

**Integrated resource management in  
crop-livestock farming systems of  
sub-Saharan Africa**

**Annual Workshop Report**

**15-16<sup>th</sup> April 2002  
ILRI-Nairobi**

# **Integrated resource management in crop-livestock farming systems of sub-Saharan Africa**

## **Annual workshop report**

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## **Introduction**

Considerable information exists on crop-livestock farming systems in East and Southern Africa, yet predictions and recommendation are difficult due to the variable nature of biological processes and the trade-offs between uses of organic inputs in the farming system. Linking these data with models that simulate livestock productivity, manure quality, nutrient release patterns, soil organic matter dynamics, and crop response could provide a means of making initial recommendations for testing with farmers. Incorporation of farmer production objectives, farmer criteria, risk assessment and farmer decision making into this approach will allow the development of improved technologies and more accurate targeting that will improve the management of crop-livestock systems, improve rural livelihoods and increase household food security.

A project funded by the Government of the United Kingdom of Great Britain and Northern Ireland to the Soil, Water, and Nutrient Management (SWNM) consortium of the CGIAR aims to link these data and models for tropical soils and cropping systems. In this project the APSIM (Agricultural Production Simulation Model) and DSSAT (Decision Support System for Agricultural Technologies) will be used.

This report highlights the progress made in the first year of this project, some of the modelling and data collection issues that have arisen and plans for the second year agreed at the annual workshop held by TSBF and ILRI in ILRI-Nairobi in April 2002.

## **Background and project description**

This SWNM project led by TSBF and funded by DFID addresses the need to better understand farmer decision making in mixed crop-livestock farming systems if we are to be able to more accurately adapt and target new technologies to poor farmers. Resource-poor farmers face difficult decisions over the use of scarce nutrient sources in crop-livestock production systems. Often the decisions taken on the use of animal products are taken without an assessment or appreciation of the impact of the potential of different uses on plant production and on soil and water resources. A deeper understanding of the comparative values and usefulness of manures and other locally available resources is required in order to increase the production and efficiency of mixed crop-livestock systems. While efforts are required to expand our knowledge of the biophysical aspects of alternative uses of organic nutrient sources similar efforts are also required on the socio-economic driving forces behind farmers' decision making. The project will utilise trade-off analysis and partial budgeting of new technologies to identify and introduce new crop-livestock technologies.

A major objective of this project is to link existing models on crop-soil and crop-livestock research and to use the extensive data contained in existing databases, for example, the Organic Resource Database developed by TSBF and Wye College and the ILRI Forage Feed Quality database, to provide data for simulation modelling. Incorporation of farmer perceptions and production objectives will allow further refinement of scenario and trade-off analysis.

The specific outputs of the project are as follows:

**Output 1:** Model(s) for assessing alternative uses and management of forage legumes and animal manures in crop-livestock farming systems developed and evaluated

**Output 2:** Identification and incorporation of farmer perceptions, farmer production objectives and farmer perceptions of risk and vulnerability into the DS tool development

**Output 3:** Decision support tool disseminated in a range of formats, including extension manual, researcher decision support system, to different stakeholders

## **Workshop objectives**

The annual workshop was held to bring together the project scientists to review progress and plan future activities. Mario Herrero, Herbert Murwira, John Ojiem, Webster Sakala and Phil Thornton all sent apologies as they were unable to attend. The agenda and participants list are given in Appendices 1 and 2 respectively.

The primary objectives of the workshop were to:

1. To review progress on data collection and collation in the different sites
2. To conduct introduction to scenario development with farmers
3. To review and develop activities in the project and to agree activities for the next six months
4. To discuss Ph.D. student involvement in the project
5. To allocate budget to ensure achievement of activities

The expected output of the annual workshop was a complete review of activities to date and an agreed workplan for the next 12 months.

## **Workshop Presentations**

### Day 1 – morning session

#### **Progress towards Output 1 Activities 1.1 and 1.2**

*1.1 Collection, collation and evaluation of information, databases and models relating to potential nutrient use efficiencies of crop-livestock farming systems*

*1.2 Standardisation of datasets and outputs for testing of models*

The first morning was taken up with four presentations and one discussion session. The presentations were reviews of the work conducted in the two sites identified in the stakeholders meeting for accelerated progression, Zimbabwe and Kenya, and two other sites, in Ethiopia and Tanzania where the partners have conducted data collection and collation. A summary of these papers follows.

#### ***Update from Ethiopia*** – Tilahun Amede

Tilahun reported on the progress to date on collection of missing identified during the Stakeholders meeting in September 2001. Collation of secondary data and a survey of 30 farmers was conducted to collect the data for the last season. A second seasons data collection will be continued to see how labour calendars, prices, feed availability etc change by season.

#### ***Update from Kenya*** – Danny Romney

The Kenya update focussed on progress made in a project entitled 'System prototyping and impact assessment for sustainable alternatives in mixed farming systems in high-potential areas of Eastern Africa' funded by ISNAR Ecoregional funds where they have set-up the data entry/database for initiation of the modelling work. This first attempt will be used as the basis for setting-up the modelling work in this project. This project is using different sites so is not repeating this study but instead is adding more sites to the overall coordinated crop-livestock work TSBF-CIAT and ILRI are conducting.

#### ***Update from Tanzania*** – Juma Wickama

The site in northern Tanzania in Lushoto conducted a survey of 123 farmers and collated existing secondary data. There is now data available on site characterization, soil analysis, cropping patterns, resource flow mapping, labour calendar, feed resources, use of manures, crop residue and organic matter management and farmer perceptions of their problems and opportunities.

This report has been published as a project report - Working Document No. 1.

#### ***Update from Zimbabwe*** – John Dimes

Of the two sites in Zimbabwe, one, Murewa, has been part of another ACIAR funded project and there is a lot of relevant data generated by that project which can be used in this project. The second site in southern Zimbabwe, Tsholotsho, has less available data and an update of progress was given (Rainfall records collected, data review meetings organised for May and June). Shamie Zingore, a Ph.D. student from Wageningen, has started his thesis research in both of these sites and will work on

completing data collection. More detail is given later in his report under Ph. D. students.

***Introduction to database for project data*** – Rob Delve

This was a general introduction and discussion to the data entry/database, mentioned above in the Kenya summary, which will be used in this project. It will be used to store all site data reported above and will be linked to units that will do linear programming, economic analysis, biophysical simulation modelling to explore scenarios for improved crop-livestock systems.

There was a lot of discussion about how, why and when this would be completed and how it would work and questions like, 'what sort of model are we developing' and 'what is a decision support tool' were asked. The general impression was do we need a complicated model or can we simply link the units together so that data generated by one unit, for example, simulated crop yield, can be used for data entry into another unit, for example, economic analysis. It was agreed that we should investigate this further and see if it was practical to link all units together or if this would make the use of the model too complicated. Due to time constraints it was decided to meet again in two to three months to have three days together to enter the data we have into this database and start the modelling process.

Day 1 – afternoon session

The afternoon was devoted to the discussion of the Ph.D. student projects and how these will link into the project. There are three Ph.D students who will conduct their thesis research as part of this project. The three students, funding source and topics are discussed.

**Shamie Zingore**, a Zimbabwean student registered at Wageningen University, the Netherlands will do his research on 'Integration of crop-livestock production systems for efficient nutrient use in smallholder farms of sub-Saharan Africa'. He is part funded by Wageningen, an IFAD development project in Zimbabwe and this project. He is presently developing his research proposal (See Appendix 4 for outline) and his research questions will address, trade-offs in legume use, use of cereal crop and legume residues, targeting of inputs to the legume or cereal crop and resource management related to soil fertility gradients. His research proposal will be reported in the next six-month report.

**Adrian Gonzalez**, a Venezuelan student registered at Edinburgh University, UK will conduct his research on two or three of the countries in this project. He is fully funded by the Venezuelan government. It is proposed that these will be Ethiopia and Tanzania. Their work will be to complete data collation and set-up the data entry/database to run the model. He will work with the field based staff and farmers in these sites to run scenarios defined with and by farmers.

**Astrid Marquez**, a Venezuelan student registered at Edinburgh University, UK, she is fully funded by the Venezuelan government. She will conduct her research on farmer decision-making, farmer criteria and decision-making and how these can be incorporated into the crop-livestock decision support tool. The results from her work will

direct which simple tools farmers would need and to guide the development of these tools.

It must be stressed that the successful completion of this project is not dependant on the completion of the student activities and rather they are adding extra components to the work.

## Day 2 – morning session

### **Future activities for Output 1 Activity 1.3**

#### *1.3 Hypothesis and scenario testing of trade-offs between competing and synergistic utilisation of organic inputs in crop-livestock systems*

The second day then moved to discussion about future activities of the project. This was started by a presentation by John Dimes on 'Evaluating maize residue inputs for crop and soil productivity using crop simulation modelling' (Appendix 5).

He considered crop productivity of maize systems at Tsholotsho, Zimbabwe, in terms of current practise and alternative residue management options over an 11-year period using the ASPIM simulation model. Simulation results showed that returning the maize residues (unfertilised or fertilised) to the soil had delayed benefits, and the lag of up to 6 years makes this option unattractive to farmers. In contrast legume residues provided immediate benefits to a cereal crop, but farmers preference is to feed such high quality residues to livestock. The question arising from this work, is what is the percentage that could be feed and the percentage to be incorporated for improving soil fertility. This presentation generated a lot of discussion about scenarios that could be explored by this approach and led perfectly into the following discussion on scenario development in each site.

The following general discussion on development of hypothesis and scenario testing of trade-offs covered many issues, for example:

- Unimodal rainfall versus bimodal
- Impact of manure quality - high versus low
- Residue management – long versus short term
- Risk quantification of management changes using long term weather datasets
- Sensitivity analysis of input-output prices

In addition to these scenarios a more detailed scenario development discussion was then held for each country and the sort of scenarios they want to develop and model developed.

### **Ethiopia - suggested scenarios**

- Use of legume cover crops
  - where to plant
  - when to plant
  - how much to incorporate
- Effects of mulching residues on preventing erosion
- Resource management for different fertility gradients within the farm

### **Kenya - suggested scenarios**

- Timing of maize thinning and effects on final grain harvest
- Change on crop land allocation, for example, Napier versus Maize
- Benefits of introducing legumes into the system
- Use of concentrates vs. use of introduced forages

### **Tanzania - suggested scenarios**

- Quantification of resource degradation given different management practices
- Maximizing returns to manure use

### **Zimbabwe - suggested scenarios**

- Where to target manure and inorganic fertilizers
- Resource management related to soil fertility
- Trade-offs of organic resources for fodder versus soil fertility

### **Future activities for Output 1 Activity 1.4**

#### *1.4 Development of a virtual laboratory for exchange of information, data, models and results amongst stakeholders*

It was agreed that Rob Delve would set-up and establish a project website for easy access to all information for partners. Initially this would be a private website and not advertised through the TSBF or CIAT web-sites. Also, that the virtual laboratory concept would be further explored with Roberto Quiroz of CIP as previously reported.



## **Future activities for Output 2 Activity 1**

### ***2.1 Understanding the context of farmer decision making, perceptions of risk and vulnerability into the DS tool development***

The first stage of application of the decision support tool is to investigate the sorts of scenarios we, as researchers, think are interesting and offer possible benefits to the farmers and farming systems. The second and most important stage is then the running of scenarios developed with the farmer groups that the project partners work with and to look at the opportunities and constraints that exist to prohibit their adoption by farmers for improving their livelihoods. It was also felt to be very important that we would be able to incorporate farmer knowledge, perceptions and decision-making into the model so we would be able to refine our thinking and review the initial researcher based scenarios and develop farmer criteria based scenarios for crop-soil-livestock systems.

The sites were requested to prepare some activities over the next six months with their farmer groups to be able to elicit the criteria farmers use for decision making, the constraints they face and what are the risks that they perceive in their farming practices. This was proposed through group interviews and key-informant discussions. The PhD student will cover more detailed studies on this aspect in the target countries.

## **Future activities for Output 2 Activity 2**

### ***2.2 Testing and development of prototype DS tool on-farm in East and Southern Africa by project partners (NARES, NGO's, IARC's, farmers)***

A workshop will be held with project partners in the next three months to start the development exercise of the modelling tool and decision support tools.

## **Agreed workplan for second year**

At the end of the workshop the activities for the second year were agreed. These were,

**Output 1:** Model(s) for assessing alternative uses and management of forage legumes and animal manures in crop-livestock farming systems developed and evaluated

- Finish collection and collation of the data from Ethiopia, Kenya, Tanzania and Zimbabwe and enter it into the project database.
- Development of standard outputs for the APSIM and DSSAT models so the data can be used for entry in to other parts of the Decision Support (DS) tool. Adaptation of databases so the DS tool can access them.
- Development of hypotheses and scenario testing of trade-offs between competing and synergistic utilisation of organic inputs in crop-livestock systems.
- Development of the structure of the virtual laboratory for exchange of information, data, models and results amongst stakeholders. Testing of the usefulness of the virtual lab for project management and information exchange.

**Output 2:** Modelling tool and decision support tools for evaluating alternative nutrient sources, management of those nutrients and impacts on soil fertility and livestock production developed and evaluated.

- Identification and incorporation of farmer perceptions, farmer production objectives and farmer perceptions of risk and vulnerability into the DS tool development.
- Development and initial testing of the prototype DS tool on-farm in East and Southern Africa by project partners (NARES, NGO's, IARC's, farmers).

**Output 3:** Modelling tool and decision support tools disseminated in a range of formats, including extension manual, researcher decision support system, to different stakeholders.

- Reporting of project results in conferences and through other media.

The annual meeting was very successful and allowed the partnership to push forwards with the project. Not all of the partners who attended the stakeholders workshop were present but all sites except Malawi were represented. All participants expressed their desire to continue to be included in the project, to provide data for the model initialisation and to be involved in the incorporation of farmers perceptions, to develop scenarios targeted to their research sites and to explore these new scenarios within the farmer research groups that they already work. The strengthening of the partnership and research work through the addition of three Ph.D students is seen as a great development and an ideal opportunity to build links with other partners and projects working on crop-soil-livestock interactions and integration in East and Southern Africa.

## Appendix 1: Annual Workshop Agenda

<b>Monday 15<sup>th</sup> April</b>		
8.00	Transport departs for ILRI	
8.30 – 9.00	Discussion of agenda and workshop objectives	Robert Delve
9.00 – 9.30	Update from Ethiopia	Tilahun Amede
9.30 – 10.00	Update from Kenya	Dannie Romney
10.00 – 10.30	Coffee break	
10.30 – 11.00	Update from Tanzania	Juma Wickama
11.00 – 11.30	Update from Zimbabwe	John Dimes
11.30 – 12.30	Introduction to database for project data	All participants
12.30 – 2.00	Lunch	
2.00 – 2.45	Introduction of Ph.D thesis	Shamie Zingore
2.45 – 3.30	Introduction of the two other Ph.D. student topics	Rob Delve
3.30 – 4.00	Tea break	
4.00 – 4.15	Review of progress	Rob Delve
4.30	Transport departs for hotel	

Tuesday 16 <sup>th</sup> April		
8.00	Transport departs for ILRI	
8.30 – 9.00	Introduction to scenario development and presentation of the valuation of crop residues	John Dimes/Rob Delve
9.00 – 10.00	Development of hypothesis and scenario testing of trade-offs	All participants
10.00 – 10.30	Coffee break	
10.30 – 11.30	How to move forward on activity on: Identification and incorporation of farmer perceptions, farmer production objectives and farmer perceptions of risk and vulnerability into the DS tool development (Output 1)	All participants
11.30 – 12.30	How to move forward on activity on: Development of the structure of the virtual laboratory for exchange of information, data, models and results amongst stakeholders. Testing of the usefulness of the virtual lab for project management and information exchange (Output 1)	All participants
12.30 – 2.00	Lunch	
2.00 – 3.00	How to move forward on activity on: Identification and incorporation of farmer perceptions, farmer production objectives and farmer perceptions of risk and vulnerability into the DS tool development (Output 2)	All participants
3.00 – 3.30	How to move forward on activity on: Development and initial testing of the prototype DS tool on-farm in East and Southern Africa by project partners (NARES, NGO's, IARC's, farmers) (Output 2)	All participants
3.30 – 4.00	Tea break	
4.00 – 4.30	Agreement of activities for the next 6 months	All participants
4.30	Transport departs for hotel	

## Appendix 2. List of participants

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