrigation equipment (e.g. treadle pump, water pump, drip etc) Other (specify)……………………..			
g. Sprayer			
h. Hoes			
i. Other (specify) ……………………			

20. Domestic assets:

Assets	**Do you own?** **1= yes** **2=no**	**If yes, how many?**	**Source:** 1=bought, 2=gift, 3=inheritance, 4=other source
a. Radio/TV			
b. Bicycle			
c. Mobile phone			

d. sewing machines			
e. Watch/clock			
f. Paraffin stove			
Other (specify) ……………………			

SECTION D: FARMER PERCEPTIONS OF CLIMATE CHANGE

20. Have you noticed any significant changes in weather patterns over the years in relation to agriculture? ***0=no, 1=yes***

21. If **<u>YES</u>**, what changes have you observed and what do you think are their causes? *(Probe for changes and tick where appropriate and add any others that the farmer mentions)*

	Tick if farmer mentions	How common are these incidences? (how many times have you witnessed them in the last 5 years)	What do you think are the main causes of these changes?
Increased number of seasons without enough rainfall			
increased floods			
Rainfall starts late and ends early			
extremes in temperatures (e.g. very cold winters/frost/very			

hot summer			
Long dry spell			
Rains do not come when they normally used to			
Other			

22. For the changes mentioned above, what are some of their impacts in your household, the environment etc

	What are the impacts of these changes to your household/ livelihoods?	What are the impacts you have observed of these changes on the environment?
Increased number of seasons without enough rainfall		
Increased floods		
Rainfall starts late and ends early		
Winters have become colder		
Summers have become		

hotter		
Long dry spell		
Rains do not come when they normally used to		
Other		

23. Do you have access to the weather forecasting data/information? *0=No, 1=Yes*

24. What different kinds of information do you get and where do you get it from?

Type of information	Source of information *1=Radio, 2=Extension* *3=Fellow farmer 4=Television* *5=other (specify)*

25. How would you rate the weather information that you receive?

	Rating *1=Poor,* *2=Average* *3=Good*	What are the reasons for your rating?	What are your suggestions for improvement?
Timelineness			
Adequacy			
Frequency of dissemination			
Usefulness			
General content			
Delivery channel			
Language of presentation			

26. If the forecast information is positive i.e it predicts that the rainfall will be enough and will be on time, what are some of the actions that you take in your farm?

Action	Do you take this action? *(tick if farmer mentions)*	Why do you take this action?

27. If the forecast information is negative i.e it predicts that the rainfall will not be good or reliable, what are some of the actions that you take in your farm?

Action	Do you take this action? *(tick if farmer mentions)*	Why do you take this action?

28. Do you have any traditional / indigenous ways of predicting the weather patterns?

Weather pattern	**Prediction Indicators**
Drought Year	
Normal year (Rainfall)	
Flood Year	
Very cold winters	
Normal winters	
Very hot summer	
Normal summer	

29. What are the trends that you have observed in the following in the last ten years?

Variables	**Increased**	**Same**	**Declined**	**What would you say is the main causes of this change?**
Crop yields				
Crop types, varieties				
Crop pests and diseases				
Livestock populations				
Livestock diseases				
Quality of pastures				
Rainfall amounts				
Water availability (for domestic use)				
Soil erosion				
Water erosion				
Wind erosion				
Farm income from agriculture				
Food availability for household consumption				

30. For those variables where there has been a change, how are you coping with these changes?

Variables	**How are you coping with change?**
Crop yields	
Crop types, varieties)	

Crop pests and diseases	
Livestock populations	
Livestock diseases	
Quality of pastures	
Rainfall amounts	
Water availability	
Soil erosion	
Water erosion	
Wind erosion	
Farm income from agriculture	
Food availability for household consumption	

31. Are you using any of the following farming practices in your farm as a result of the changes in weather patterns?

Farming practice	Do you use? ((***Tick as if farmer mentions)***	When do you use? *1=All the time* *2=During drought years* *3=During good rainfall years*
Potholing		
Ripping		

Crop residues		
Chemical weed control		
Tied ridging		
Winter ploughing		
Conservation basins		
Using drought tolerant varieties		
Changing crops		
Mulching		
Intercropping		
Monocropping		
Fallowing		
Other		

32. Are there some crop production practices that you use in good rainfall years and avoid in drought years? If yes, which ones

Cropping practice	Do you use in good rainfall years? *0=No 1=Yes*	Do you use in drought years? *0=No 1=Yes*	Reasons
Use of fertilizers			
Hire of labour			
Use of irrigation			
Others (specify			
Other			
Other			

SECTION E: VULNERABILITY AND CLIMATIC RISK MANAGEMENT

33. How long does the main harvest last in a good and bad year and how do you fill these shortages?

	Number of months harvest lasts	Strategies the household uses to cope with shortage
Average good year		
Average bad year		

34. During which month last year (2007) growing season did your household have enough or shortages (*Indicate the food availability trend across the year by* ticking either enough or not enough)

Month	*Enough*	*Not Enough*	*Month*	*Enough*	*Not Enough*
January			July		
February			August		
March			September		
April			October		
May			November		
June			December		

35. Which of the following can you say was true for your household at any point in time during last year as a coping strategy for food shortages? (Tick appropriate box)

	1 = Yes	**2 = No**

Sold livestock		
Sold household assets		
Consumed seed stock		
Ate food normally we do not eat (wild food)		
Reduced amount of food eaten		
Ate fewer meals per day		
Sought daily work outside farm		
Migrated		
Borrowed cash or food		
Sold firewood		
Rented out land		
Withdrew children from school		
Looked for relief		
Other (specify)		

SECTION F: GENDER, SOCIAL AND HUMAN CAPITAL

36. Which trainings have you received on agricultural production the last 3 years?

Topic of training	Who organized the training?	Who attended the training 1=Husband; 2=Wife; 3= Both	How did you use the knowledge/ skills? 1=Applied on my farm; 2= Trained others; 3=other………….

37. How would you assess your ability to do the following?

	How would you assess your ability, **currently?** *0=Not good* *1= good* *2=Very good*
Interpret weather information	
Use weather information to plan for the season	
Determine which practice to use during drought years	
Determine varieties of crops to plant for different conditions e.g drought , flood etc	
Train other farmers on how to use weather information	
Keep own farm records	

37. Are you currently a member of any farmers' group or local association in this village? If yes, give the name

Name of group or association (*include local institutions*)	**Type of group** (*1 = Mixed, 2 = Women's,* *3 = Men's*)	**Your position in the group** (*1 = Committee member,* *2 = Ordinary member*)	**How long have you been a member of this group?** (*in years*)

SECTION H: DEMOGRAPHIC CHARACTERISTICS

		Codes	Response
H1.	Sex of household head	*1= male 2 =female*	
H2.	Wealth rank category (Household perception)	*1= Poor, 2= Medium, 3= Rich*	
H3.	Age of household head *(Actual number of years)*		
	Age of household spouse *(Actual number of years)*		
H4.	Marital status of household head	*1=married 2=widowed 3=divorced 4=single, 5=polygamist*	
H5.	Household head's farming experience in years		
H6.	Education level of household head	*1=none, 2=primary, 3=secondary, 4=tertiary*	
H7.	Position of household head in the community	*1=ordinary citizen* *2=head man* *3=religious leader*	

H8	Other occupation of head of household head	*1=Business* *2=Teacher* *3=Other self employment*	
	Type of house	*Roof (1=Thatch 2=Iron tin roof 3=Tile)*	
		Walls (1=Mud and sticks 2=Unburnt brick 3=Burnt brick 4=Wood 5=Stone	

G9. Is there anything you would like to share with me pertaining to weather changes/climate change?

____

Annex 4: APSIM Training

Three project team members attended APSIM training at Matopos Research Station from March 11 to 13th. They were Veronica Mukuvaro, Prospard Gondwe, Phillip Tirivanhu and Martin Moyo, an ICRISAT SO assigned to the project also participated. The 3-day Program is given below. About 80% of the program was completed. The SCF analysis using SOI phases had to be done using APSIM Outlook as a post-analysis of APSIM output using an Australian sceanrio. I failed to get the SOI module to work in the APSIM User Interface. Also, we ran out of time to do simulation of an actual experiment. The participants all expressed the view that they needed more time - 5 days, up to 2 weeks was suggested.

Going forward:

Yes, it was crammed. The objective in keeping it short was to shift the APSIM learning into an individual mode by setting follow-up tasks to build on the introduction. The following tasks and timelines were agreed:

(i) Complete the Crop simulation exercises on crop rotations (sorghum-wheat-chickpea and maize-groundnut) and email 1st graph of results (capture into Word using Control Print Screen keys strokes) **by March 20th**.
(ii) Build on the CC analysis for Masvingo – modify maize simulations to simulate CC scenario's for groundnut (peanut) and pigeonpea (pigeonp). Also **by March 20th**.
(iii) Source up-to-date long term climate records for Zimbabwe and Zambian test sites, plus additional Provincial sites. Conduct an analysis of rainfall and temperature data to determine current evidence of climate change. (I shared the Inception Workshop Presentation as an example). Complete 1 met station analysis in each project district (Lower Gweru, Lupane, Monze, Sinazonwe) **by March 31st** . One objective here is to make more progress in our climate data sourcing for the project.
(iv) Analyze the SOI phase signal using historical rainfall and crop simulation output for 2 test sites in Zimbabwe and Zambia (**by mid May**) and subsequently for 3 or 4 additional Provincial sites in each country. I expect further assistance with this analysis will be required. The objective would be to make a preliminary presentation on the forecast signal efficacy in each country at the Annual meeting in June. But it is dependent on obtaining the historical climate data.

Annex 5: Livingstone Progress Review Report (2008)

Building adaptive capacity to cope with increasing vulnerability due to climate change

Progress Review Workshop

29-31 July 2008

Chapa Classic Lodge, Livingstone, Zambia

1.0 Presentation of progress by objectives team leaders

1.1 Objective 1 and 2

Objective 1: Establish small-holder farmers' perceptions on risks associated with climate change in the project areas

Objective 2: Determine how rural communities have coped with existing climate variability and extremes and develop appropriate strategies for adapting to future climatic change

A start up workshop was held in Bulawayo from 7 to 8 June 2007. A follow up workshop was also held in Victoria Falls from 11 to 12 October 2007. An inception workshop report was produced. Allocation of responsibilities amongst project members was achieved in these two workshops.

The project sites (camps/wards) have been identified, two each in Zambia and Zimbabwe. The local leadership and institutions that we will be working with have been informed of the project. A visit report was produced.

It was noted during the Victoria Falls meeting that it was important to come up with consolidated survey tool with input from all project researchers to avoid having many researchers going to ask farmers similar questions. A survey tool was developed after the Victoria Falls meeting.

Baseline surveys were carried out at both sites in Zambia and the survey data analyzed. In Zimbabwe the survey was carried out in Lower Gweru and data is pending compilation and analysis.

A paper that will be published in the Chemistry and Physics of the Earth journal was presented at the 8th WATERNET/WARFSA/GWP-SA symposium from 31 Oct to 2 Nov 2007 in Zambia. The paper demonstrates that the hardest hit communities by climatic change will be the rural poor in the drier areas, where crop failure due to drought is already common and chronic food emergencies afflict the region in most years.

1.2 Objective 3: Build Capacity and Competency within Zambian and Zimbabwean Institutions to use Simulation and Climatic Forecasting tools for Predicting Climatic Variability

Two under-graduate courses/modules on Climatic Change and Adaptation and Agronomic Modelling have been developed and have been approved by the Deans' committee on Academic Regulations at MSU. Teaching of the modules will commence in September 2008 when the University opens

A climatic change and adaptation and Agronomic Modeling Teaching laboratory with 13 computers and 2 printers was established at MSU

The five PhD students have developed their proposals. Four have registered with the University of the Free State (South Africa) while one has registered with the University of Pretoria (South Africa). PhD supervisor visited 2 Zambian PhD students in Oct 2007 and one PhD student in March 2008. 3 PhD and 1 MSc students were trained on the use of APSIM model.

1.3 Objective 4: Application of crop modelling, seasonal climate forecasting and participatory action research to improve smallholder crop productivity and climate risk management in drought-prone regions of Zimbabwe and Zambia

The team contributed to the questionnaires to elucidate current perceptions of climate risk.

A field visit to Zambia was made in March 2008 by Dr Dimes, Prof Walker and Prof Mugabe. An interaction with farmer interactions on reactions to SCF supplied by Zambian Meteorological was done. The interaction was very positive and farmers requested for earlier dissemination. A trip report was circulated to project members in March 2008.

Sourcing of long term climate records for sites in Zambia was done and has to be done for Zimbabwe.

APSIM Training was conducted in March 2008 and Prospard, Veronica, Phillip, Martin Moyo participated in it. A report was produced and circulated to members. A climate Change Analysis paper was presented at the SADC-EU Conference in Lusaka in June 2008.

1.4 Objective 5: Develop, test and disseminate climate risk communication materials and appropriate delivery mechanisms

Durton presented an interesting DVD with the work he had done during the year. However the DVD is too long and should be edited so that it becomes shorter – not to distract viewers.

2.0 Students progress reports

2.1 Durton Nanja: Develop, test and disseminate climate risk communication materials and appropriate delivery mechanisms

His supervisors are Prof Walker and Prof Musvosvi.

2.2 Makuvaro: Impact of climate change and variability on smallholder farming in Zimbabwe, using a modeling approach

There is need for climate data for Zimbabwe to enable her to start simulation modeling. Francis and Cyrial were tasked to go to the met offices in Harare to acquire this data as soon as possible/before end of September 2008 because both Cyrial and Veronica could not proceed with their work without this data. **(Meterorological data from Thornhill, Lupane and Tsholotsho have been sourced after the workshop and will be circulated soon when the MSU internet improves)**

She has identified method of down scaling climate data (SDSM 4.2) and downloaded software & manual; identified data requirements and web sites. She has also obtained experimental data for model validation purposes from research stations

Literature review on SOI and rainfall in Southern Africa / Zimbabwe has been done.

Veronica needs to participate in FGDs in Lupane and analyze survey information to get outputs for objective. She also needs to do trend analysis (Regression) of climatic data for study sites –objective 1a) (if data is available)

2.3 Gondwe: Cropping Decisions Under Variable Climate for Southern Province Smallholder Farmers in Zambia

His supervisors are Prof.Sue Walker-UoFS, Dr. E. Phiri-UNZA and Dr. J. Dimes-ICRISAT.

An intensive Quasi-PRA have been done in Mujika that included historical time lines, population trend lines, crop trend lines, soil fertility, village mapping.

Prospard conducted an experiment in Bulimo village to demonstrate the effects of time of planting, tillage method and variety on maize yields. The mother trial with 27 treatments was not replicated and he was encouraged to replicate the trial in the coming season so that it could be analysed. The mother trial plots was analysed as a 3 x 3 x 3 factorial experiment with no replication

For the baby trials, sixteen volunteer farmers were selected from Mujika camp scattered over the three participating villages and supplied with inputs. The baby trials were planted on various dates according to the convenience of the farmer.

Effect of Date, Tillage, Variety and Date x Tillage interaction on maize yield were significant. The effect of the rest of the treatments were not significant. It can be concluded from this trial that planting early, irrespective of tillage and variety, is strongly encouraged; planting early in combination with the use of basins is encouraged in Mujika area and; planting late and use of basin seems to give low yields mainly due to water logging.

2.4 Murewi: Probabilistic multimodel climate change projections for southern Africa

Cyrial is registered with the University of Pretoria, Dept. of Geography, GIS and Meteorology and his promoters are Prof. Willem Landman (University of Pretoria, Dept. of Geography, GIS and Meteorology South African Weather Services) and Francios Englebrecht; (University of Pretoria, Dept. of Geography, GIS and Meteorology.

The main goal for the study is to develop regional probabilistic multimodel climate change (CC) projections over southern Africa with reduced the uncertainty, for use in the studies to assess the impact of climate change on crop production, ecosystem, health and hydrologic water resources.

The expected outputs are to produce site specific plausible regional climate change scenarios and localized climatic forecasts that will be used by agricultural adaptations to climatic changes and variability in the project.

The achievements made to date are review of methodologies (WIP), has downloaded GCM monthly and daily data and has familiarised himself with statistical tools (CPT and SDSM)

The outstanding tasks are generating climate forecasts and climate change projections (downscaling) to project sites, collection and analysis of historical climatic data for project sites (Zimbabwe), analysis of trends, variability, seasonality, frequencies and occurrences of extreme events for the variables, involved in Training of smallholder farmers on the concept of climatic forecasts and their usefulness in making decisions for cropping and livestock activities (Project), and develop training materials to address the role/usefulness of climatic/seasonal forecasts in farming activities

2.5 Mubaya: Farmers coping and adaptive strategies to climate variability and change

Chipo is registered with Free State.

Together with some project members she has completed the Zambian survey, has done the Lower Gweru survey, has done initial PRAs in Zambia and Lower Gweru, preliminary analysis for Zambia survey has been done (see section 3 of this report for some preliminary results)

She has to do the Lupane survey, initial PRAs, in-depth case study interviews and follow up PRAs –wealth ranking.

2.6 Mutswangwa: An Economic Assessment of Smallholder Farmers' Adaptive Capacity to Climate Change in Zimbabwe

Eness' supervisors are Dr K Mazvimavi (ICRISAT) and Dr G Kundhlande (UoFS) and she is registered with University of Free State.

She has participated in the Zambian baseline survey, registered with her University, participated in the Lower Gweru baseline survey and writing of her proposal is in progress.

Outstanding activities include finalising the project proposal, follow ups to collect missing data and finalising the thesis outline

2.7 Masere: Assessment of biophysical thresholds affecting farmers' adaptive capacity to climate change

His supervisors Prof Mugabe and Dr Munodawafa.

Proposal writing is in progress. Philip participated in the APSIM training that was done in Bulawayo in March.

His outstanding activities include selection of farmers to study before farmers start ploughing for the 2008/2009 season soil sampling and analysis and implementing the Mother and baby trials in Lower Gweru. It was felt that his work fits more in Objective 4 rather than 2.

3.0 Presentation of the Zambian survey results

Chipo Mubaya presented some preliminary analysis of the survey which was conducted in Zambia early this year.

Findings from the study indicate that there are 2 groups of elements that pose risk to farmers and these are climate and non-climate risk elements. Climate risks were mentioned by a high percentage of respondents with 82, 3%. Of interest is that more farmers in Sinazongwe district highlighted climate risks than farmers in Monze district. Climate related risk elements include erratic rains, excessive rains, floods and droughts. Other elements highlighted by farmers are dry spells and extreme temperatures. On the other hand, non-climate risks mentioned include lack of and late supply of inputs, low soil fertility, lack of draught power and labour constraints. In addition, limited land and livestock and crop diseases were highlighted.

The study further finds out that in order to deal with these risk elements, farmers either cope or adapt in different ways. Farmers' coping mechanisms include digging shallow wells in cases where there is unavailability of water. For unavailability of food and less income from agriculture, they engage in gardening, picking wild fruits and off farm work such as trading in fish, hiring out labour and brick making, among others. Buying of food and stream-bank cultivation are also some of the coping mechanisms employed. Adaptation mechanisms include growing of drought tolerant crops, early land preparation, livestock rearing and crop diversification, among others.

Farmers have their indigenous ways of predicting weather conditions. With regards to indicators for a drought year, the study finds out that while climate indicators are the most common, there is mention of abundance or scarcity of certain wild fruit. These climate indicators include extended cold season, floods or excessive rains and strong winds in October. Few and absence of special birds and insects such as swallows and ants and cultural beliefs such as many boy children born in a season are some of the indicators for a drought year. Indicators for a normal year are an antithesis of those for a drought year. Climate related indicators are still the most common and these are hot summers and moderate winds. In this category, birds and insects in large numbers and more girls born that season than boys indicate that there is going to be a normal season.

Findings reveal impacts that can be categorised into positive and negative impacts of climate variability and change. Negative impacts on the household include poverty resulting specifically from decline in income from agriculture. Hunger, resulting in decline in food unavailability due to erratic rains and droughts also features as a common impact. Other household impacts include water unavailability resulting from droughts and human diseases such as colds resulting from extremely cold seasons and malaria in hot humid conditions. Negative impacts on the environment include drying up of water sources and pastures due to droughts and land water logging, gulleys and siltation of water sources and gardens due to floods and excessive rains. Farmers also mentioned positive impacts on both households and the environment. These emanate specifically from early rains and sometimes excessive rains. Positive impacts on the household include availability of water for domestic use and higher food stocks. Positive impacts on the environment include high levels of water in water sources, green vegetation, early shooting of grass and rich pastures.

4.0 Outstanding activities for each of the objectives and timeframe

4.1 Objective 1

Specific Objective	**What has been done**	**Pending**	**How**	**When**	**By whom?**
Charactise the farming systems	- Household questionnaires - Focus Group Discussions - Data compilation	- Secondary data - Case studies	- Collecting Secondary data - Questionnaire: Sampling at District level	- before the cropping season, during and after	- ZARI & AGRITEX - Survey team
Develop farmer typology	All done				
Establish farmers' perception of climate change	All done				

Document the effects of climate and variablity		- livestock breeds, calving , weaning rates and productivity - Vegatation cover	- Case studies - Case studies	- before the cropping season, during and after	-Survey team - Survey team

4.2 Objective 2

Specific Objective	What has been done	Pending	How	When	By whom?
Identify attitudes to risk and vulnerability and farmers' perceptions of climate change and coping strategies to meet their livelihood goals using participatory tools		- Actual climate data - Investment decision	- collected from the Met. Department - Case Studies	- before the cropping season, during and after	-Mr Nyanja (Zambia) - Proff Mugabe & Mr Murewi (Zimbabwe)
Identify, characterize, and		- In depth case studies on adaptation and	- Case studies	- before the cropping	- Survey team

disaggregate indigenous and innovative adaptations to climate change by gender, social capital and resource endowment		coping - Social practises such as labour sharing groups, sharing resourses	 - One FDG per ward/cam p	season, during and after	 - Survey team
Quantify the biophysical, resource and economic threshold that affect farmers adaptive capacity to climate change through FDGs, interviews and participator y diagnosis tools, such as, participator y budgeting		The biophysical requirements/threshold s for the use of certain technological adaptive strategies -Literature review on the economic returns			Tiri Eness
		Feed workshop for farmers of survey results		Decembe r 2008	-Survey team

4.3 Objective 3: Build capacity and competency within Zambian and Zimbabwean institutions to use simulation and climatic forecasting tools for predicting climate variability for facilitating rural communities in developing and evaluating improved coping strategies

Specific Objective	What has been done	Pending	When	By whom?
(a) Develop and conduct training courses and lectures to address identified training and information needs on climate change and adaptation of Zambian and Zimbabwean institutions	Two courses/module outline have been developed and have since gone through the Deans' Committee on academic regulations, await endorsement by the Academic Board at MSU. UNZA have incorporated elements of climatic change and adaptation in their existing courses	Training extension workers on aspects of climatic change and adaptation and agronomic modeling Preparation of course materials for undergraduate and extension officers	By November 2008 By January 2009	MSU- Francis, JD, Adelaide, UNZA- Elijah, Durton, Mate By all - Francis to coordinate
(b) Provide support to MSU and UNZA to build capacity in use of	A computer lab with 13 computers and 2 printers at MSU has been established			

simulation models and scenario analyses through development of agronomic modelling and climatic adaptation courses that will be taught at both universities				
(c)Train post-graduate students (3 PhD and 4 MSc/MPhil) in all aspects of the project	4 PhD students registered, 3 MSc students registered and 1 MSc student identified and will start August			
(d)Train lecturers from MSU and UNZA in all aspects of the project during the inception phases of the project	In-house and ongoing			
(e) Explore and	Nothing so far			

strengthen synergies between public and private sector institutions that support the development of smallholder agriculture in both Zambia and Zimbabwe				

4.4 Objective 4

Specific Objective	What has been done	Pending	When	By whom?
4a. Quantify farmer perceptions of climate risk in SAT cropping systems and influence on investment decisions.		Reconciled the original project proposal with the current proposal (VicFalls) Work with Chipo to extract the information for the questnr for obj. 4		John Dines Prospard and

		To have a meeting with Chipo before leaving Gaps in the baseline data to be filled by FGDs		Veronica Chipo, Prospard JDP, Walker Chipo, Eness, Veronica
4b. Comparing farmer yields estimates with simulated ylds		Radiation generation and filling the data Data from Moorings to be used for the SOI signal assessment JJA for Sep. SOI rainfall for OND, JFB rainfall. (Central Pacific SSTs-Nino3.4 for Zambia) Compare the 10 yrs of historical	End of September	Prospard and Sue Prospard, Durton and Cyrial

		MET Sept forecasts to the SOI index use Morings data for Zambia and Gweru data for Zimbabwe to check for the strength of the signal. Compare Historical seasonal forecast of MET dept. for Sept. to the SOI index Preliminary analysis of site Crop Yields using APSIM	28th August Mid September	Prospard, Durton, Cyrial and Veronica Durton for Zambia and Cyril for Zimbabwe Veronica and Prospard
4c. Evaluate crop management options as response to SCF with the		1. To be done 1st in Zambia on the 29th Sept(Prospard, Durton, Sue, JPD, Mukata, 2 camp Officers), and	28 September in Zambia and 6 October Zimbabwe	Virginia, Francis, Sue, JPD, Cyril, Veronica and Philip with

farmers		next in 2. This is a three day workshop, with 20 farmers from Monze and 12 farmers from Sinazongwe. 20 farmers from L Gweru and 12 from Lupani Two mother trials, in each district and 5 baby trials per village. with a number of baby trials of 5 per village		three extension officers in Zambia and JPD, Francis, Cyrial, Virginia, Adelaide, Philip, Ignatious and Extension officers Prospard, Francis, Phillip and Ignatious
4d. Assess the impact of future climatic change scenarios on crop management strategies		Participatory simulation Downscaling of the climatic data for both Zambia and Zimbabwe: data needed from Zambia.		Veronica Cyril

4.5 Objective 5 Objectve 5

Develop, Test and disseminate climate risk communication materials and appropriate delivery mechanisms.

Cyril to do what Durton is doing in Zambia – talking to farmers about seasonal climate forecasting (SCF)

To improve the extension officers' dissemination pathways

What are the views of extension officers in conveying seasonal climate forecasts

In service training course by the project staff – make use of guys from the met office – as part of Objective 3

5.0 Impact of climate change on crop productivity in Zimbabwe SAT at the end of 21st Century (John Dimes, Peter Cooper and K.P.C. Rao)

John presented a paper that he had presented at the SADC-EU Symposium on Climate Change and Soil and Water Management Lusaka, May 27-30, 2008.

6.0 Presentation of Outcome Mapping - Concepts (Jan Van Ongelvalle)

Jan presented the Outcome Mapping framework since he felt that that it normally takes 3 full days to go through Outcome Mapping so that participates would be able to come up with their plan. Francis presented what he and Nanja had started on the OM whilst at a workshop in Egypt. The group came up with six boundary partners after some deliberations. The boundary partners that were identified are Target farmers groups, Extension staff, Research scientists, meteorological officers and MSU undergraduate students.

It was agreed that Mugabe and MSU staff are given one month of finalise the OM plan and give it to Jan so that the OM plan is completed before 30 September 2008. Jemaimah must be involved in the development of the OM plan.

6.1 Outcome challenges

The team broke into four groups to come up with Outcome Challenges and Progress markers for each of the boundary partners. The four boundary partners were Extension staff, Research scientists, meteorological officers and MSU undergraduate students.

6.1.1 Metrological Officers

Seasonal Climate Forecasting (SCF) is easier to apply in farmer management decision-making

Expect to See:

1. Improved technical skills of Met Officers in development of SCF and interpretation of SCF for agricultural production management (crop simulation skills)
2. Training of Extension Officers (by Met Office) in interpretation of SCF for farmers
3. Training in how to measure and record rainfall by target farmers
4. Timely provision of SCF and implications for crop management

Like to See

1. Testing the reliability (accurate) of SCF
2. Knowledgeable Extension officers that can interpret and understand SCF and other Met information for farmers

Love to See

1. Utilisation of SCF for improved food security and economic growth of SHF
2. Agro-Met more prominently used in Agricultural Development Planning

6.1.2 Extension Officers

The project intends to see extension staff that is trained and knowledgeable on climatic variability and change issues. The extension staff will be able to disseminate and clarify climatic change/forecast information to non-project targeted farmers and stakeholders (NGOs, Fertiliser/Seed companies) in debate on climatic variability and change issues.

Progress Makers

Expect to see

1. expect them to attend training sessions on climatic variability and change
2. to have access to appropriate and timeous climate forecasts

Like to see

- improved understanding and communication of seasonal forecasts
- improved understanding of climatic adaptation and coping strategies

Love to see

- disseminating and simplifying seasonal forecasts to farmers
- teaching farmers adaptation and coping strategies to alleviate effects of climate variability and change

6.1.3 MSU students

Expect to see

- Students to enroll for the course
- Develop comprehensive training materials
- Allocation of resources for students research

- Modules to be publicized in and outside the country

Like to see

- Students attending lectures
- Project members being involved in training/teaching
- Students participating in practical aspects
- Students from other faculties taking up the course
- Interaction of students with project team members
- Enrolment of international students

Love to see

- Awareness of students to climate change issues in relation to the local environment
- Capacity building to a higher level i.e. lecturers also receive training
- Capacity building among students for continuity reasons so that they impact the knowledge to the organizations they join after training
- Students being employed by the Extension and Met. departments

6.1.4 **Research Scientists**

Expect to see

- Presentation at project workshops/meetings
- Publications in newsletters/bulletins
- Attendance at project meetings/workshops
- Simple statistical data analysis
- Write a proposal
- Have general scientific knowledge of subject matter

Like to see

- Presentation at national/regional workshops/meetings
- Publications in local/regional scientific journal
- Attendance at local/regional meetings/ workshops
- Use specialised packages

Love to see

- Presentation at international workshops/ meetings
- Publications in international scientific journal
- Attendance at international meetings/ workshops

- Use specialised packages for data analysis and report results
- Develop original/new idea and write a proposal

Annex 6: Livingstone Progress Review Report (2009)

Building Adaptive Capacity to Cope with Increasing Vulnerability Due to Climate Change

IDRC Climate Change Project Meeting 27 -31 July 2009

(Kaazmein Lodge, Livingstone, Zambia)

Objective

The meeting was convened in order to assess project progress, workplan for the 2009/2010 and provide hands-on exercise on the use of the APSIM generic model. It was also intended to identify what still needs to be done in order to conform to project team targets as well as the donor's expectation as well as discuss budgetary issues.

Opening remarks by Francis Mugabe

- Alluded to the challenges they faced in organizing the meeting including but not limited to late disbursements of funds from ICRISAT –India but pointed out that it was important that the meeting would go ahead (John Dimes apologized on behalf of ICRISAT for the inconvenience).
- Thanked everyone for the hard work during the past year
- Pointed out there will be need for an extension for the project up to June 2010 as experiments will still be in the field by March when the project is expected to be concluded
- Pointed out the need to work hard and cover all the activities so that we are compliant with what we promised the donor
- Highlighted that funds disbursed by the donor were not what project partners expected and in most cases were below the expected.
- There will be funds to see the project through to June 2010 but as a contingency measure, the project management has deducted 10% of partner allocations for reallocation to critical activities

Presentations

1. **Adelaide Munodawafa…….. Objective 1 (**Determine how rural communities in southern Zambia and southwestern Zimbabwe, that are representative of

Africa's semi-arid regions, have coped with climate variability and extremes and developed appropriate strategies for adapting to future climatic change)

- Baseline survey……….characterization of farming systems and document effect of climate variability and change
- Cover gaps identified in previous reports (investment decisions by farmers, case studies on adaptation and coping strategies by farmers)
- Questionnaires and FGD where administered in Lower Gweru and Lupane
- 24 farmers involved dependent on resource endowment group per site
- Wealth ranking criteria was presented for both Lower Gweru and Lupane where livestock ownership is very important.
- Rich help poor with ploughing and poor are hired for weeding etc
- Perceptions of climate change and the coping strategies were also presented
- Factors influencing investment decisions by farmers
- The differences in livestock ownership between Lower Gweru and Lupane (more) could point to the differences in level of crop-livestock interaction and intensities between the 2 sites

Questions

- We need to know how many people in each village/ward and how these people were selected for the case studies?
- We need to know the frequency (%) was calculated? It is the number of farmers who said yes (out of 24)
- How did you select the 12 farmers in each village? We worked with some of the farmers so we know their profiles (resource ownership)

2. Update on building capacity in climate change and variability analyses and the use modeling tools by Francis Mugabe

- 2 modules in crop simulation modules and climate change and adaptation modules have been approved by the academic board at Midlands State University but lost semesters last year and could not teach it, will do so in August 2009
- In Zambia no modules at universities but will incorporate in existing courses
- Extension officers from both Zimbabwe and Zambia have attended training workshops
- John Dimes is training students and extension on using APSIM
- Undergraduate attachments, students in Zimbabwe have been attached
- Some elements not done e.g. explore and strengthen synergies especially with private sector
- CSIRO came to SA for training in APSIM in 2008

Questions

- Some post-grad are on track but we need discuss and see if they are really to finish on time
- In terms of outputs, by this time next year we need to know how many students have gone through the simulation modelling exercise for reporting pursposes.

3. **John Dimes---------Objective 4 (**Use FPR approaches linked with simulation and climate forecasting methods to develop and evaluate scenarios with farmers that enable adaptation to climate variability)

- Quantify farmers' perceptions of climate risk in SAT cropping systems and their influence on investment decision.
- A student will start in ICRISAT on quantification of perceptions, to compare farmer perceptions and other tools
- The work will be mostly covered by students
- Spearheading the use of APSIM cropping systems as analyses tools
- Farmer workshops conducted in each 4 target districts (Monze, Sinazongwe, Gweru and Lupane)
- Farmer input in mother baby trials (2 in Zambia and 4 in Zimbabwe)
- Tillage, variety and fertility management responses to SCF
- Climate data sourcing and analysis, Training at UFS
- APSIM training ---------at UFS in Dec 2008 (included management response to SOI)
- Reverse engineering (inverse modelling) using a field experiment data
- Farmer workshop report -----------Zimbabwe and Zambia
- On-farm experimentation well carried out
- Climate change analysis paper presented (Tamale, Ghana and Waternet SADC Conference)

Questions

- What is reverse engineering, is it the same as inverse modelling?
- Yes, you have a result and try to get there

4. **Durton……. Objective 5 (**Develop, test and disseminate climatic risk communication materials and appropriate delivery interventions)

- Team of three people working together

- How the project is influencing the partners/ boundary partners
- Outstanding issues remain, continued monitor of the effectiveness of the selected dissemination pathways and practices.
- All outstanding activities are likely to be met by end of project next year.

Questions/comments

- This activity is only confined to Zambia and not Zimbabwe

Student Presentations

5. **Eness Paidamoyo Mutsvangwa-------------Assessment of climate change vulnerability, a case study in Lupane and Lower Gweru**

- Presented the whole Mphil Thesis
- Collected data through the survey carried out in 2008
- Analyses of data going back and forth (due to new gaps and deficiency in data)
- Managed to register now second year student
- Need to collect data for institutional arrangements eg Agritex, Markets

Challenges

- Collecting data not specific for the study
- Not having my supervisors as active members of the IDRC Climate project
- Visit to UFS for one on one with supervisors
- Target to submit by November 2009

Questions/comments

- Why come back on 20th of Nov and not 30th of November that gives you more time to submit your Thesis?
- Data collection is for project not Thesis and you need to make sure you get what you want from there
- Draw lines when you need to end on data collection otherwise you will not finish
- There are still gaps in data that need to be filled
- Supervisors are not in the project, maybe we could have co-opted some of her requirements into the work that was done to cover gaps in the baseline

6. **Pospard Gondwe - Objective 4 (**Use FPR approaches linked with simulation and climate forecasting methods to develop and evaluate scenarios with farmers that enable adaptation to climate variability)

- Highlighted the different partners in the project
- Demonstrate with APSIM to develop treatments for the 2008/2009 season
- Input distribution done
- Field visits with Prof. Sue Walker
- 7/15 and only 1 female farmer did a complete set of experiments, others could not manage due to shortage of implements and labour
- Harvesting of MBT was done successfully in May 2009
- Data analysis was done using R-software (What is that?)
- Most farmers did not do other treatment so they ended up doing the conventional treatments as mentioned above
- Fertility response higher under ripping than conventional tillage
- Only fertility was significant and tillage was not across farmers' fields
- Manure and control shows similar results highlighting the lack of good response from manure in the short term.
- Manure did well in Zinazeze
- Data was abnormal and had to be transformed by taking the square root of initial values
- Discovered that in some instances, farmers have little knowledge about manure and its use in crop production

Questions/comments

- Acidic soils/ fertilizers /---------------use manure?/ lime?
- Have the soils been characterized?
- What should extension do about results that show ripping doing less than conventional
- Why farmers did not do any other treatments?
- Results from MBT poses the greatest challenge to the project…………………..the lower rates give equal yields to the recommended rate sof fertilizer

7. Phillip Masere---------Motherbaby Trials Lower Gweru

- Trials conceptualized by farmers with help of simulation models
- Tillage*variety*fertilizer
- Baby trials were farmer managed
- 2*2 experiments per farm
- No significance difference between manure and control
- Registered with University of SA and he should be provided more funds to complete his studies

Comments

- Quality of manure is not being shown in the presentation
- How is the manure is handled?
- Low quality of manure used
- Collect social data relate that yield?
- Confusion about in which Natural region is Lupane and Lower Gweru

8. **Chagonda Ignatious- Mother baby trials from Lupane**

- In natural region 4 with high frequency of droughts
- Soils predominantly shallow sands
- Treatments developed with inputs from weather forecasting and farmer input
- The ridge effect was negative on the crops
- Results show that recommended fertilizer rates are giving less yields compared to low rates

Questions/comments

- Where are the statistical analyses?
- What about registration? Will be going to register next week at UNISA at Department for 1 year.
- Why no differences across sites on yield…………..inconsistent results. Consistent results to fertility
- Lack of response to manure……….need to look at why low responses to manure
- Literature searches on manure is recommended

9. **Veronica Makuvaro-------Impact of climate change on smallholder farming in Zimbabwe, using a modelling approach**

    - Already has a background on study area, justification and objectives
    - Summarize results, discuss and write-up the chapter
    - Write-up of remaining Chapter sections
    - Have to validate APSIM using A. Moyo's data from long-term experiments.
    - Sensitivity analysis is still outstanding
    - Crop simulation under different crops, agronomic management and climatic conditions
    - Has created APSIM Met files, have confirmed on the greenhouse emissions to consider

- Determine actual changes in temperature, run the model and compare results
- Write-up of Ch 2-5
- Will not be able to finish the study by April 2010 but Dec 2010
- Need funding to travel to ICRISAT and UFS as well as farmer workshops

Comments/questions

- What are the predictions in temperature? Indications are that Temperature will be low and John Dimes agrees quoting a paper presented recently.
- Literature review is for the broad Thesis not for Chapters?
- Submit budget requirements and also apply for fellowships to complement the limited funds available

10. Murewi Cyril T.F.- Downscaling of climate variability and change over central southern Africa for uptake by rural farmers

- Change of title after consultations with supervisors
- Not yet started the write-up of data
- A review of downscaling approaches have been made
- Geographical weighted regression instead of using the nearest grid point
- Another season is required for the dataset to be complete
- Participated in APSIM workshops and did work on SOI rainfall relationships
- Quality of data is very poor which is a major challenge
- Is unable to finish within the project timeframe so need an extension of 12 months (not sure if the extension is from now or from when the project is supposed to finish)

Questions/comments

- What is ENSO? Combination of sea-surface temperature and SOI
- Where did you get data for the ENSO, The NOA websites
- Why use from Dec, Jan, Feb yet the season start in October and runs through to April?
- Need an explanation that although the season starts in October, the focus of the study will focus is on Dec, Jan and February.

11. Durton E. Nanja – Results of the Mother baby field trials in Zambia

- Most farmers believe there is climate change
- Others do not understand what it is and have to guide the discussion
- Volunteers were not a problem
- Differences in management could have been affected by a number of factors like expectations and traditions
- Translate from English to Tonga for more understanding
- Radio programs and audio cassettes

PhD work------------Objective 5 (Develop, test and disseminate climatic risk communication materials and appropriate delivery interventions)

- Has already completed a review and collected rainfall data
- Complete data collection by May 2010
- Spend 5 months at UFS.

Questions/comments

What strategies are you using to improve dissemination?

12. Identification of gaps not covered since previous meeting

Group 1- Objectives 1 and 2

- Case studies in Sinazongwe remain
- Feedback meetings with farmers
- Eness surveys should be included in the plan
- Characterization of farming system
- Not sure about the involvement of Agritex in future activities (agritex should be involved)

Group 2- Objective 3

- Modelling workshop has not been done and earmarked for December 2009
- Private sector……..sugar industries for example to be included in the project
- Teaching of climate change course (gone through the academic board but has not been taught at MSU)
- UNZA will not come with new modules but will incorporate in existing courses

- Which companies are important (seed, fertilizer, chemicals are important to be engaged), who can link these to the farmers?

Group 3-Objective 4

- 3 students failed to register
- Can still register at UFS before end of August 2009
- Students should try that route of UFS than UNISA as it gives them more opportunity
- Some administrative discussions regarding the students
- To use APSIM to simulate actual results reported in the meeting
- Farmer engagement in mid-October with last year results and weather forecast…..plan is to maintain experimental designs
- Reduce experiments which are too complex (Prospard)
- Challenges of different treatments every season
-

Group 4- Objective 5

Francis feels that everything is on track but the budgets are not as expected and they have subtracted 10% as contingency measures. These funds will be allocated to critical activities such as those of Durton who got only USD10K yet has has enormous amounts of work to do.

13. **Francis T. Mugabe…………..Improving food security through increased productive water use: A case study from southern Zimbabwe**

- In southern Zimbabwe farmers only get a decent yield in 2 out of 5 years
- Distribution of rainfall is important , more than the totals received
- Mentioned survival strategies with response to drought
- Constraints to productive water use (storage capacity, high evaporation, labour shortages, volume of water in dams, quality of next season not known
- Yield increases can be up to 4 to 5 times with better water use.

Questions/comments

- Is this work published? Yes there are 3 publications which are available

14. **John Dimes……………Background to modelling work**

- Crop simulation modelling in the project (only some members)

- Keen for more exposure to APSIM on the capabilities and what it can do
- Problems is that after training no use, give students hands-on experience on APSIM
- Because in previous projects, researchers are put in the role of a farmer and make tradeoff decisions
- Does the model perform satisfactorily?
- Make decisions and see what the outcome will be on crop production, enhance the use of APSIM, not so perfect
- Overview of APSIM by John Hagreaves, introduction to UI, the scenarios

15. John Hagreaves………APSIM Overview: Agricultural Production systems modelling

- APSIM means Agric Production Systems Simulator
- Modelling farming systems
- Mathematical representation of reality
- Developed by APSIRU in late 80s and early 90s as research tool with application across the world
- Simulates yield crops, pastures, trees, weeds
- Soil processes
- He described the key features of APSIM and the engine that links the different processes
- Covers most important crops in the tropics
- Weaknesses --------not all processes/events are captured (Non-N & P nutrients, biological N fixation).
- How the models are built, the stages
- www.apsim.info/apsim/ and //groups.gogle.com.au/group/apsim

Questions/comments

Can we use erosion data from 15 years to do simulations? Yes there are examples from India etc

16. John Dimes ………..APSIM demonstration (UI)

- Open APSIM UI and open an existing simulation
- Overview of how to start a simulation
- Daily climate data to run
- Clock, for how long the simulation will run
- Summary file is an Apsim file that is automatically generated
- F1 is paddock or field
- Manager folder contains the decisions that we are going to make

- Set the simulation / sowing window
- The model can show potential food security situations for a site

Questions/comments

- How do you set the parameters,
- How do we access the code for the processes that are happening
- Weather data……………what you suggest that we use for scenarios……….will use 20 years
- It will be interesting to see how conservation agriculture can be incorporated in the simulation modelling?
- Do you need agriculture background to run the model………..yes you need basic agronomy especially when you talk about plant population and other management decisions.

17. John Dimes……………..Introduction to scenario analysis

- Individual assessment and then group work
- A hand-out is given
- Will not use seasonal climate for making simulations and decisions
- Baseline data is paramount for the modelling scenarios
- Planting window can be changed

18. Any Other Business

- Any other business of the workshop
- Do you have mechanism to follow-up on the activities
- Reporting, nobody knows who is doing what, communication and access of information ?
- Opportunities for follow-up projects

19. Discussion on publications

- ***The following are the suggested papers for the special publication in 2010***

1.1. Evidence of climate change in Zimbabwe and Zambia compared to farmers' perceptions versus meteorological data
1.2. Participatory use of seasonal climate forecast for farm management decision- follow up of the AgSAP conference
1.3. Use of crop simulation models to add value to seasonal climate forecasts
1.4. Productive water use as a coping strategies- for climate variability and change

1.5. Quantifying smallholder farmers' vulnerability to climate change: A case study of Lupane and Gweru
1.6. Survey results: adaptive strategies Zambia and Zimbabwe
1.7. Effect of climate variability and change on crop and livestock productivity, and land water resources in semi-arid areas of Zimbabwe
1.8. Participatory experimentation as a response of smallholder farmers to seasonal climate forecasts
1.9. Impact of climate change on crop production in Zimbabwe and Zambia

Authors for the papers

- Journal of experimental agriculture, offering special editions have drafts by 31st of September and journal by mid-year 2010.
- Paper 2 and 8 could be related……………number 2 is on process and 8 is on experimental results
- On paper 5 can we include Zambia as well not just Zimbabwe as currently is the case (What has Chipo done on this?)
- Data exists for paper 5 but analysis is required, Eness to look and see if its enough
- Paper 7 is on Zimbabwe because it was not done in Zambia but we can wait for the
- Paper 1 (Cyril and Durton)………….leader is Cyril
- Paper 2 & 8 (John, Sue, Adelaide, Veronica and Francis) ……….leader 2 is John, 8 is Prospard
- Paper 3 (Leo, Veronica, John, Cyril, Hargreaves, Victor, Prospard)……………….John leads
- Paper 4 (Francis, Chipo and Adelaide)…………….Francis
- Paper 5 (Eness, Chipo, Adelaide)………………...Eness
- Paper 6 (Chipo, Durtona, Eness)………………Chipo
- Paper 7 (Case study team), first version for Zimbabwe and the other for both countries…………remember to put it on the agenda again
- Paper 7 can be split but there is need to look a bit more into it…………..Adelaide
- Paper 9 (John, Durton , Cyril, Leo)………………….Steve Prune

APSIM feedback

- Problems with setting- up the model to run, weed module was a problem because it is based on Johnson grass which competes very much with maize

- Changed weed population
- Is your modelling taking advantage of the communal nature of the grazing systems where crop residues are shared?
- Modelling exercise incomplete maybe too complicated, weed parameterization, climate data for Lupane, good learning exercises
- Analysis of SOI/ENSO signal for rainfall and crop yield- the relationship and signal month for target districts
- Analysis using conditional management

Annex 7: Seasonal Climate Forecast reports Zambia and Zimbabwe 2008

REPORT ON FARMER PARTICIPATORY WORKSHOPS HELD IN LOWER GWERU AND LUPANE (ZIMBABWE) ON RESPONSE TO SEASONAL CLIMATE FORECASTS.

A. INTRODUCTION

Farmer participatory workshops, one per IDRC / CCAA project site, were held in Lower Gweru and Lupane districts of Zimbabwe on 15-17 and 30-31 October 2008, respectively. These workshops came shortly after similar ones were held in Zambia. The overall objective of the workshops was to promote/enhance use of Seasonal Climate Forecasts by smallholder farmers, to maximize on crop productivity. Specific objectives were:

- To learn about Lower Gweru and Lupane farming systems
- To introduce seasonal climate forecasting and present the 2008/09 seasonal forecast to farmers
- To introduce crop simulation modelling to farmers
- To decide together with farmers, field experiments/trials for 2008/09, in response to the 2008/09 climate forecast.

Workshop participants and facilitators

A total of 33 farmers (.17 men and 16 women) in Lower Gweru participated, while in Lupane, there were 30 farmers (26 men and 4 women). The farmers were drawn from Mudubiwa and Nyama wards in Lower Gweru and from Daluka and Menyezva wards, in Lupane. Farmers were randomly selected from three villages in a ward and at least five farmers were selected from each village. Table 1 shows the participating villages for each ward in the two project sites.

Table 1: Wards and villages from which participating farmers were drawn from

Site (communal area)	Ward	Villages	Workshop Venue
Lower Gweru	Mudubiwa	Gwabeni /Gebuza Madinga Mxotshwa	Maboleni secondary school
	Nyama	Guduza Mathonsi Msingondo	
Lupane	Daluka	Daluka Mafinyela Strip road	Lupane district council hall.
	Menyezva	Banda Masenyane Menyezva	

Seven Agricultural Extension Officers and one meteorological officer attended the workshop in Lower Gweru, while five five Agricultural Extension Officers and two meteorological officers attended the workshop in Lupane. Workshop facilitators were from Midlands State University (MSU), ICRISAT and the Zambian and Zimbabwean Meteorological Departments. Appendix I gives a list of the workshop facilitators.

Workshop content

Appendices (IIa) and (IIb) show the workshop programmes for Lower Gweru and Lupane districts respectively. The differences in the content came about as a result of a review meeting held after the Lower Gweru Workshop. To this effect it was agreed that "visioning" using the "River code" and Evaluation of Farmer Expectations by farmers themselves, be included on the Lupane workshop. In Lower Gweru, farmer expectations of the workshop were captured, but an evaluation exercise to see whether these expectations were met, from the farmers' perspective was not done (oversight on the part of facilitators). The Lupane workshop was shortened to two days due to non-availability of daily climatic data (rainfall, maximum temperature, minimum temperature and solar radiation) for the site. This made it impossible to do simulation runs for the following purposes:

a) Simulating crop yields for a couple of seasons (10 -15 seasons) and compare with rainfall pattern for those years (idea was for farmers to appreciate inter-annual variability of rainfall and how yields also tend to vary from season to season partly because of the variability in rainfall).
b) Answering farmer questions, for example, what yield differences would arise as a result of growing hybrid maize versus open pollinated varieties or as a result of using different fertilizer levels, etc.

Despite the absence of daily climatic data, the concept of crop simulation was also introduced and explained to the Lupane farmers.

B. SUMMARY OF WORKSHOP DELIBERATIONS.

"Visioning" using the River Code.

The river code (a play) was acted by the farmers with the help of facilitators. It helped the participants and facilitators see/share the farmers' livelihood vision. It was established that opportunities and challenges to achieve farmers' vision, exist within the farmers' communities and that there were steps that the farmers could take to achieve their goals. The play was used by facilitators to encourage farmers to desist from developing a dependency syndrome, but rather acquire the necessary knowledge and skills for sustainable farming and improved livelihoods.

Farmer expectations

After the IDRC/CCAA Zambia/Zimbabwan project objectives were briefly outlined, project activities in project areas to date reviewed, and current workshop activities briefly mentioned to the farmers, the farmers were asked to list their expectations of the workshop Table 2 gives a list of what the farmers expected to get /gain from the workshop.

Table 2: Farmer expectations of the worksho

Farmer group	Farmer Expectations
1. Lower Gweru	• Researchers to integrate with farmers in their work • To get information on what the season was likely to be, so that they could correct on last season's mistakes (*last season, 2007/08 excessive rains /floods were experienced and farmers were not prepared for this. There was total crop failure for most farmers and a number could not plant due to persistent rains from end of November to mid February).* • To get information/advice on which crop varieties to grow under conditions of changing climate • To get information on which crop varieties to grow on what soils? • To get information on which crops could yield better, maize or small grains under a changing climate • To know how to use the El Niño and wind information in deciding on what to do in their farming activities • Experts to share their knowledge with farmers • To get the climate forecast for the 2008 / 09 season • To get this coming season (2008 /09) 's rainfall forecast for purposes of planning farming activities • To be told more about climatology
2. Lupane	• To get planting seed • To get fertilizers • To get seasonal climate forecasts for the 2008/09 season • To get knowledge on farming • To know the early maturing varieties and the best soils on which to grow them • To get information on seed acquisition

Farming Systems and rainfall calendar. A summary of available information on the farming systems was presented. This information was provided by farmers from the project sites, who participated in the Focus Group Discussions (FGDs) held in July and August 2008. Information presented was on opportunities and constraints to agricultural production and on livestock and crop production systems. Additional information sought during the workshop, through brain storming and open discussions with farmers included soil types and tillage systems used by farmers. Table 3 provides a summary of the dominant soil types and tillage systems employed by farmers in the project areas.

Table 3: Summary of the dominant soil types and tillage systems employed by farmers

Farmer group	Ward	Soil types	Tillage systems
Lower Gweru	Mudubiwa	- Granitic sandy loams (inhlabathi) - Red clay soils (isibobvu) - Sodic soils (isikwakwa) - Dark clays (pseudo vertisols?) (isidhaka)	- Conventional ploughing before onset of rains to incorporate manure. - For those with draft power and implements , ploughing is followed by harrowing and then planting - Most plough and plant simultaneously, but this practice is often associated with high weed infestation - Zero tillage (conservation ploughing) is also practised by some farmers, to cope with draft power and tillage implements shortage) - Depending on crop, rainfall regimes and whether manure was used or not, weeding is done 2-3 times per season. Cultivators and hand hoes are mostly used. A few farmers use herbicides.
	Nyama	- Granitic sandy loams (inhlabathi) - Red clay soils(isibobvu) - Sodic soils (isikwakwa)	
Lupane	Daluka	- Kalahari sands (Gusu) – (black and white) – most dominant soil type in ward. - Black clays (Isidhaka) - Red clays (Isibomvu) - Bhemba (mixture of gusu and black clays ?? *to verify*	- Most farmers plough and plant simultaneously. - Others practise zero tillage (*Gachompo*), whereby the only place where soil is disturbed is the planting station (holes are dug and seed is planted). 2 -3 weedings are generally done, but

		soil type)	for pearl millet weeding is often done only once. Cultivators are used for sole crops (maize and sorghum mostly). Hand-hoe weeding is the most common weed control method used.
	Menyezva	- Kalahari sands (Gusu) – (black and white) – dominant in Banda and Masenyane villages - Sandy loam (Inhlabathi) – dominant in Menyezva village. - Black clays (Isidhaka) - Bhemba	

Detailed agronomic practices were obtained from Resource Allocation Mapping done by individual farmers. In this exercise, farmers indicated the sizes of their fields and soil types for each field and provided information on what they grew in each field in the 2006 / 07 and / or 2007 / 08 season. They also indicated the agronomic practices they planned to implement in the 2008/09 season. Agronomic management (planting dates, fertilizer types and amounts, dates of weeding, etc) of the fields and crop yields obtained were captured. They also indicated yields that they would normally get in a good and bad season.

Information on the rainfall calendar was also sought from the farmers. This included information on start and end of the rain season; when effective rains (planting rains) are received; occurrence of dry spells; occurrence of floods and droughts; wettest and driest months of the season. Farmers also provided dates when they normally sow their crops.

Rainfall calendar: Lower Gweru

Some rains (*Bumharutsva*) are received in September and these are expected to rot stover. Beginning of the rain season is expected around mid October (15 -18 October, in most cases). If these rains (called *insewula*) are substantial, they may germinate the dry planted crop. If there is good crop emergence following these rains, it is an indicator of a good season. Reliable rains, for planting purposes, are often received around mid November. Farmers normally plant with the November rains on heavy soils whereas they can dry plant on light soils. For the past five (5) years, the wettest months have been December and January, but previously these have been December and February. Dry spells are often experienced in January and have a duration of 3-4 weeks. In Nyama ward some farmers irrigate part of their fields using pond water, to rescue the crops from effects of dry spells. To cope with the effects of dry spells, farmers also concentrate on the gardens, do not apply top dress fertilizer and weed early morning. Farmers in Lower Gweru practise contour ridging, deep ploughing and autumn ploughing (soon after harvesting) to conserve soil moisture.

Floods are rarely experienced, but in 2007/08 fields were flooded and most crops suffered from water-logging effects. The rainfall season ends late march to mid-April.

Rainfall calendar: Lupane

Rains start in mid to late October and these rains, nowadays, are the planting rains. Since 1989 most farmers (53%) have been planting with the October rains and their strategy is to plant at this stage so that when the season is not good enough (that is, if after the initial rains, inadequate rains fall subsequently), then they can re-plant. Most farmers stagger plantings (planting stretches from as early as October to December). Latest plantings can be as late as January. Dry planting is practised by approximately 60% of the farmers and this is done with pearl millet, sorghum and also maize. Wettest months are November and December. Farmers don't employ any strategies to deal with the dry spells.

Seasonal Climate Forecasts

The presentations for both Lower Gweru and Lupane started with the presenters soliciting for the farmer's anticipations for the 2008-09 season based on their experience and knowledge of the local indicators to the seasonal rainfall. Farmers in both areas were then introduced to the concept of seasonal climate forecasting including the technical terms used in these forecasts. This was then followed by presentation of the 2008/09 seasonal rainfall forecast by the Zimbabwe Department of Meteorological Services personnel. Farmers were advised to make use of the SCFs in making farming decisions.

Farmers' anticipation of the 2008-09 rainfall season

The Lower Gweru farmers had a mixed view of the 2008-09 rainfall season. Some of the farmers anticipated a good season while others foresaw below normal rains. However, the majority said the season would be a good one as was supported by most local indicators such as the extent of fruiting of some trees. A few farmers said they had heard the forecast from the radio and television whilst the majority had no knowledge of the forecast from the meteorological department. Those who had heard the forecast from the media gave a correct version of the forecast.

All the Lupane farmers present concurred that the 2008-09 season would be a good one based on their local indicators, which included persistent strong Northerly winds, very hot afternoon temperatures and the cry of the *inkanku* bird in the morning and evening. Farmers in the Lupane area said they could not access the forecast from the radios as transmission was generally very poor and none of them knew about the existence of the meteorological station near the centre. Whilst farmers said they relied on local indicators to predict the seasonal rainfall, they were informed that the forecasts issued by the Department of Meteorological Services were based on remote indicators such as the global teleconnections, in particular the SSTs in the South Pacific and Indian Oceans.

<u>Definition of terms used in the SCF</u>

The terms Normal, Above Normal and Below Normal were explained to the farmers. For each of the sites the climatological rainfall averages were used to define these three terms for the two periods, October to December (OND) and January to March (JFM). For Gweru normal rainfall amount is in the region of 201 and 300 mm for the period OND and between 301 and 401 mm for the period JFM. The normal rainfall amounts for Lupane are between 208 and 258 mm for the OND period and between 333 and 385 mm for the JFM. They were informed that these SCFs do not give the onset, end of season as well as rainfall distribution within the season.

<u>The 2008-09 SCF</u>

According to the Department of Meteorological Services, the 2008-09 season was subdivided into two portions (October, November and December) OND and (January February and March) JFM. The forecast for Lower Gweru was Normal to Above Normal for the period OND while Normal rains were expected for the period JFM. The forecast for Lupane was Normal to below normal for the period OND Normal to below normal rains were expected for the period JFM. Towards the end of the workshops the 2008/09 forecast was re-iterated and farmers tested on their understanding and interpretation of the SCF.

Crop Simulation Modeling

The concept of crop modeling was introduced at both the Lower Gweru and Lupane workshops, in the simplest possible way, to enable the farmers to understand it. The following questions were answered by the presentation:

1. What is a model?
2. What tasks does it perform?
3. What are the requirements for the model to run (as regards met data, soil data, crop type in terms of its genetic-coefficiency, management practices?
4. How can crop simulation modeling help farmers to improve their farming systems / crop productivity / crop yields?

Farmers were encouraged to keep all their crop management records since they are a useful input to the model. Such information needs to be accurate for the model to produce quality results. Records to be kept include:

- Sowing dates
- Crop type and variety
- Weeding dates
- Fertilizer type, amount and dates of application
- Soil type
- Yields

This kind of information was captured when farmers drew their individual Resource Allocation Maps (RAMs) and was used to validate the APSIM model. Model validation however, was not done for Lupane because long-term daily climate data, which are an input in the APSIM model, were not available for this site. For the Lower Gweru workshop simulations were run using information supplied by the farmers on their RAMs. For the 2007 /08 season the simulated yields were different from the actual yields. The major reason for this variation was that of water logging problems as a result of the heavy rains that fell in December 2007, and the model does not simulate water logging properly. Yield differences could also be due to errors in estimating crop yields and field sizes on the part of farmers. However, the simulated yields, over the years, reflected inter-annual variability that marched with variability in rainfall. The 'What if scenarios were also tested using the model to illustrate the effect of changing certain agronomic practices, for example, the effect of adding manure or inorganic fertilizer to a crop and weeding times.

Farmers understood the crop modeling concept. This was evidenced by their ability to narrate/ describe what a model is, how it works and how it can help them improve crop yields. In an exercise carried out to find out what farmers thought about the usefulness of the model, farmers agreed that in normal years (without floods), simulated yields matched with yields they expected in Lower Gweru and that some of their questions were answered by the model.

Field experiments

In each of the two districts, farmers were given an insight of what field experimentation is and they were informed that these experiments could provide answers to some of their farming problems. Farmers then got into groups, according to their villages, to deliberate on farming problems they encountered and possible solutions they had to these problems, given the 2008 /09 seasonal climate forecasts. Based on the farmers' suggested experiments, input from researchers and the scope of the project, field experiments were designed according to the problems each village had highlighted. In Lower Gweru, crop simulation modelling outputs were used as an aid to experimentation decision, while in Lupane, the unavailability of climatic data led to deferment of the modelling input, to next season's experimentation decisions. However, the concept of simulation modelling was introduced to the farmers.

In coming up with the experiments, farmers' problems were ranked at district, ward and then village levels and the most common were given priority in treatment allocation. The problems of a ward would be addressed in the mother trial which is researcher managed and consists of several treatments. In Lower Gweru, it was agreed that the mother trial would consist of tillage (flat and ridges) x variety (local, short and medium maize varieties) x fertilizer level (zero (0) manure, manure, lower level and recommended fertilizer) treatments. The proposed experimental design was a split-split-plot design with tillage as the main plot factor and variety as the sub-plot factor. Fertilizer levels were to be applied to all varieties according to treatments.

In Lupane, the consensus was to have tillage x varieties x fertilizer level treatments and a similar experimental design to Lower Gweru was adopted. Whilst farmers in Lupane indicated a strong bias towards use of small grains and short season crop varieties, it was felt that the field experiments should consider options that would maximize on the expected rainfall season (normal to below normal season, with a higher probability of normal conditions both for the first and second half of the season).

One (1) mother trial would be conducted in each ward and in each village; four (4) baby trials would be managed by the farmers, bringing the total number of baby trials to 24 per district. The baby trials, with plot size of 10m x 20 m per treatment, would address problems of a particular village. Inputs for the mother and baby trials were to be supplied by the project and these included seed and fertilizer. By mid-October, 2008 some of the fertilizers and maize seed had already been acquired for the Lower Gweru experiments. It was proposed, at the Lupane workshop, that some of the maize and small grain seed and fertilizer, be acquired through the *Maguta* government input scheme, with assistance from AGRITEX. All farmers undertaking the baby trials would also be provided with a rain gauge and a record book each. In Lupane, the first batch of 10 rain gauges was given out to the farmers. In both Lower Gweru and Lupane, the Zimbabwe Department of Meteorological Services personnel were tasked to assist with the siting of the rain gauges and training of farmers on how to take the rainfall measurements. A summary of the baby trials for Lower Gweru and Lupane is shown in table 4a and 4b respectively.

Table 4a: Baby trials to be conducted in Lower Gweru in the 2008 / 09 season

Ward	**Village**	**Trial**
Nyama	Guduza	Maize variety (OPV and early hybrid) x tillage (flat and ridge)
	Matonsi	Maize variety (OPV and medium hybrid) x fertility (manure and low level fertilizer)
	Msingondo	Fertility (low and recommended) x variety (early and medium maturity)
Muduviwa	Gwabeni /Gebuza	Maize variety (OPV and early hybrid) x fertility (low and recommended)
	Madinga	Variety (early and medium maturity) x fertility (manure and low level fertizer)
	Mxotshwa	Maize variety (OPV and early hybrid) x fertility (low and recommended)

Table 4b: Baby trials to be conducted in Lupane in the 2008 / 09 season

Ward	Village	Trial
Menyezwa	Menyezwa 2	Manure and recommended fertiliser x Maize variety (OPV vs early maturing hybrid)
	Banda 5	Pearl millet versus sorghum x low and recommended fertility
	Masenyane 1	Tillage (ridging and flat) x early and medium maturing maize varieties
Daluka	Mafinyela 3	Tillage (ridging and flat) x early and medium maturing maize varieties
	Daluka 4	Tillage (ridging and flat) x early and medium maturing maize varieties
	Strip road 6	Pearl millet versus sorghum x manure and recommended fertility

From discussions held with the farmers and the nature of experiments proposed by the farmers, in response to the 2008/09 forecasts, it was evident that farming decisions are influenced by rainfall / SCFs include decisions on the following: choice of crop and variety, tillage systems to use, planting date, fertilizer amounts to use and when and how to weed.

Evaluation of farmers' expectations of the workshop. Were their expectations met?

At the end of the workshops, an evaluation of whether farmers' expectations were met or not was done for both Lower Gweru and Lupane. For Lower Gweru, it was felt that to a greater extent, the farmers' expectations were met. Farmers were indeed involved in the designing of experiments and information was shared among farmers and "researchers". The 2008/09 rainfall forecasts were presented to the farmers and discussions on how the farmers would maximize crop production, given these forecasts, were carried out. Some of the farmers' expectations that involved "best cropping options" were answered using crop simulations and some would be answered by joint researcher-farmer field experiments. It was, however, suggested that in future, farmers themselves do the evaluation as well. Hence for the second workshop (Lupane workshop), evaluation was done by farmers.

According to the facilitators, Lupane farmers' expectations that fell within the project's mandate were met. These expectations included expectations to get seasonal climate forecasts for the 2008/09 season; to get knowledge on farming and to know the early maturing varieties and the best soils on which to grow them. The other expectations, for example, to get planting seed, to get fertilizers and to get information on seed acquisition were outside the project's mandate and were therefore not met. An opportunity to explain what the project was there for was availed. From the farmers' view point some of the objectives were met while others were not. Most of the farmers acknowledged that they initially were not clear on what the project was there for, and hence some of their expectations were completely outside the project's mandate. However, a few farmers still expected to get planting seed from the project. They insisted that their main problem was unavailability of seed and so they would be grateful if the project provided some seed. Some were contented with the fact that they were going to get at least some seed (either maize or pearl millet) for the baby trials. Some of the farmers appreciated that they gained useful knowledge during the workshop, but they would appreciate even more, if they were advised on how and where they could get seed. The District Agricultural Officer took some time to respond to the farmers' seed concerns. Overally, the farmers acknowledged that they had learnt a lot about their farming systems. They also advised that in future farmer workshops be held in August / September and latest early October, when they are not busy in the fields.

Lessons learnt

The best time to have meetings / workshops with farmers is well before start of the rainy season preferably in August and September (soon after the release of the SCF) when they are not very busy in the fields.

Ways and means of SCF dissemination were found to be crucial if SCFs had to be meaningful to the farmers because even after the forecasts were presented to the farmers, wrong interpretations were given by some of the farmers, particularly those in Lower Gweru. It took some time for them to grasp the forecasts and interpret them correctly.

Timely dissemination of the SCFs is important if farmers are to benefit from them.(By the time the Lupane workshop was held and SCFs presented to the farmers, some farmers had already dry planted some of their fields).

Annex 8: Progress reports on experiments (Zambia and Zimbabwe)

A PROGRESS REPORT OF FIELD EXPERIMENTS ON THE 'BUILDING ADAPTIVE CAPACITY TO COPE WITH INCREASING VULNERABILITY DUE TO CLIMATE CHANGE" PROJECT (ZIMBABWE).

1.0 INTRODUCTION

Following the farmer participatory workshops which were held in Lower Gweru and Lupane districts of Zimbabwe on 15-17 and 28-31 October 2008, respectively, farmers came up with the experiments they wanted to do in the 2008/09 season. At the workshops farmers were grouped according to the village they come from. Each village indicated the problems and the possible trials they were interested in, given the seasonal climate forecast of the 2008/09 season. Four farmers from each of the 6 participating villages from each district volunteered to host the baby trials. Experiments from all groups (villages) were then combined so as to come up with treatments in the Mother trials. There are 2 mother trials in each district; one in each ward. **(Refer to Report on farmer participatory workshops held in Lower Gweru and Lupane on response to seasonal climate forecasts)**

In Lower Gweru, the mother trials are in Guduza village, (Nyama Ward) and Mxotshwa village, (Mdubiwa Ward). In Lupane, the mother trials are in Banda village, (Menyezwa Ward) and Strip road village, (Daluka Ward). There are four (4) baby trials in each village and the baby trials are 2x2 experiments, that is 2 factors by 2 levels. The following tables show the nature of the baby trials in the 2 districts in the respective wards and villages:

Table 1.1: The table shows the treatments that each village conducted in the Baby trials in Lower Gweru in the 2008/09 season

Ward	Village	Trial
Nyama	Guduza	Maize variety (OPV and early hybrid) x tillage (flat and ridge)
	Matonsi	Maize variety (OPV and medium hybrid) x fertility (manure and low level fertilizer)
	Msingondo	Fertility (low and recommended) x variety (early and medium maturity)
Mudubiwa	Gwabeni /Gebuza	Maize variety (OPV and early hybrid) x fertility (low and recommended)
	Madinga	Variety (early and medium maturity) x fertility (manure and low level fertilizer)
	Mxotshwa	Maize variety (OPV and early hybrid) x fertility (low and recommended)

Table 1.2: The table shows the treatments that each village conducted in the Baby trials in Lupane district in the 2008/09 season

Ward	Village	Trial
Menyezwa	Menyezwa	Manure and recommended fertiliser x Maize variety (OPV vs early maturing hybrid)
	Banda	Pearl millet versus sorghum x low and recommended fertility
	Masenyane	Tillage (ridging and flat) x early and medium maturing maize varieties
Daluka	Mafinyela	Tillage (ridging and flat) x early and medium maturing maize varieties

	Daluka	Tillage (ridging and flat) x early and medium maturing maize varieties
	Strip road	Pearl millet versus sorghum x manure and recommended fertility

The mother trials had similar treatments. This came as a result of shared problems between farmers from the two districts. Both mother trials have a split-split plot treatment structure of which the land form/tillage (ridge and flat) is the main plot factor while the 3 maize varieties are the sub plot factors on which 4 levels of fertility were applied.

The tillage/ land form were:

1. Flat.
2. Ridge.

The fertility levels were as follows:

1. Control- no manure, no fertilizer.
2. Manure- 4.166 tones/ha (N equivalent of the low fertilizer assuming 0.75% N).
3. Low fertilizer level – 31.25kgN/ha.
4. Recommended fertilizer level – 65.75kgN/ha.

Varieties used were:

1. Early – SC403.
2. Medium – SC513.
3. OPV (open pollinated variety).

2.0 ESTABLISHMENT OF MOTHER - BABY TRIALS

2.1 LOWER GWERU MOTHER TRIALS

The first mother trial was established in Nyama ward at Mr. Busi Tshuma's field on the 6^{th} of November 2008. The trial was dry planted. The ridges were destroyed with the first rains that were of high intensity coupled by the sandy nature of the soils (hence the effect of ridges was eliminated).

The mother trial in the Mdubiwa ward was established on the 13th of November 2008. Planting was done with the rains. The setup is good and treatment effects are clear. There is however a marked deference between replications. This is so because the first replication was planted on a piece of land that was ploughed using an ox-drawn plough, while the other two were planted on a piece of land that was prepared using a tractor drawn plough. Data collection is in progress.

2.2 LOWER GWERU BABY TRIALS

The unavailability of seed in the country forced all the farmers who participated in the baby trials to plant late. Seed was supplied by project members from Zambia. A demonstration on how to plant the baby trials was carried out at Mr Joseph Mabhena's farm on 13th of November 2008. Most farmers understood what they were supposed to do as evidenced by their trials. Some farmers could not plant because the seed was distributed to them by the other farmers late.

Table 2.1: The table shows the list of farmers, their wards, villages and dates of planting who participated in the 2008/9 baby trials (Lower Gweru).

No.	Name of farmer	Ward	Village	Treatment	Date of planting	Date of weeding	Comment
1	Sonile Ncube	Nyama	Matonsi	OPV or SC513 x manure or fert low	11/01/09	26/01/09	Applied Compound D on manure plots
2	Benjamin Ncube	Nyama	Matonsi	As above			Did not Plant
3	Magrace Ntini	Nyama	Matonsi	As above	18/12/09	30/12/08	Plots affected by water logging
4	Million Matonsi	Nyama	Matonsi	As above	22/01/09	13/02/09	Got seed late but good crop
5	Luke Dube	Nyama	Gudhuza	OPV or SC403 x landform	14/12/08	04/01/09 26/01/09	Good trial. Setup done as advised
6	Samson Mpofu	Nyama	Gudhuza	As above	16/12/08	28/12/08 14/01/09	Trial setup was good and good management
7	Elphine Khanye	Nyama	Gudhuza	As above	17/12/08	29/12/08	Trial setup was good and

						15/01/09	good management
8	Cashel Mpofu	Nyama	Gudhuza	As above	15/12/08	01/01/09	Mixed varieties and no plot boundaries
9	Woody Dube	Nyama	Msingondo	SC403 or SC513 x fert low or Fert recommended			At the time of visit the roads were not accessible to this village, although farmers report that the trials are okay
10	Annah Moyo	Nyama	Msingondo	As above			As above
11	Sazisa Ncube	Nyama	Msingondo	As above			As above
12	Joseph Dube	Nyama	Msingondo	As above			As above
13	Joseph Mabhena	Mdubiwa	Mxotshwa	OPV or SC403 x Fert Low or fert Recommended	13/11/08	20/12/08 14/01/09	Trial setup was done by researchers and used as a demonstration to other farmers
14	Getrude Bonde	Mdubiwa	Mxotshwa	As above	14/01/09	12/02/09	Received seed late but good trial
15	Hilda Chimusoro	Mdubiwa	Mxotshwa	As above	9/01/09 (on 1st 2 plot) 11/01/09 (last 2 plots)	01/02/09	Received seed late but good trial

16	E. Moyo	Mdubiwa	Mxotshwa	As above			Farmer was absent when visited.
17	Ezekiel Sibanda	Mdubiwa	Madinga	SC403, Sc513 x manure or fert low	9/12/08	30/12/08 17/01/09	Setup good, but used hoe to dig part of the last plot
18	Akesithi Nyathi	Mdubiwa	Madinga	As above	10/12/08	31/12/08 20/01/09	Plots affected by water logging
19	Pesline Sibanda	Mdubiwa	Madinga	As above	10/12/08	30/12/08 15/01/09	Applied top dressing on manure plot
20	Evelyn Mpofu	Mdubiwa	Madinga	As above			Farmer was not around when visited
21	Linnet Tshange	Mdubiwa	Nsukunenji	OPV or SC513 x manure or 0 manure			Did not plant. Did not get inputs- on time
22	O. Ncube	Mdubiwa	Nsukunenji	As above			As above
23	E. Gwabeni	Mdubiwa	Nsukunenji	As above			As above
24	K. Dube	Mdubiwa	Nsukunenji	As above			As above

2.3 LUPANE MOTHER TRIALS

Establishment of the first mother trial was done in Daluka ward at Mr. Lameck Sibanda's field on 20/11/08. The trial is close to the homestead. This mother trial had a poor stand in some plots because the farmer's guinea fowls ate up some of the planted seeds. Plots that were not disturbed are however showing treatment differences.

The Menyezwa ward mother trial was planted on 23/12/2008 at Mr. Sipho Mpofu's field. The delay was due to the outbreak of anthrax in the Lupane area that caused all animals to be vaccinated rendering them unfit for draft purposes. The trial has an excellent stand and collection of records is underway. Two plots (71 and 72) in replication three had a poor germination/stand due to water logging

2.4 LUPANE BABY TRIALS

Just like in Lower Gweru, the unavailability of seed in the country forced all the farmers who participated in the baby trials to plant late. A demonstration on how to establish the baby trial was done at Mr. Paulos A Ncube's field in Banda village, Menyezwa ward on the 23rd of December 2008. Most farmers understood what they were supposed to be doing as evidenced by their trials.

Table 2.2: The table shows the list of farmers, their wards, villages and dates of planting who participated in the 2008/9 baby trials (LUPANE).

No	Farmer Name	Ward	Village	Treatments	D.O.P	weeding	Comments
1	Victor Moyo	Daluka	Mafinyela	Landform x OPV or SC403	01/01/09	25/01/09 10/02/09	There was water logging in plot 1. Significant fertility gradient exist among the plots (near homestead)
2	Sizelo Khumalo	Daluka	Mafinyela	As above	03/01/09	27/01/09	Fair crop
3	Patty Mkadla	Daluka	Mafinyela	As above			Did not plant
4	Mr. Nkomo	Daluka	Mafinyela	As above	28/12/08		Good trial, but forgot to thin
5	Monday Ndlovu	Daluka	Strip Road	Sorghum or OPV x manure or fert recommended	04/01/09	22/01/09 25/02/09	Had poor sorghum germination so he replanted peal millet
6	Mafanta Ndhlovu	Daluka	Strip Road	As above	04/01/09 10/01/09	27/01/09 25/02/09	Planted maize first then sorghum later hence two planting dates

7	Sibusiso Ndjovu	Daluka	Strip Road	As above	15/01/09	10/02/09	Fair crop
8	Subagent Tshuma	Daluka	Strip Road	As above	19/01/09	18/02/09	Planted Pan 6889 maize variety in his trial
9	Dala Ngwenya	Daluka	Daluka	Landform/Tillage x SC403 or SC513	28/12/08 12/01/09	23/01/09	Replanted plot 3 on a later date
10	Ester Moyo	Daluka	Daluka	As above	11/01/09	11/02/09	Used variety KEP however, good crop
11	Vulindlela Ncube	Daluka	Daluka	As above	11/01/09	10/02/09 26/02/09	4th plot water logged
12	Mkandla	Menyezwa	Menyezwa	Fert recommended x OPV or SC403	29/12/08	14/01/09 26/02/09	Very good plot
13	Jonard Kheswa	Menyezwa	Menyezwa	As above	26/12/08	14/01/09 23/01/09	Very good experiment
14	Fred Moyo	Menyezwa	Menyezwa	As above	26/12/08	01/01/09 18/01/09	Delayed thinning otherwise the best baby trial
15	Niglos Khumalo	Menyezwa	Menyezwa	As above		15/01/09	Mixed experiment with own crop

						30/01/09	
16	Pantos A Ncube	Menyezwa	Banda	Sorghum or OPV x Fert low or fert recommended	23/12/08	27/01/09 22/02/09	Top dressed all plots using urea
17	Misheck Mpofu	Menyezwa	Banda	As above	29/12/08 10/01/09	15/02/09 12/02/09	Lots of variation due to poor germination. Farmer replanted
18	Thompson Moyo	Menyezwa	Banda	As above	30/12/08	08/01/09 15/01/0922/02/09	Planted 2 maize plots and 1 sorghum. Plots are in good condition
19	Kervin Mpala	Menyezwa	Banda	As above	01/01/09	30/01/09	Had germination problems, fair crop
20	Mtenjwa Ndlovu	Menyezwa	Masenyane	Land form/tillage x SC403 or SC513			Could not meet the farmer upon visit
21	Lot Donga	Menyezwa	Masenyane	As above	28/12/08	25/02/09	Poor germination across all crops
22	Phazila Mhlanga	Menyezwa	Masenyane	As above	01/01/09	15/02/09 22/02/09	Had smaller plots of 10 x 10m. Also poor germination/crop stand

3.0 RAINFALL

Table 2.3 shows the monthly total rainfall that were received in November, December and January in Lower Gweru and Lupani. The rainfall totals for October, November and December were above normal at all the recording stations except at Mr Ngwenya's farm in Lupani. January was very wet with all the recording stations recording more than 160 mm of rainfall except at Mr Sibanda's farm. Mr Ncube in Lower Gweru received more than 380 mm of precipitation in January.

Table 3.1: List of farmers, their wards, villages and monthly rainfall totals (mm) for Lower Gweru and Lupane for the months of November, December and January (2008/09 season)

Farmer name	District	Ward	Village	Oct	Nov	Dec	Jan	Oct, Nov and Dec totals
Ezekiel Sibanda	Lower Gweru	Mudubiwa	Madinga	0	236	223	294	459
Benjamini Ncube	Lower Gweru	Nyama	Matonsi	0	137	206	382	343
Monday Ndlovu	Lupane	Daluka	Strip road	0	126	235	198	361
Lameck Sibanda	Lupane	Daluka	Strip road	0	199.5	73	132	273
Patty Mkandla	Lupane	Daluka	Mafinyela	0	121.5	152	235.5	274
Dala Ngwenya	Lupane	Daluka	Daluka	0	116	91	191	207
Niglos Khumalo	Lupane	Menyezwa	Menyezwa	0	42.6	366	163	409

4.0 OBSERVATIONS

- This current season, we experienced problems of acquiring inputs and had to get seed from our Zambian colleagues, and this inconvenienced the farmers who had already selected and prepared their fields to host the baby trials.

- The mother trials were established well on time except the one in Menyezwa where there was an outbreak of anthrax so the draft animals were not supposed to be used within the first 2 weeks after vaccination.

- Few farmers who had the opportunity to get the inputs on time, planted earlier than others and their trials are good. The majority of the farmers who received the inputs late managed to plant and some of the trials are quite good given that the rainfall season is not yet over.

- There is growing interest and confidence among many farmers, some of them non-participatory, in the practices the project is bringing.

- Some farmers had to temper with treatments especially those without fertilizers as they felt that they could run a loss by not applying any fertilizers.

Annex 9: Report on case studies conducted in lower Gweru and Lupane areas of Zimbabwe.

1. Introduction

During the IDRC / CCAA project review workshop in Livingstone, Zambia (27 –29 July 2008) progress reports were presented by objective leaders and students on what had been achieved to date. After that a review of all the activities was made, constraints and gaps were also identified and the way forward for the second year charted.

An extensive Baseline Survey, whose main objective was to establish farmers' perceptions on risks associated with climate change and variability (CC&V) in the project areas, was carried out during the beginning of this project. While some specific objectives such as developing farmer typology and establishing farmers' perceptions on climate change were addressed during the baseline survey, other specific objectives such as the characterization of the farming systems as well as documenting the effects of climate change and variability were not adequately covered. There was also need to establish the factors that influenced the farmers' investment decisions and a range of other social issues like labour sharing groups and sharing of resources among farmers. It was then agreed that some case studies involving Individual Farmer Interviews (IFI) and Farmer Group Discussions (FGDs) be carried out to help fill in the identified gaps. Therefore, both methodologies were used to collect information from the farmers.

The Case studies were carried out in Lower Gweru (Mdubiwa and Nyama Wards) between the 26th and the 30th of January 2009 and in Lupane (Menyezwa and Daluka Wards) between the 23rd and the 27th of February 2009. This report highlights trends of the preliminary results of this study, as most of the data collected has not been statistically analyzed yet.

2. Objectives

The objectives of the study were to carry out in-depth case studies on:

i. The characterization of farming systems as practised by farmers,

ii. The factors that affect farmers' investment decisions

iii. The effects of climate change and variability on livestock productivity, land degradation, vegetation cover, crop productivity and water resources,

iv. Adaptation and coping strategies that the farmers use to combat the effects of climate change and variability and

v. The common social practices that the farmers use in order to alleviate pressure of work or shortage of farm implements or inputs

The characterization of farming systems as well as the farmers' investment decisions were carried out using the individual farmer interviews, while the social practices were entirely covered under the FGDs. The other objectives were assessed under both methodologies.

3. Methods

Individual Farmer Interviews and Focus Group Discussions were used to solicit data on the adaptation and coping strategies employed by rural farmers in Mdubiwa and Nyama Wards (Lower Gweru) as well as Daluka and Menyezwa Wards (Lupane). For the IFIs 12 farmers were selected from each of the four wards. Four farmers from each of the three villages in each ward were interviewed. In the sampling of farmers for the IFIs and FGDs gender and age considerations were made. Checklists were developed for both methods.

FGDs were used to understand social activities that help farmers to cope and adapt with Climate Variability and Change. Climate Variability and Change induced changes and understand existing coping and adaptive strategies in agricultural productivity and the environment were studied through both interviews and FGDs. In the FGDs brainstorming and group work were the techniques used to gather the required data. A recap and review of the SCFs was also done in the FGDs.

4. Preliminary results

4.1 Individual farmer interviews

4.1.1. Agronomic practices

Tillage systems

The predominant tillage system across the two study areas (Lupane and Lower Gweru) is conventional tillage where the source of draft power is oxen and /or donkeys. In Mdubiwa ward a substantial number of farmers also use zero tillage while in Nyama few farmers use zero tillage as well as "*chibhakera*", where hand hoes are used to till the land. In Daluka and Menyezwa wards another fairly common tillage practice is "*gatshompo*" (use of planting basins) which is more prevalent in Daluka than Menyezwa.

Crops and varieties grown.

A wide range of crops is grown by farmers in Lupane and Lower Gweru wards. The range of crops is similar in both areas and the difference lies in the extent to which the crop is grown in the two study areas. All interviewed farmers grow maize. The second most grown crop in Lower Gweru is groundnuts, followed by sorghum. Cowpeas are also grown in both wards with more of the crop being grown in Mdubiwa. Sweet potatoes are grown more widely in Nyama and a few farmers in this ward also grow pearl millet. In Daluka and Menyezwa wards, sorghum and pearl millet are grown by more farmers than in Lower Gweru, with groundnuts and cowpeas being the main legume crop in Menyezwa and Daluka wards, respectively.

Early maturing hybrid maize varieties are the most commonly grown across the four wards. Local Open Pollinated Varieties (OPVs) of the crop are also grown by a significant number of farmers particularly those in Daluka and Menyezwa wards. Some of the farmers interviewed were not sure of the groundnut varieties they were growing. However, from those that knew the varieties and from the description of varieties given by the farmers, it was established that Natal Common is the most commonly grown variety in all wards. In Daluka and Menyezwa wards, a significant number of farmers also grow Valencia Red, while a few grow Valencia white. In the main 'small grain' growing wards, Daluka and Menyezwa, the dominant sorghum variety is Macia white, while for pearl millet, Pearl Millet Variety 3 (PMV3) is the main variety.

Fertilizer types used

Cattle manure is used by more than 50 % of the farmers in each of the four wards. Most of the farmers in Mdubiwa ward, apply the manure at planting stations whereas in Nyama the majority broadcast the manure. More farmers in Nyama than in Mdubiwa also use inorganic fertilizers namely Compound D and Ammonium nitrate or Urea. In Lupane, more farmers than in Lower Gweru use cattle manure. In both Daluka and Menyezwa wards the manure is either broadcast or applied at planting stations. In-row application of manure is also practised by a few farmers in Menyezwa ward.

Weeding.

The majority of farmers in both Lower Gweru and Lupane weed their fields twice in a season. Approximately half of the farmers in either area use both cultivators and hoes, while the other half practises hand-hoeing only. A few farmers particularly those who practise zero tillage sometimes weed three times in a season.

Water management techniques

Winter ploughing followed by contour ridging are the water management practices used by farmers in Nyama and Mdubiwa wards, while contour ridges are the main water harvesting technique employed in Daluka and Menyezwa wards. Winter ploughing is the second mostly used technique in Menyezwa ward. In both Daluka and Menyezwa wards, approximately a third of the farmers who use planting basins use mulch to conserve moisture.

4.1.2 Livestock production

Cattle is the dominant livestock type in Lower Gweru, however most farmers in Mdubiwa ward have goats as compared to those in Nyama ward. The dominant livestock breeds were Brahman crossing in Mdubiwa and Mashona in Nyama ward. Major cattle diseases were gall sickness and a number of unspecified tick borne diseases. Farmers did not know the names of the diseases.

Most of the interviewed farmers in Lupane district have cattle and donkeys. Cattle are the dominant livestock type. The dominant breeds are Brahman crossing in Menyezwa and the Nkoni in Daluka ward. Black leg was the most dominant cattle disease in Daluka while heart water and lump skin were the other diseases affecting cattle but to a lesser extent. In Menyezwa lump skin was the dominant disease and other diseases included heart water, senkobo and black leg.

4.1.3 Factors affecting farmer decisions

Investment decisions

Food security and need for cash were the major factors that influenced the farmers to grow the crops they had grown this season (2008/09) in Nyama ward. In Mdubiwa ward, the second factor after food security was the input availability. Due to the unavailability of seed and fertilizer farmers were forced to grow what was available .In both wards of Lupane district, the major factors that influenced the farmers' decisions were food security, need for cash and input availability.

Decisions influenced by climatic factors

Choice of crop to grow and planting dates were the major decisions that were influenced by climate in both the Lower Gweru and Lupane districts, although varieties to grow came out strongly in the Daluka ward.

Deviations from usual practice

Reduced range of crops grown this season as compared to what was grown over the past 5 to 10 years, reduced hectrage of maize and use of different varieties were the major deviations from farmer's usual practice in Lower Gweru. The major reason for the deviations was seed unavailability. Some farmers in Lower Gweru especially those from Mdubiwa ward also pointed out that they practised conservation tillage this season for the first time. In Lupane district deviations from farmers' usual practice included reduced hectrage of maize, more sweet potatoes grown and limited range of crops grown. The major reasons for the deviations were seed unavailability and climate change.

4.2 Farmer group discussions

Mdubiwa ward (women and men) ages<30 to >60

The important parameters that farmers in Mdubiwa ward used for wealth ranking amongst themselves are livestock ownership and numbers, homestead and ability of a farmer to carry out all farming activities without relying on other people. Using these criteria farmers could then be easily categorized as poor, medium or rich. The villagers also categorized the less privileged to be the orphans, the aged, the terminally ill, the widows and the able bodied and healthy but "resource poor" beings. The social interactions that exist between the poor and the rich are that the rich help the poor by ploughing for them, giving them farm inputs, food and other items such as soap and clothes, for their upkeep. On the other hand, the poor provide the much needed labour for the rich. The communities also have social groups, which help ease workload and address issues at community level, e.g. gully reclamation and acquisition of farm inputs.

The community's perceptions on CC and V were that in general, the livestock numbers had gone down, no proper breeds maintained, vegetation cover in grazing land poor and land degradation rampant. Crop yields had gone down drastically, while water sources were drying up and becoming unreliable. While these reasons were attributed to climate change, it was noted that some changes were as a result of the economic meltdown in Zimbabwe, where availability of inputs was a problem. The coping strategies that the farmers were using were putting buffer strips and ploughing across the gradient to curb rampant soil erosion due to poor vegetation cover. The farmers also plant early, use early maturing varieties (if available) and practise conservation tillage and have to dig deeper wells and/or boreholes for their domestic and livestock water supply

Nyama ward

Wealth ranking was much simpler and was based on the ownership of livestock and adequate farm implements and inputs.

The social interactions that exist between the farmers are:

The farmers interact by forming groups during ploughing and weeding operations "amalima". They exchange and borrow farming implements from each other. People also help the less privileged by weeding and ploughing and fencing their fields and giving them seed. Apart from the agricultural based groups, the communities work together to maintain roads and to construct or maintain contours.

Rainfall (pattern and amount) was characterized as the main factor that affected the observed changes, especially on vegetation cover and land degradation as a result of CC. Indigenous breeds have disappeared and crossings (mainly Brahman) have emerged. Land degradation and siltation of rivers and dams is prevalent. Yields have been drastically reduced mainly due to non-availability of seed and fertilizers. Water resources have not been stressed as Nyama ward is low lying, has a high water table and thus also prone to water logging.

Daluka ward

Wealth ranking by the farmers was based on livestock ownership and numbers as well as ownership of farm implements and inputs. The rich interact with the poor by hiring them for labour, lending them cattle and ploughing their fields. The farmers also work together during such operations as ploughing. The less privileged get help from the local NGOs and community leaders. In Daluka ward exist a number of social groups whose aims range from helping the poor, looking after the ill to community development issues. The leadership rests with the farmers themselves while the NGO and Government may provide funding and expertise.

The observed changes due to CC and V are as follows: prevalence of diseases, shortage of grass for grazing, reduced yields, water shortage and siltation of rivers and dams. The coping strategies were identified as sporadic dipping, digging deeper wells and boreholes, supplementary feeding, planting short season varieties and conservation farming.

Menyezwa ward

Wealth ranking among the farmers was based on whether or not the farmer had all that was needed for farming. The poor and rich interact through “amalima”, giving the less privileged what they lack, registering them with donor organizations, hiring them to provide paid labour and paying fees for the orphans. The social groups within the ward are basically those that are trying to alleviate poverty and suffering of the people through self help projects.

The changes that were observed due to CC and V are; poor rainfall, vegetation cover, prevalence of diseases, gullies, drying up of rivers. The coping strategies used are: planting sisal in the veld, planting short season varieties and practicing conservation tillage.

Annex 10: Lady Luck visits the Semi-Arid Tropics (SAT) was in a Zambian newspaper after a field day in March 2010

Sometimes things work out just the way you want them to. And so it has been the case for the first season of field experimentation in the IDRC funded project, 'Building adaptive capacity to cope with increasing vulnerability due to climate change'. The dark, rain laden clouds have not stopped coming across the field sites in Zimbabwe and Zambia in the 2008/09 cropping season. The field crops have responded magnificently, with the largest cobs, heads and biomass production in many a season. But this is not the lucky part. Huge variations in seasonal rainfall are the norm in the SAT regions of these two countries, so having a good season is to be expected from time to time. Rather, the luck is that the seasonal climate forecast (SCF) given to farmers at a series of workshops in October 2008 has proven to be so correct – normal rainfall for Oct-Dec and normal to above rainfall for Jan-Mar. Back then, a preliminary analysis of the past ten SCF's in Southern Province of Zambia indicated a success rate of about 60%, meaning there was a fairly high probability (40%) that the forecast in our first season would turn out to be not so accurate. However, fortune favours the brave and Lady Luck was on our side.

We have been luckier still with the favourable distribution of rainfall, which has been highly regular from December through to almost the end of March. This has meant that the experimental treatments chosen with the farmers in October have also proven to be the right choices. Back then, based on the forecast, it was decided that this would be the season to favour investment in higher rather than lower rates of fertiliser and to use longer rather than shorter duration crop cultivars. The treatment responses in Mother (researcher managed) and Baby trials (farmer managed) in the 4 project districts (Monze and Sinazongwe in Zambia, Lower Gweru and Lupane in Zimbabwe) are clearly evident and will provide a good basis for model evaluation and economic analysis by the higher degree students being supported by the Project. However, choices made in regard to tillage treatment have proven to be not so critical under the current seasonal conditions.

In Zimbabwe, with the economic and political upheavals stacked against successful implementation of a field program, the team at Midland State University have beaten the odds and delivered a highly successful field program in 2 districts, starting with the farmer workshops last October. In Zambia, progress is even better. There the Project has managed to implement a truly effective partnership between the Zambian Agricultural Research Institute and the Metrological Department. This was on display at the just completed field day held on March 23rd, World Metrological Day, at the Bulimo village, in Monze district. The field day was organised by team members Durton Nanja (ZMB) and Prospard Gondwe (ZARI) with excellent support from Provincial Government (with attendance by the Provincial Minister (Mr Munkombwe) and the Provincial Commissioner (Ms Joyce Nondo)) and the private sector (attendence by Afgri, ZamSeed, ATS, ZNFU and CFU). Testimonials by farmers clearly indicated that the farmers have learnt to value the SCF in recent seasons, and appreciate very much the new opportunity that the project brings to work with ZARI to evaluate alternative options based on the forecast.

The large number of local farmers (>100), and Headmen from 12 other villages that participated in the field day is further evidence of the farmers interest in the Project outputs. However, for the Project objective of building capacity, the most rewarding aspect of the field day was the support shown by the ZMB. In addition to the Director of Meteorology, Mr Maurice Muchinda, about 12 Met officers representing the Provinces of Zambia attended the field day to learn more about how this partnership with ZARI and farmers was being implemented on the ground. The obvious success of the partnership was perhaps best summed up in the address to the farmers by the Permanent Secretary of the Provincial Minister, when he stated that 'the link between the Met Bureau and ZARI that we have seen here today is truly marvellous' and is a wonderful example of an effective 'information, education communication' strategy.