

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

Initial stakeholders workshop

17-18th September 2001

ILRI-Nairobi

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

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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 some of the modelling, data issues and farmer participatory research identified at an implementation workshop held by TSBF in ILRI-Nairobi and the plans developed to address them.

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

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

Workshop objectives

A project implementation workshop was held to bring together scientists working on integrated nutrient management, farmer participatory research and with crop and livestock simulation models from a variety of agro-ecosystems in the tropics in East and Southern Africa. The agenda and participants list are given in Appendices 1 and 2 respectively.

The primary objectives of the workshop were to:

- Review the current status of crop-soil and crop-livestock research and models that simulate soil N and P dynamics, soil organic matter formation, crop/forage yields and livestock production
- Review current work and datasets on integrated nutrient management in crop-soil-livestock systems
- Select field trials within collaborative projects to collect the information needed to test the performance of the models for simulating nutrient availability and crop growth following the addition of organic and inorganic sources of N and P.
- To refine the project outputs and activities where necessary
- To agree on the partners for project implementation
- To agree the workplan and Activity Schedule for the three year project

The expected output of the stakeholder workshop was a completed workplan, with specific partners identified to conduct the agreed outputs and activities.

Workshop Presentations

The first morning was taken up with five presentations, the first by Mike Swift to lead into the new project following a successfully completed Phase I project with DFID on 'Confronting soil erosion and nutrient depletion in the humid/sub-humid tropics'. Four papers giving an overview of current research on crop-soil-livestock research followed. A summary of these papers follows.

How we got to where we are now – Mike Swift (TSBF)

The presentation started with an overview of how the different funded projects under the SWNM umbrella approached the problem from different scales, from the plot research to the use of modelling to investigate trade-offs at the farm level and to allow extrapolation. Highlights of some of the results of the first DFID funded project to SWNM in East Africa were presented as a background to the current DFID funded project.

Crop-Livestock Research – Dannie Romney (ILRI)

The work of the Market Orientated Smallholder Dairy project managed by ILRI but with a range of partners was presented. Research highlights were presented as well as some of the data that is available for the current project, from household surveys to farm level resource allocation/nutrient balances.

Crop-livestock modelling – Phil Thornton (ILRI)

This was a 'what are we doing, where and why' presentation and focussed on the conceptual framework of the approach of ILRI and partners and some of the tools available for integrating our work. Gaps were identified that this project would be able to fill, for example,

- Analysis of multiple plots and over time
- Multiple enterprises on the farm and their interactions
- Leaf stripping/thinning during the season/deheading and how to handle these in models
- Crop residue quality and impacts of this on management of resources
- How feed quality affects manure quality
- Competition for land between legumes and grasses

STORM and SLATE, two decision support tools were also presented as potential contributions to this project

Crop-soil research – Bernard Vanlauwe (TSBF)

This presentation looked at our experiences with organic resource quality, organic/inorganic interactions, production of crops and biomass on-farm and highlighted many results from East and West Africa. Interventions points in the system were presented, for example, where to target rock P additions, to the maize directly or through a legume fallow the season before. Also, how soil fertility

management varies with the distance from the household and how this impacts on resource allocation and management. The linkages to local knowledge and knowledge systems were discussed in terms of sustainable livelihoods.

Crop-soil modelling – John Dimes (ICRISAT-Bulawayo)

The APSIM model and its application in modelling experimental data in East and Southern Africa was presented. Its application in scenario analysis was shown where the use of a limited amount of fertilizer and weeding regimes were compared through simulation to help us understand the implications of the different scenarios on the productivity and profitability of the farming enterprise.

Working group reports

After group discussions it was decided to deviate from the proposed Agenda (Appendix 1), so after the presentations the workshop participants split into two working groups to discuss the project as a whole. This was so that all participants would have an understanding of the project before looking into the individual outputs and activities in more detail.

Each group was asked to think of the project in terms of:

- Which areas am I interested in
- What can I offer this project
- How do I want to be involved in the project
- What are the research gaps
- Where is the data to fill these gaps
- What do we need to do to fill these gaps
- What are the first activities to start and where

Group 1 report

What to offer

- Models as decision making tools
- DSSAT, CENTURY, APSIM
- Focus on one or two models and link this to livestock

Research gaps

- Where are the organic resources coming from?
- Do investment strategies favour livestock?
- Gender aspects on resource use and control e.g. manure, trees?
- Leaks in the system –management of nitrogen losses
- What are the model imperfections

Possible scenarios

- Simulation on the use of crop residues e.g. what would be the return when fed to livestock cf. direct incorporation? (Edinburgh ruminant model & APSIM)
- Possible sites: Ethiopia, Kenya, Tanzania

Socio-economic considerations

- Cultural aspects and choice of crops e.g. legumes in Zimbabwe and Kenya
- In some tribes men milk cows and women never touch them and in others it the opposite way around

Virtual laboratory

- CIP is working in this area and has offered to do this for the project
- The challenge for this project is the collection and collation of datasets for this laboratory

Output 2

- 2.1 More of field testing management options with farmers rather than a decision support tool for evaluating alternative nutrient sources.
- Incorporate farmers' priorities
- 2.2 Decision support system needs to include information on risks, not just the decision points
- 2.3 To be achieved through existing networks of individuals working in the region. It was thought that given the number of countries that West Africa should not be a priority and the project should focus on Eastern and Southern Africa

No explicit discussion was reported from Outputs 1 and 3, although some their content is covered in the other points. This was attributed to the concerns the group had over Output 2 and so they focussed most of their discussions there.

Group 2 report

What to offer

- East Africa is intensive vs. Southern Africa is extensive
- Which models do we want to use
- Adding legumes to systems

Data needed at the farm level (Data needed) – Output 1

- Time factor (seasonality, length of storage, quality with time)
- Composition (dung, urine, residue)
- Composting methods
- Forages available

- Rationales behind resource allocation decisions, farmers criteria
- Legumes, feeding vs. soil fertility
- Quantity and quality of manures and organic resources
- Characterisation of communities
- Identifying intensification opportunities

Data requirements for models:

Crop

Crop/livestock

Daily weather, rainfall, radiation, min/max temp

Soil data
(Physical/chemical)

feed data
(Digestibility, amount)

Crop information

Herd information

Crop management

Herd management
(Manure management)

Data on manure management needs collating for this project

Possible scenarios – Output 1

- Value of residues, as feed for livestock or for soil fertility
- Should residues be fed or composted
- Should farmers try to increase yield or reduce variability
- Selling/trading of residues and manures

Output 2 – testing and dissemination

- Parameters, biophysical, socio-economic
- Niches and conditions for legumes
- How do we make knowledge available for testing/evaluation
- Model testing is distinct from farmer evaluation

Dissemination – Output 3

- Baseline, how and why is this proposed
- Timeframe, the project seems very short to look at adoption
- What is the process of generating user-friendly information
- Should the project also produce policy briefs

After the two groups reported back to plenary there was a general discussion about the working groups reports and the project in general. Most of the discussion revolved around the issue of farmers priorities and farmers decision making, this is highlighted by several comments that came out in the discussion,

- We need to understand the system and the impact of different approaches

- We need implicit links to farmers
- Generate understanding of the system, to increase options available, to increase productivity and profitability
- How do we 'formalize knowledge', if farmers had more/better knowledge would they do something different or not
- The linked models can be used to screen scenarios related to farmers desired outcomes and production objectives
- Development and evaluation of scenarios with farmers themselves
- Include constraints like, labour, capital, policy as well
- The project is about information flow and making research applicable and available to farmers

The discussion focussed our thoughts and was encapsulated by one comment that 'we need to understand where in the farmers decision making process is the provision of information most critical and in what format do we need this information'. A brief discussion then followed on the difference between information to choose a technology versus information for using a technology.

Proposal discussion

The group then decided not to split again to discuss the outputs individually but to have a general discussion on each one.

OUTPUT 1

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

The group agreed upon this output as it was in the original proposal. Discussion of the individual activities followed.

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

Seven potential sites were identified where research work has already been conducted that could be supplemented by this project to initialise the models and provide background for scenario development. The group then developed a criteria list for site selection and filled in the table for each partner (Table 1) and similarly for data requirements from each site (Table 2).

1.2 Standardisation of datasets and outputs for testing of models

ILRI proposed that the data entry format that was developed by the Systemwide Livestock Program (SLP) project on Trans-regional Analysis of Crop-Livestock Systems could be used for data entry to standardize the information in an Access database. This would collate the data requirements for Level 3 analysis (farm household modelling) for the project and feed into the trans-regional project the

outputs from this project. The minimum data requirements guidelines for collecting and entering this data will be circulated to the seven sites by the 7th October. Once these guidelines are received each partner will see what data they have and provide a timetable and budget for collection and collation of this data.

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

Following the discussion about site selection and data requirements, two sites, Kiambu in Kenya and Tsholtoho in Zimbabwe, were considered the most advanced in terms of data availability, modeling experience and they gave a contrast between the East and Southern Africa sites in terms of intensification, production systems etc (Table 1). These two sites will start activities immediately with the other five sites following once their data is collected and collated.

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

Robert Quiroz of CIP has agreed to host the results, datasets, model simulation runs etc on the SLP virtual laboratory once results are available.

Table 1: Criteria for site selection developed during the workshop, giving criteria, site, country and partner

Criteria	Kiambu Kenya ILRI	Vihiga Kenya AHI	Embu Kenya AHI	Lushoto Tanzania AHI	Manyamula Malawi Chitedze ARC	Tsholtoho Zimbabwe ICRISAT & TSBF	Mwera Zimbabwe DR&SS and TSBF	Awassa Ethiopia AHI
Different forms of competition	Land pressure between crops and livestock	Land pressure between crops and livestock	Land pressure between crops and livestock	Water for irrigation and household Land for cash or food crops	Extensive grazing	Capital and labour for livestock and crops	Land pressure between crops and livestock	Land pressure between crops and livestock Within farm between homestead crops and the outfield
Crop system	Maize, bean, coffee, tea, Napier	Maize, beans, vegetables	Maize, bean, coffee, tea	Vegetables, fruits, maize, beans, banana, coffee, tea	Maize, beans, groundnuts	Sorghum, millet, maize, cowpea, groundnuts	Maize, groundnuts, sunflower	Maize, beans, sweet potato, enset, coffee
Livestock system	Cross-bred	Cross-bred	Cross-bred	Local	Local	Local	Local	Local
Market access	High	Low	Low	High	Medium	Low	High	Low
Population pressure	High	High	High	High	High	Low	Medium	V.High
Available data (See Table 2)	Lots	Lots	Lots	Lots	Lots	Lots	Lots	Lots
Rainfall (mm)	1200	1600	1200-1400	1200	700-1000	550	850	1300-1400
Land size (ha)	1.0	1.0	1.5-2.0	0.8-1.0	1.0-1.5	5.0	2.0	0.5
% off-farm income	66	33	25	10	10	60	30	10
Livestock objectives	Milk and manure	Milk and asset	Milk and manure	Manure and asset	Manure and asset	Draft, meat and asset	Manure and asset	Draft, milk, asset
% using fertilizers	75	40	70	90 (cash crops)	<30	<10	80	40%

Table 2: Data required I each site for modelling and scenario analysis for each site, country and partner

Data required	Kiambu Kenya ILRI	Vihiga Kenya AHI	Embu Kenya AHI	Lushoto Tanzania AHI	Malawi	Tsholtoho Zimbabwe ICRISAT & TSBF	Mwera Zimbabwe DR&SS & TSBF	Awassa Ethiopia AHI
Weather for modelling	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Systems characterization	Household survey 1999 →	Household survey 2001 →	Bits and pieces	PRA 1999 >400	Household survey 1999 >50	Household survey and PRA 2000 (TSBF) ICRISAT BM site in 1997		PRA, data from AHI
Socio-economic	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Crop data	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bio-physical data	Yes	Limited	Yes	Yes	Yes	Yes	Yes	Yes
Labour	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Seasonal feed availability	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Input costs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prices	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Livestock (Nos. and types)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Farmer production objectives	Yes	No	On-going	Yes	Yes	Yes	Yes	Yes
Soils (intra-farm variation)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Resource management through' resource flow mapping	Yes (42 farms)	Yes	No	Yes (40 farms by wealth/gender)	No	Yes (by ICRISAT)	Yes	Yes (by AHI)

OUTPUT 2

A decision support tool for evaluating alternative nutrient sources, management of those nutrients and impacts on soil fertility and livestock production developed and evaluated.

This second output of the project caused a lot of discussion amongst the group as detailed in the Working Group Reports.

2.1 Field evaluation and verification of promising model predictions for integrated crop-soil-livestock production systems through multi-locational standardised network experiments

It was felt that the project should not use the linked models *per se* to develop scenarios and then test them on-farm as proposed in Activity 2.1 but instead should incorporate farmers perceptions, farmer production objectives and the farmers perceptions of risk and vulnerability into the modelling work. This would enable us to refine our thinking and review the initial researcher based scenarios and develop farmer criteria based scenarios for crop-soil-livestock systems.

It was agreed that the wording of this activity should be rephrased to include these new ideas and should read as, *understanding the context of farmer decision making*.

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 lot of time was spent discussing whether developing a DS tool was really the aim of the project, and if it was, who it was it for – researchers, extension or farmers? Whilst it was agreed that a researcher based DS tool was not what the project partners wanted to produce, some sort of conceptual framework and methodology linking databases, models and farmer perceptions was needed and should be developed during the project.

Testing and development would involve strategic research conducted to fill knowledge gaps that were identified during the project activities, either in the provision of initial data or to capture farmer perceptions etc

2.3 Revision of prototype and testing over a wider range of sites including West Africa

Again some revision was agreed to the wording of this activity and it was proposed to read as, *revised scenario testing, revision of DS tool and testing over a wider range of sites*.

The exclusion of West Africa was thought wise as the project was thought to be very ambitious and a concentration in East and Southern Africa was thought preferable to allow the partners to develop this project fully and not be stretched too thin.

OUTPUT 3

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

As this is the last part of the project it did not receive very much discussion from the group and it was agreed that this would be covered in more detail in the next meeting in 12 months time. Through the general discussions several points related to the activities arose and these are covered below.

3.1. Development of user-friendly versions of the decision support tool with different stakeholder groups (farmers, NGO's etc)

This activity was thought critical to ensure that the linked models, which are very researcher focussed, are translated into more appropriate formats for other stakeholders. As presently the form the linked models and DS will take is unclear the exact nature of these materials was not finalized.

3.2. Hold a series of training events with stakeholders to demonstrate the decision tools

3.3. Development of criteria and baseline survey for future impact monitoring

The issue of a baseline survey was discussed and questioned by some participants, as this project is not seen as a technology dissemination project to farmers involving large numbers of adopters but more a research tool for a smaller group of researchers, extension and NGO personnel. This item will be discussed further at the annual meeting in six months time.

3.4 Dissemination of DS tool through conference papers, journal articles and the internet

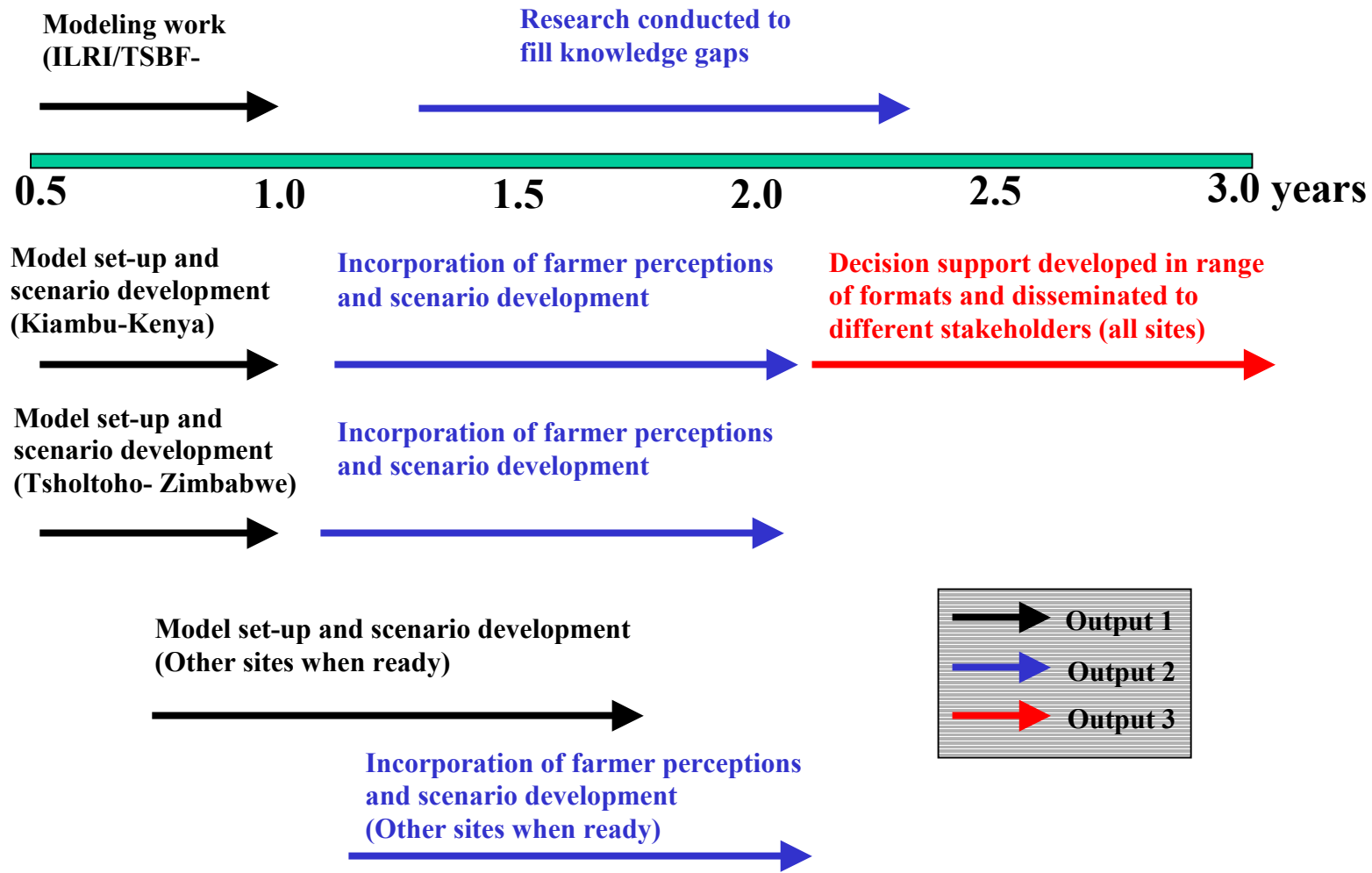
The production of policy briefs was also considered a critical part of this.

Summary and agreed actions

The stakeholders workshop has highlighted some changes to the Activities agree in the initial proposal and DFID is requested to review these changes to the proposal as outlined in this workshop report.

The final part of the workshop was the development of the Activity chart for the project (Figure 1). The stakeholders workshop took two days and proved very successful in introducing the proposal and project activities to all the participants. All participants expressed their desire to be included in the project, to provide data for the model initialisation and to be involved in the incorporation of farmers perceptions etc into scenario runs, to develop scenarios targeted to their research sites and to explore these new scenarios within the farmer research groups that they already work. The inclusion of this work in existing research projects was seen as an ideal opportunity to explore crop-soil-livestock interactions and integration in research sites across East And Southern Africa.

Figure 1: Activity chart for project activities agreed at the Stakeholders Workshop



Appendix 1: DFID Stakeholders workshop Agenda

Day 1		
Session 1		
8.45 – 9.00	Registration in ILRI Conference Room	
9.00 – 9.15	Introduction	Robert Delve
9.15 – 9.30	Outline of the workshop/agree Agenda	Mike Swift
9.30 – 9.50	Crop-livestock research	Danny Romney
9.50 – 10.10	Crop-livestock modelling	Philip Thornton
10.10 – 10.30	Crop-soil research	Bernard Vanlauwe
10.30 – 11.00	Coffee break	
11.00 – 11.20	Crop-soil modelling	John Dimes
11.20 – 11.50	General discussion	
11.50 – 12.30	Discussion of the proposal	Robert Delve
12.30 – 14.00	Lunch break	
Session 2		
14.00 – 14.20	Discussion of Output 1 - Model(s) for assessing alternative uses and management of forage legumes and animal manures in crop-livestock farming systems developed and evaluated	
14.20 – 15.00	Working groups	
15.00 – 15.30	Coffee break	
15.30 – 16.00	Working group reports and synthesis	

Day 2		
Session 3		
9.00 – 9.20	Discussion of Output 2 - A decision support tool for evaluating alternative nutrient sources, management of those nutrients and impacts on soil fertility and livestock production developed and evaluated	
9.20 – 10.00	Working groups	
10.00 – 10.30	Working group reports and synthesis	
10.30 – 11.00	Coffee break	
11.00 – 11.20	Discussion of Output 3 - Decision support tool disseminated in a range of formats, inc. extension manual, researcher decision support system, to different stakeholders	
11.20 – 12.00	Working groups	
12.00 – 12.30	Working group reports and synthesis	
12.30 – 14.00	Lunch break	
Session 4		
14.00 – 15.00	Agree revised workplan, responsibilities and budget	
15.00 – 15.30	Coffee break	
15.30 – 16.30	Agree revised workplan, responsibilities and budget	

Appendix 2. List of participants

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