Dynamic Simulation Modelling for Agricultural Development: Status and Needs

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Presentation outline

- The supply side of dynamic simulation models
- The demand side
- How can supply be matched to demand?
- What needs to be done in the future?

Acknowledgements

This work has involved, and is still involving, many people in many different institutions.

Much of it revolves around the value of inter- and multi-disciplinary teams ...

... in spite of the difficulties of doing such work, the problems in publishing it, and the difficulties of being evaluated appropriately for team-based systems science in many institutions.

We, as agricultural researchers, administrators and teachers, still live in disciplinary times, by and large.

Is there a "modelling problem" ?

- Relatively large investment in modelling work over many years
- Recent reviews bemoan the lack of direct impact of modelling and the lack of uptake of models in decision support
- Why is this, what can be done?

There is an "agricultural research for development" problem ...

- **Relatively large investment over many years**
- **Lack of direct impact, lack of uptake**
- **Why is this, what can be done?**

The "modelling" issue is merely one aspect of a much broader problem

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Agricultural Systems
Volume 7, Issue 1 (July 1981)

- The climatic potential for beef cattle production in tropical Australia: Part II - liveweight change in relation to agroclimatic variables

- Agricultural development effort in Nigeria: an economic appraisal of the Western State settlement scheme

- Simulation modelling for orchard management

- Simulation of beef cattle production systems in the Llanos of Colombia, part I. Methodology: An alternative technology for the topics

- A computer simulation model of ovine fascioliasis

Agricultural Systems
Articles in Press (April 2004)

- Agent-based social simulation: a method for assessing the impact of seasonal climate forecast applications among smallholder farmers

- An empirical model for quantification of symbiotic nitrogen fixation in grass-clover mixtures

- How the uncertain outcomes associated with aquatic and land resource use affect livelihood strategies in coastal communities in the Central Moluccas, Indonesia

- The costs of soil carbon sequestration: an economic analysis for small-scale farming systems in Senegal,

- A mechanistic dynamic model to estimate beef cattle growth and body composition: 1. Model description

Classification of simulation models by processes modelled and unit of analysis

Unit of analysis in the model	Processes modelled				
	Biophysical	Socio-economic, econometrics-based	Socio-economic, rule-based	Cultural	Integrated
Single unit (representing all individuals)					
Single unit, various clusters					
Population cohorts					
The individual					

Classification of simulation models by processes modelled and unit of analysis

Unit of analysis in the model	Processes modelled				
	Biophysical	Socio-economic, econometrics-based	Socio-economic, rule-based	Cultural	Integrated
Single unit (representing all individuals)	Crop model	U_{max} household model			
Single unit, various clusters		U_{max} household model	PHEWS		Savanna-PHEWS
Population cohorts	Savanna ecosystem model	?			
The individual		?		Artificial society models	

Representative household models (of some typology)

1 Simulation models (physical processes)

a Take existing crop models for the crop components and animal models for the animal enterprises and lump them together

Issues of:

- Where do you draw the system boundary?
- Complexity
- Data requirements
- Calibration and validation
- Technically how to deal with crop-livestock interactions

Representative household models (of some typology)

1 Simulation models (physical processes)

b Develop something new that attempts to limit complexity of the model but still meets the objectives of the research

Issues of:

- Time, effort and resources required
- Model sensitivity – are there simple ways to represent complex processes?
- Data
- Calibration & validation

Representative household models (of some typology)

2 Mathematical programming

Develop a household model that integrates biological, social and economic aspects of the system, built around an objective function and sets of production activities and constraints

Issues of:

- How can the relevant biological processes be adequately represented as input-output coefficients?
- How flexible is the framework for general experimentation?
- Is enough known about smallholders' objectives, attitudes?
- Data
- Calibration & validation

Representative household models (of some typology)

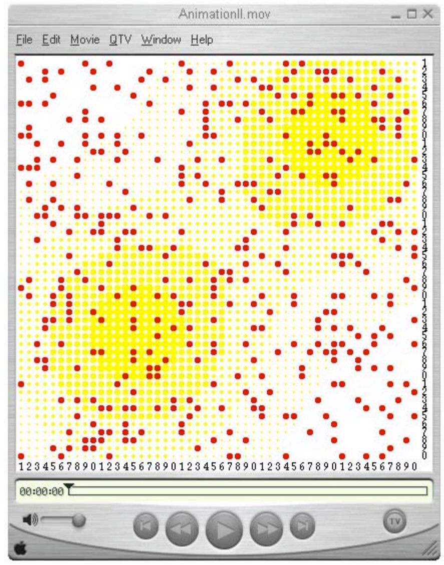
3 "Systems dynamics" models

Develop a model built on flows and feedbacks based on the analyst's (or analysts') perceptions of key system processes

Issues of:

- Are the relevant biological processes adequately represented?
- Is enough known about the system and those who operate it?
- How to relate revealed characteristics of the model to the real world, if not process-based?
- Formal, independent validation may be well-nigh impossible

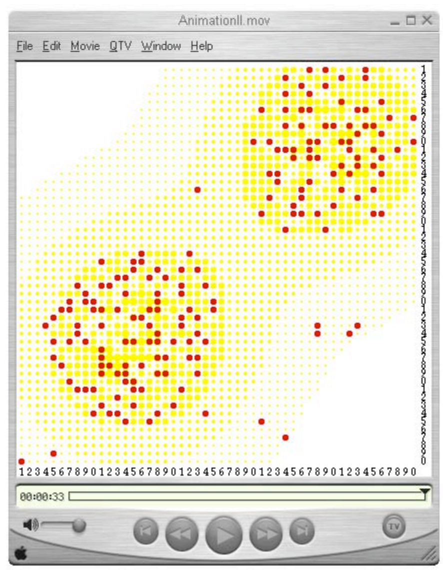
SUGARSCAPE



Agents (in red) harvest sugar (yellow) from a landscape of renewable resources. Each period each agent searches its neighborhood for the site richest is sugar, moves there and harvests the sugar. Sugar grows back at unit rate. Agents die if they are unable to find enough food to satisfy their metabolic demands.

Epstein and Axtell,
The Brookings Institution, Washington DC

SUGARSCAPE



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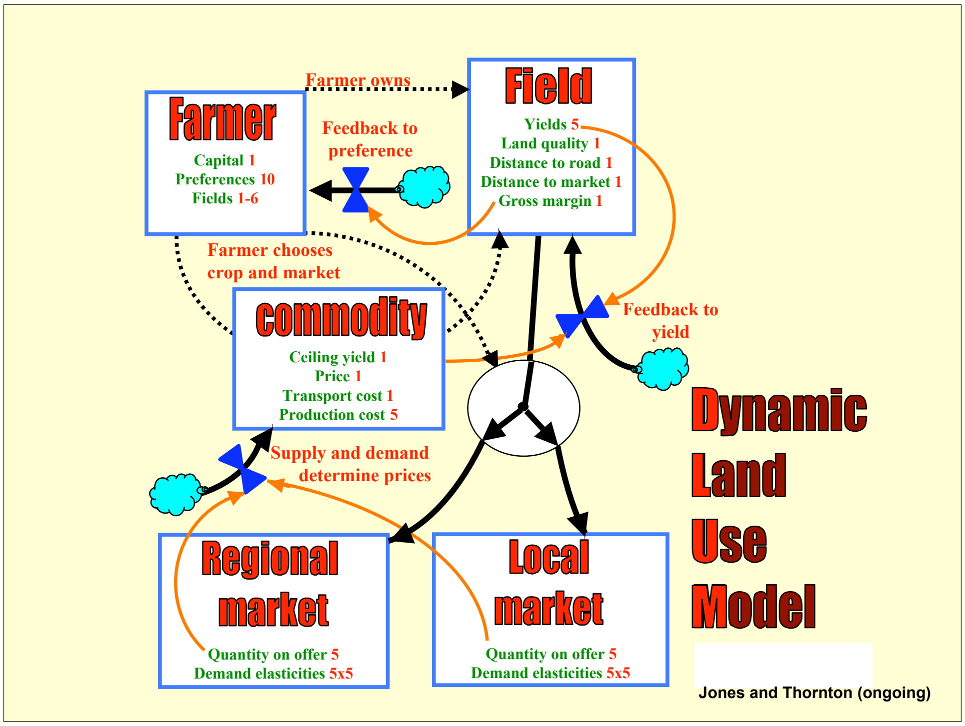


Towards (agent-based) integrated models

- Simple models can produce complex system behaviour

- Can we check model behaviour against real-world behaviour (by using survey methods and representative households)?

- In these types of models, what is the trade-off between complexity and realism -- how far to push this type of model?

- And are simulation results more characteristic of the model than of the real world that is being modelled?

Presentation outline

- The supply side of dynamic simulation models
- **The demand side**
- How can supply be matched to demand?
- What needs to be done in the future?

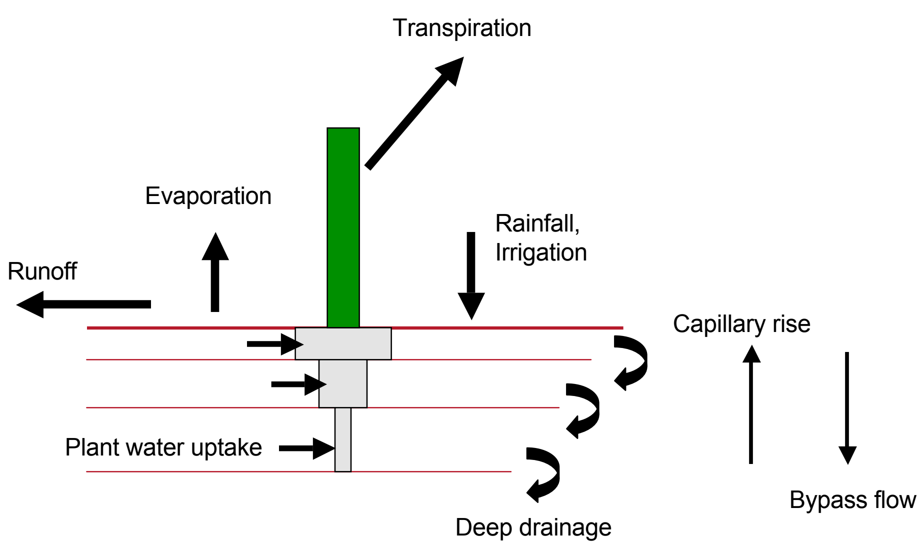
Information needs in agricultural development

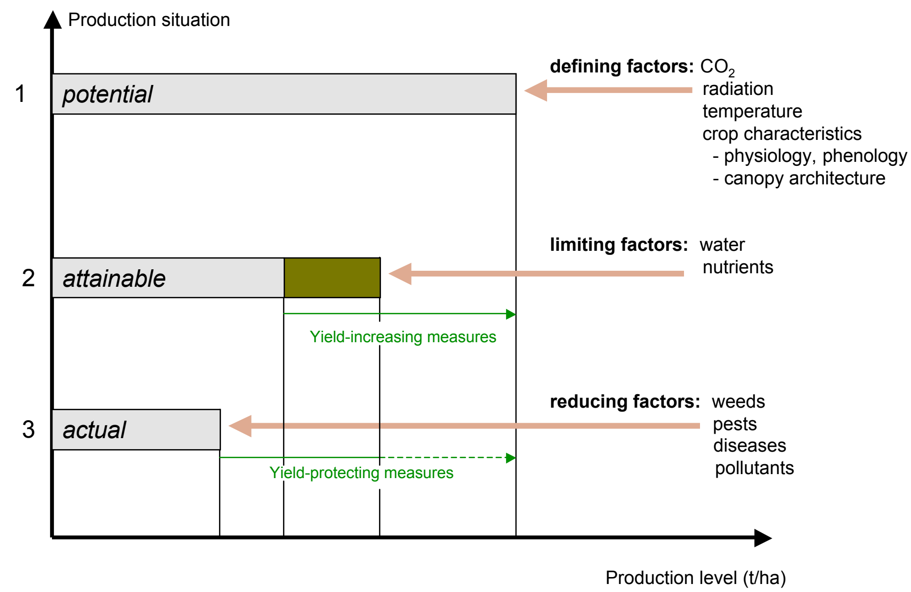
- Research itself
- Impact assessment, research planning, monitoring and evaluation
- Policy formulation
- Management / decision support / conflict resolution
- Education

Information needs:
Research

- Frameworks for describing well-understood processes
- Replicable methods and tools for investigating phenomena
- Can models help?

Crop model water balance

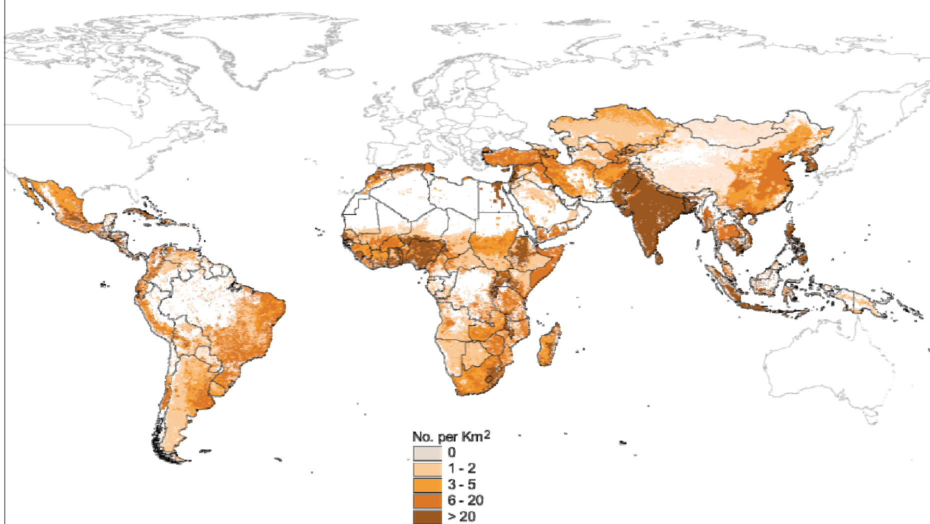




Information needs:
Impact assessment and research planning

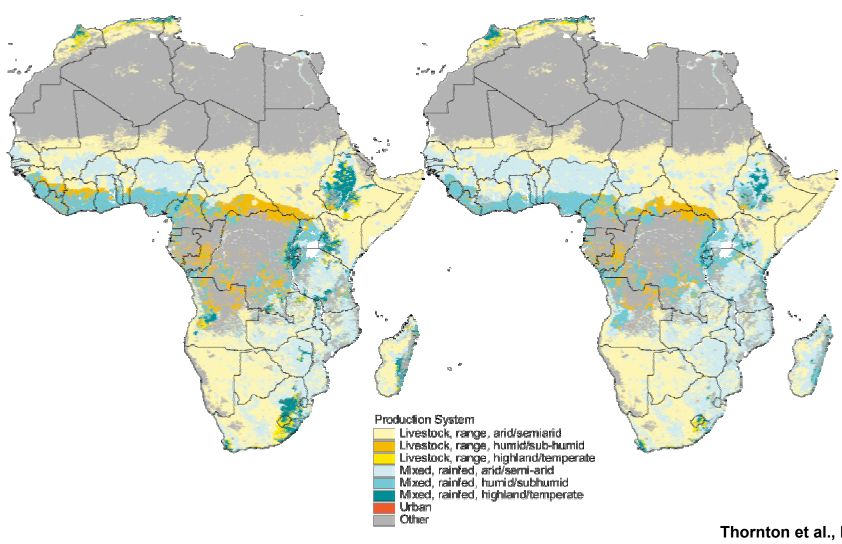
- What has worked in the past, where, and why?
- Given limited resources, what should we work on in the future, and where, to maximise research impact?
- What constitutes a coherent portfolio of research activities that fully addresses institute goals?
- Can models help?

Density of *Poor Livestock Keepers* by Farming System



Thornton et al., ILRI, 2002

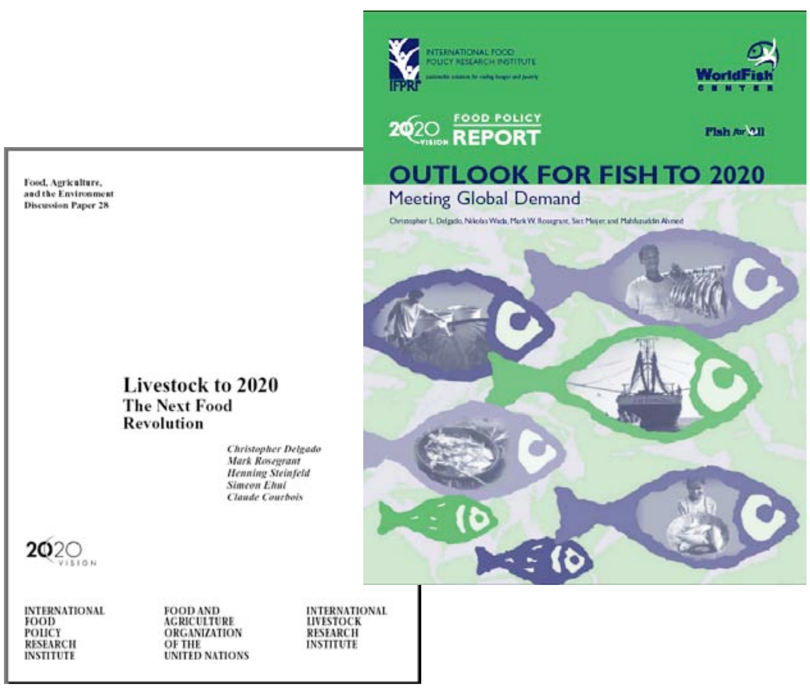
Expected changes in Production Systems
2000 to 2050



Thornton et al., ILRI, 2002

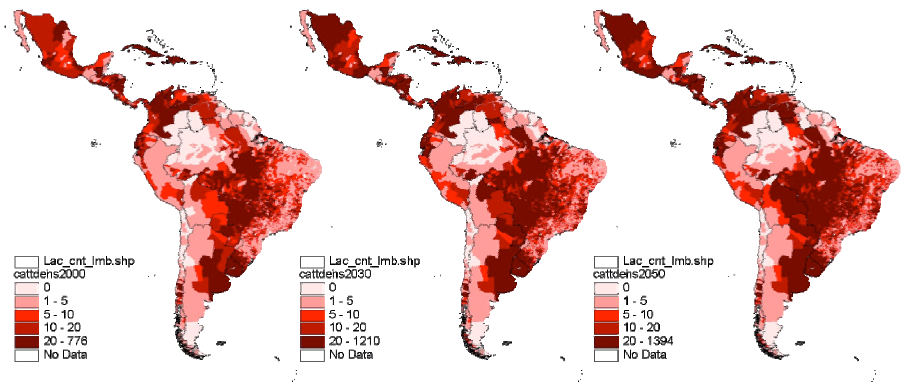
Information needs:
Policy formulation

- Which policies will bring about government and societal objectives, and how should these be applied, and where?
- Which groups will benefit from policy changes, and which will not?
- Can models help?



LAC Cattle Density 2000 to 2050 weighted by current cattle density

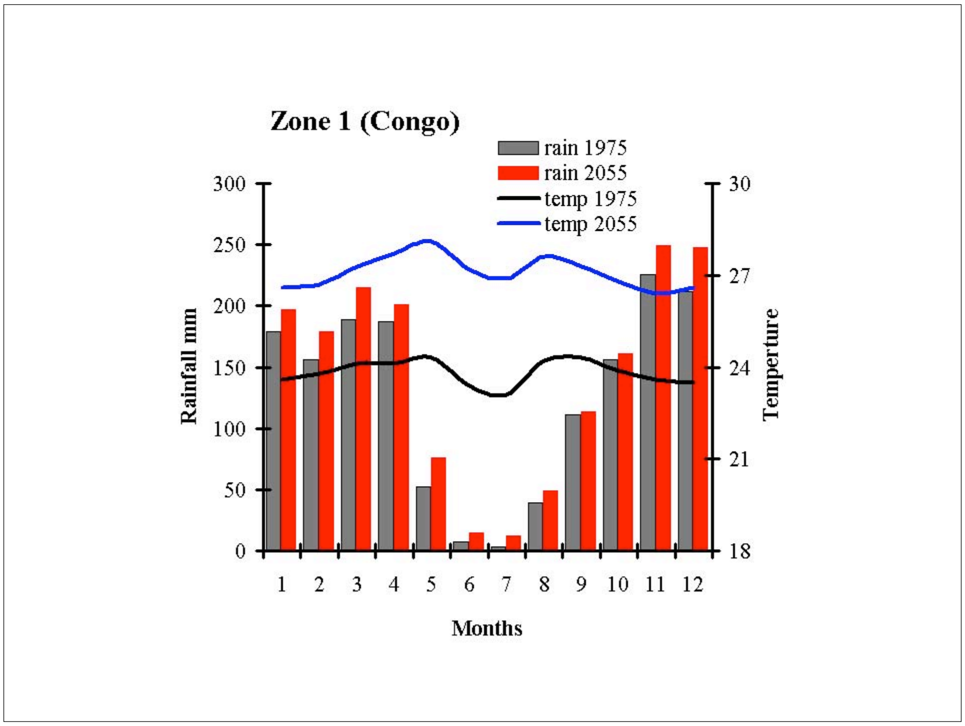
2000 **2030** **2050**

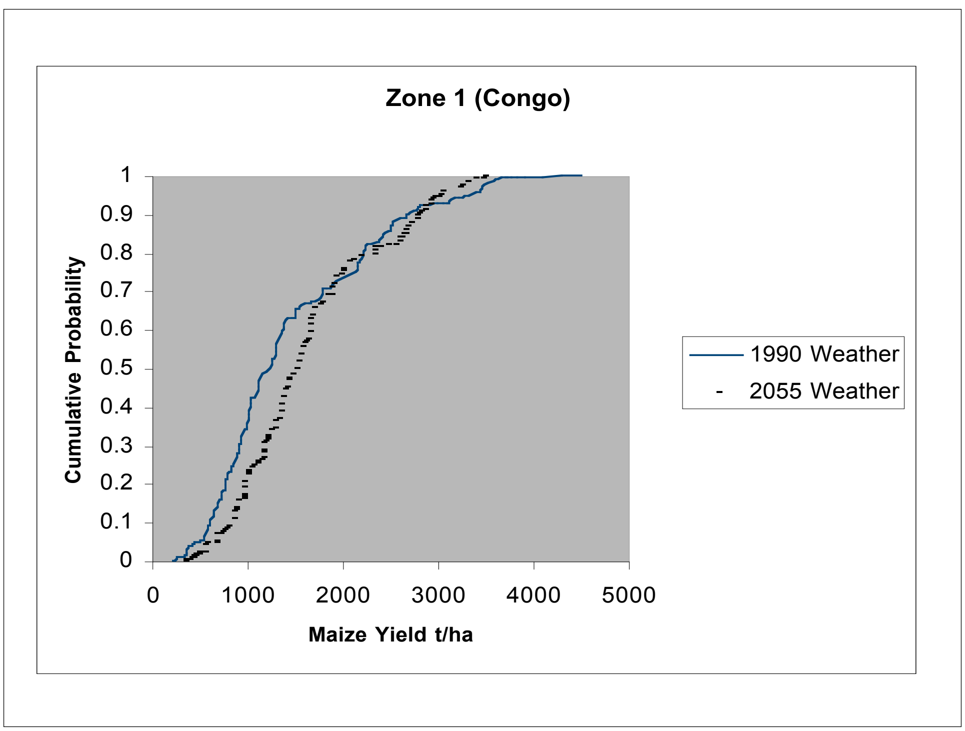


Kruska et al., ILRI, 2004

Information needs:
Management, decision support

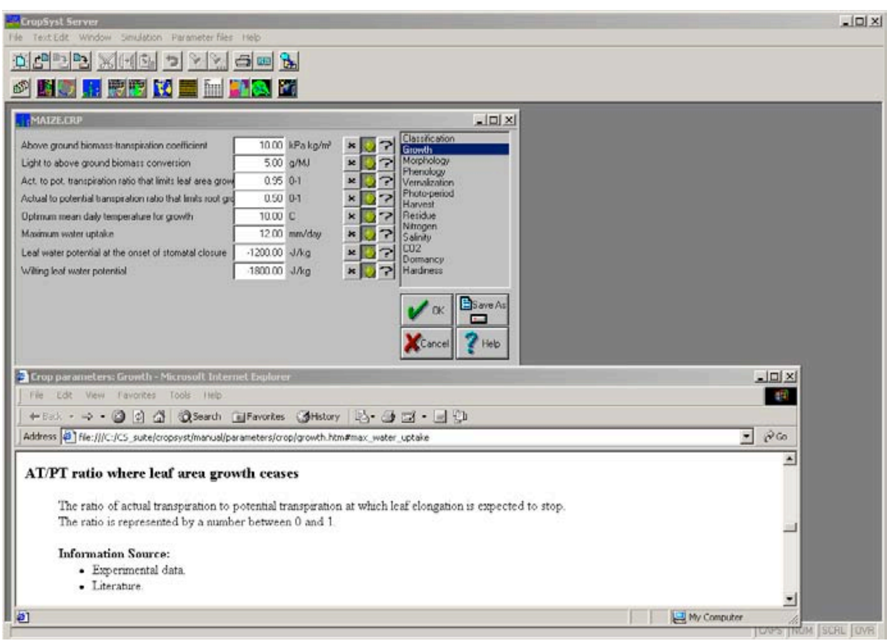
- Which crop and livestock management options are most appropriate for particular conditions, now and in the future?
- When should action be taken against a crop or livestock disease?
- Can income be maximised while minimising nutrient losses and maximising capital asset values in livestock?
- Can models help?


Zone 1 (Congo)
rain 1975
rain 2055
temp 1975
temp 2055
Rainfall mm
Temperture
Months
300
250
200
150
100
50
0
30
27
24
21
18
1 2 3 4 5 6 7 8 9 10 11 12

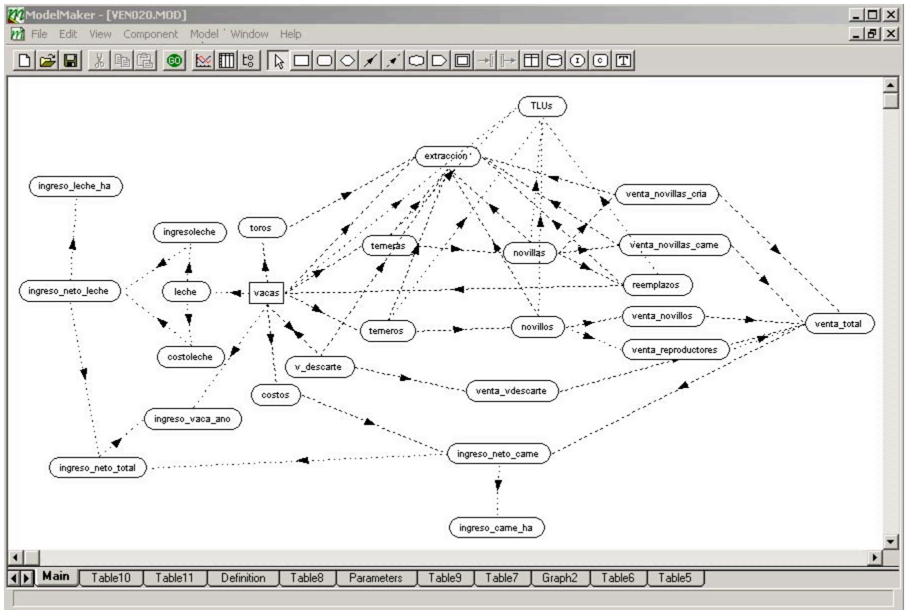

Zone 1 (Congo)
Cumulative Probability
Maize Yield t/ha
1990 Weather
2055 Weather
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0 1000 2000 3000 4000 5000

Information needs:
Education

- How can university curricula be adapted effectively to make use of recent scientific progress?
- What are cheap and effective ways for students to learn about biophysical processes?
- How can school children and farmers learn effectively about livestock hygiene and human nutrition?
- Can models help?



CropSyst (Stockle and others)



Edinburgh Livestock Model (Herrero, Fawcett and others)

Presentation outline

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Agricultural research for development

- **Publicly-funded agricultural research: $400 billion since 1972 ($5.6 billion to the CGIAR)**
- **Millennium Development Goals: e.g. halve number of poor people between 1990 and 2015**
- **Effectiveness of research for the poverty goals of development – is the supply of research outputs being matched appropriately with the demand?**

Have models been used effectively to date?

- "Simulation modelling has struggled for relevance in real-world agriculture and for impact on farmer decision-making" (Carberry, 2004)
- "Decision Support Systems have fallen far short of expectations in their influence on farm management" (McCown, 2002)
- " ... technology in search of problems to solve ..." (Many people, on many occasions)

What is needed to match supply of models and tools with demand for certain types of information?

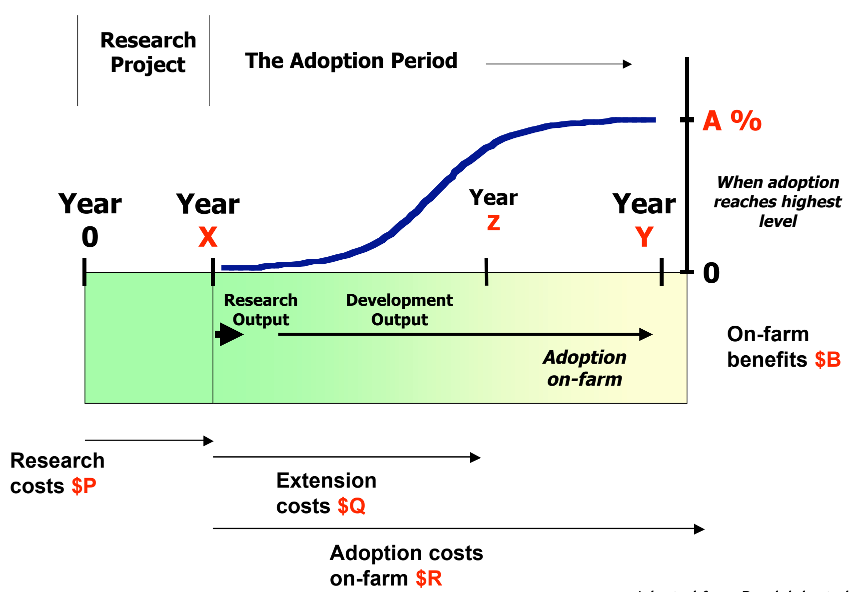
Four brief examples

Example 1: A model-based study that had negative impact -- an ILRI impact assessment

"Maize as food, fodder and fertiliser in intensifying crop-livestock systems in East and Southern Africa: an *ex ante* impact assessment of technology interventions to improve smallholder welfare"

Thorne et al. (2002)

Costs and benefits of the research and adoption processes



Adapted from Randolph et al., 2001

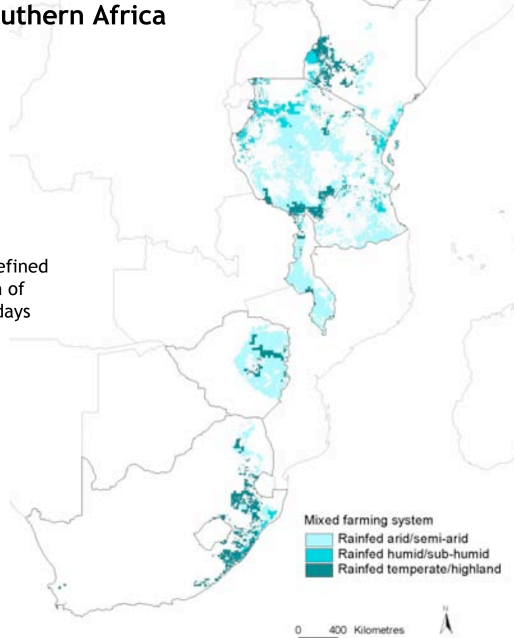
Characteristics of four maize-based mixed systems identified in the Eastern and Southern Africa region

		Population (persons km^{-2})	% of land cultivated
Small intensive	SSI	>250	>20
Medium intensive	MSI	100-250	10 - 20
Medium semi-intensive	MSSI	30-100	1.5 - 10
Medium extensive	MSE	<30	0 - 1.5

Source: Thorne et al. (2002).

Farming systems in mixed maize areas in five countries of East and Southern Africa

"Arid/semi-arid" is defined as areas with a length of growing period <180 days



Thorne et al. (2002)

Interventions considered:

- Use of collected weeds of the maize crop for livestock feeding
- Improved management of green maize stover for feed use
- Improved feeding systems incorporating dry maize stover
- Chopping / soaking of dry maize stover
- Use of replacement fodder crops
- Intercropping
- Improved manure management strategies
- Selection and/or breeding for improved digestibility of maize stover

Baseline data for small-scale intensive farming systems in Kenya, Tanzania and Zimbabwe

	Kenya	Tanzania	Zimbabwe
Grain yields (kg/ha/annum)			
Maize yield	2000	1300	1450
Intercrop yield	1240	975	0
Forage quality (CP g/kg DM)			
-Dry season	65	55	50
-Rainy season	110	95	70
Forage quantity (g/kg LW0.75/day)			
-Dry season	239	140	180
-Rainy season	214	320	284
Milk yield (kg/day)	9	12.5	8
Soil Fertility			
-	-629	-391	-366
-	-74	-46	-43

Sources of baseline data and incremental productivity estimates

- Country case study reports (Kenya, Tanzania, Zimbabwe, Republic of South Africa, Malawi)
- FAO stats
- Literature review
- Kiambu and Tanga longitudinal studies (ILRI and partners)
- GIS data layers (ILRI and partners)
- DRASTIC: Thorne (1998)
- ANORAC: Thorne and Cadisch (1998)
- DSSAT v3 Maize (Tsuji et al., 1997)

Mean percentage change (± s.d.) in baseline parameters in response to interventions in small-scale intensive farming systems in Kenya, Tanzania and Zimbabwe

	Increased density of maize	Offer extra 2 kg concentrate	Napier replaces maize	Increase stover digestibility
Grain Yields (kg / ha / annum)				
- Maize	**0**	**3** *(+0.3)*	**-47** *(+1.5)*	**0**
- Intercrop	**0**	**0**	**-33** *(+28.9)**	**0**
Forage Quality CP (g /kg DM)				
- Dry season	**0.1** *(±0.23)*	**21** *(±3.6)*	**11** *(±2.3)*	**0**
- Rainy season	**11** *(±3.6)*	**14** *(±2.1)*	**16** *(±2.1)*	**0**
Forage Quantity (g DM/kg LW $^{0.75}$)				
- Dry season	**3** *(+3.1)*	**33** *(+11.5)*	**15** *(+7.0)*	**0**
- Rainy season	**18** *(+3.6)*	**23** *(+5.0)*	**38** *(+6.7)*	**0**
Livestock Products				
- Milk yields *(l / day)*	**7** *(+0.7)*	**31** *(+7.1)*	**17** *(+1.2)*	**0.2** *(+0.08)*
Soil Fertility (kg / ha / year)				
-	**0**	**-8** *(±1.5)*	**-16** *(±2.1)*	**0**
-	**0**	**-13** *(+1.2)*	**-7** *(+1.2)*	**0**

Summary of feasible interventions by system, with an indication of the research and/or extension effort needed to realise the potential net benefits

System[1]	Intervention	Research level needed	Extension level needed
SSI	Use of collected weeds	none	high
	Improved green stover management	moderate	moderate
	Improved feeding systems	moderate	moderate
	Improved manure management	high	very high
MSI	Use of collected weeds	none	high
	Improved green stover management	moderate	moderate
	Improved feeding systems	moderate	moderate
	Improved manure management	high	very high
MSSI	Improved feeding systems	moderate	moderate
	Intercropping	low	high
MSE	Intercropping	low	high

Summary of results

• Improved feeding systems have substantial potential in the more intensive systems

• Promoting the use of intercropping in more extensive systems (where not already practised) offers substantial net benefits

• Improved green stover and manure management have modest research and extension costs, and could provide significant net benefits in more intensive systems

• The number of viable options decreases as system intensity decreases

• The amount of research effort needed decreases as system intensity decreases

• The amount of extension effort needed for many options is high, whichever systems are being targeted

Impact of study within ILRI

- Zero impact to date on research resource allocation
- Caused a great deal of ill-feeling on the part of scientists involved with feeding resource strategies, and consequent frustration on the part of the Impact Assessors
- Why the problems? The study did not pay adequate attention to internal stakeholders (i.e. ILRI scientists), who felt threatened by the results (some current research activity is not likely to have impact) and rubbished the methods and the study
- So what is happening now? We will repeat this study at the request of ILRI management, who are putting in place a mechanism for taking the results of IA and using them for resource allocation
- So what's the lesson? All the stakeholders matter.

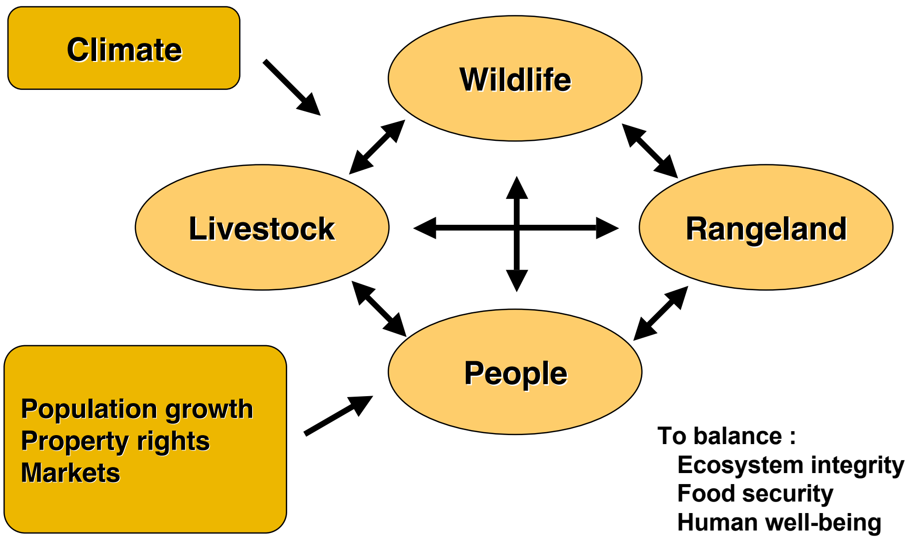
Four brief examples

Example 2: A model-based study that will probably have very little (if any) impact – a Livestock CRSP project with ILRI involvement

"A household economics and well-being model for assessing trade-offs between agro-pastoralists, livestock and wildlife: Kajiado District, Kenya"

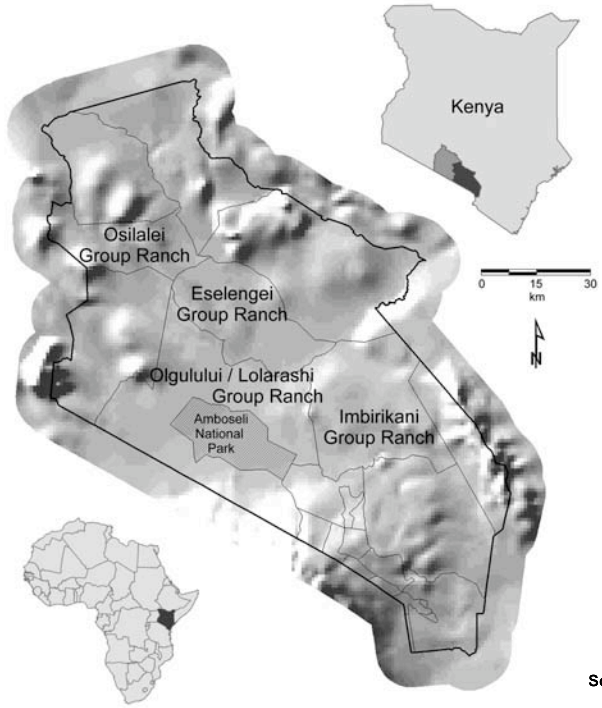
CSU, ILRI, partners in Kenya and Tanzania

Policy options for easing resource conflicts on rangelands: the Savanna decision-support model



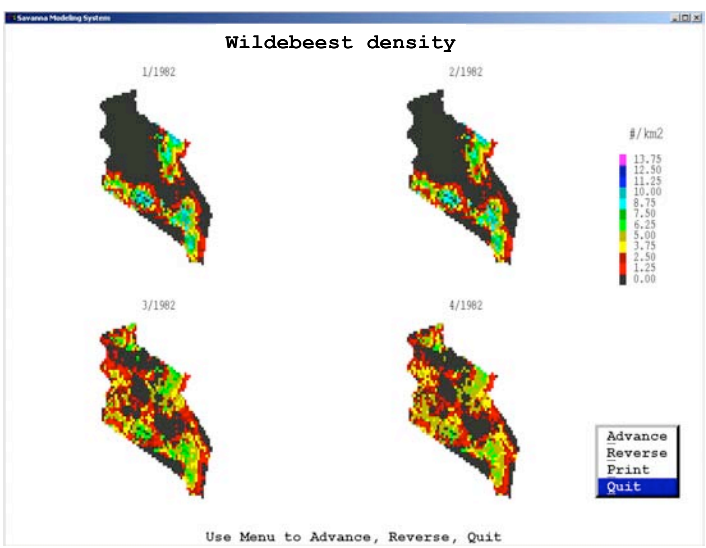
Agro-pastoralism in Kajiado

- Part of Masailand, group ranches set up in the mid-1960s
- Population increase, social change, rising economic expectations → group ranch subdivision and households growing rainfed maize (unsuitable conditions), irrigated vegetables in the swamps
- Wildlife numbers declining in Kajiado at the same time
- Can competing objectives of wildlife conservation for tourism, agro-pastoralists' well-being, and livestock production be balanced?
- Global Livestock CRSP and NSF Biocomplexity grant involving CSU-NREL, ILRI, partners



Source: R Boone (2003)

Savanna – a spatially-explicit ecosystem model (Coughenour)

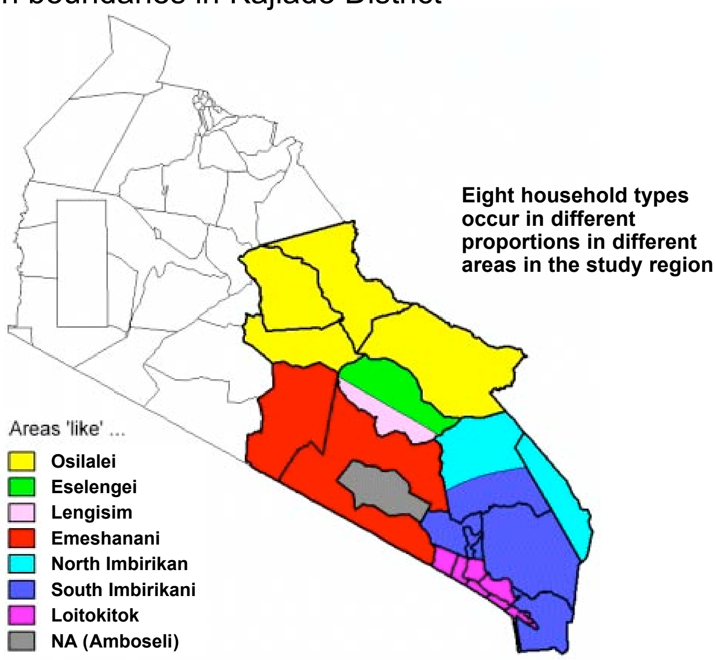


Different household types in the group ranches

- All households have livestock
- Some have access to
  - Rainfed agricultural plots (maize, beans for home consumption)
  - Irrigated agricultural plots (mostly vegetables for sale)
  - Rainfed plots on the slopes of Kilimanjaro (maize, beans)
- Some have a small business, often livestock trading
- Eight household types, each with three wealth levels to describe size of land holdings and herd sizes etc.

Data from S Burnsilver (2003)

Group ranch boundaries in Kajiado District



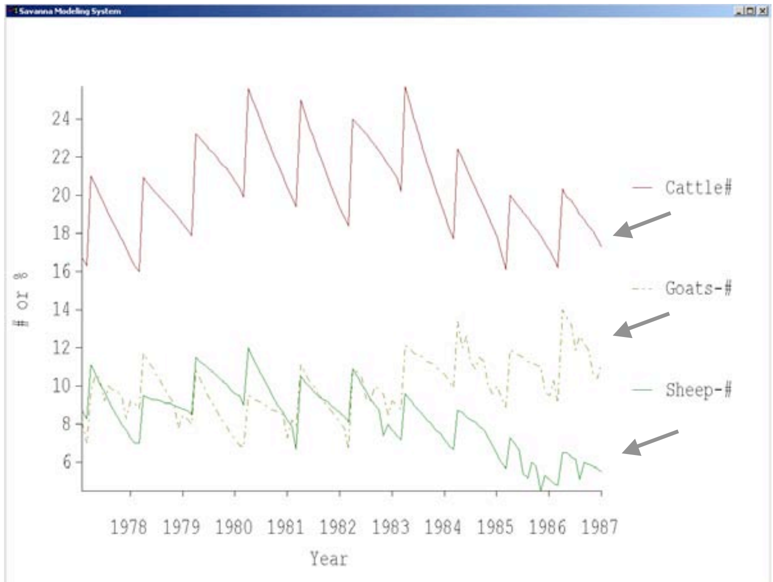
Pastoral Household Economic and Well-being Simulation Model (PHEWS)

- A simple accounting and rule-based model that describes cash-flow and dietary energy intake in households
- For 24 different household types (8 types x 3 wealth levels):
  - Dietary energy flows (maize, milk, meat, sugar, vegetables)
  - Cash flow, household expenditure decisions
  - Livestock sale and purchase decisions
  - Cropping decisions
  - Cattle, sheep, goat herd dynamics handled by Savanna
- Use linked Savanna-PHEWS model to simulate scenarios:
  - If the landscape is subdivided and animal movements restricted, what are the impacts on household incomes and food security?

Key model outputs

- Proportion of diet that cannot be met from the household's own resources
  - Gifts, other transfers, drought relief
- Annual household income from selling livestock
- Proportion of food that is produced by the household itself
- Tropical Livestock Units per Adult Equivalent
  - 6-8 TLU per AE needed for pure pastoralism
- Proportion of consumption satisfied

Baseline scenario: herd size evolution for poor LBI households



Some results of scenario analysis

Control run (current conditions)

- **Most households need some external calories sometimes, but not many and not frequently**
- **30 - 46% of calories are home-produced -- only rich households can be purely pastoral (9 TLU per AE). Most households (> 80%) have to crop or be in business**
- **In general, the more diversified the household, the better, in terms of food security and income**

Some results of scenario analysis

- **Subdivision scenarios (cattle, wildlife movement restricted)**
  - **For all GRs, resulted in substantially fewer livestock**
  - **To maintain current food security and income levels, livelihood strategies would have to change, or household numbers be reduced to keep herd sizes stable**

- **Restrict wildlife access to private lands through fragmentation**
  - **Cattle and shoat numbers eventually increase substantially, with significant impacts on household well-being**
  - **But wildlife numbers decrease markedly**

Where is this work going?

- Scenario results presented to local stakeholders at 6 community meetings during mid-2003
- More scenario analysis to be done on subdivision and other fragmentation issues, and use of cross-bred animals
- With many household types, are there other ways to simulate households? Agent-Based Modelling techniques for next versions of PHEWS
- Ultimately, the impact of this work will probably not be very great, as the major players are not fully involved
- So what's the lesson? All the stakeholders matter – pastoralists, local community leaders, politicians

Four brief examples

Example 3: A model-based study that is having local impact – a Wageningen University - KARI - ILRI project funded by the Dutch Ecoregional Fund

"System prototyping and impact assessment for sustainable alternatives in mixed farming systems in high-potential areas of Eastern Africa"

Waithaka et al. (2004)

A common problem in sub-Saharan Africa --

Increased population density leading to:

- Increased demand for food (milk, maize)
- Smaller plots and farms (intensification)
- Wide variety of farming systems
- Constraints on expansion of cultivated land
- Changing markets

Project objectives

- Characterise mixed farming systems according to their management objectives: “prototypes”
- Combine prototyping, simulation, household modelling to identify possible system improvements
- On sample farms, work with farmers to identify options that suit them, implement them and monitor over two growing seasons
- Disseminate methodology developed and tested at research sites in Kenya within the ecoregion

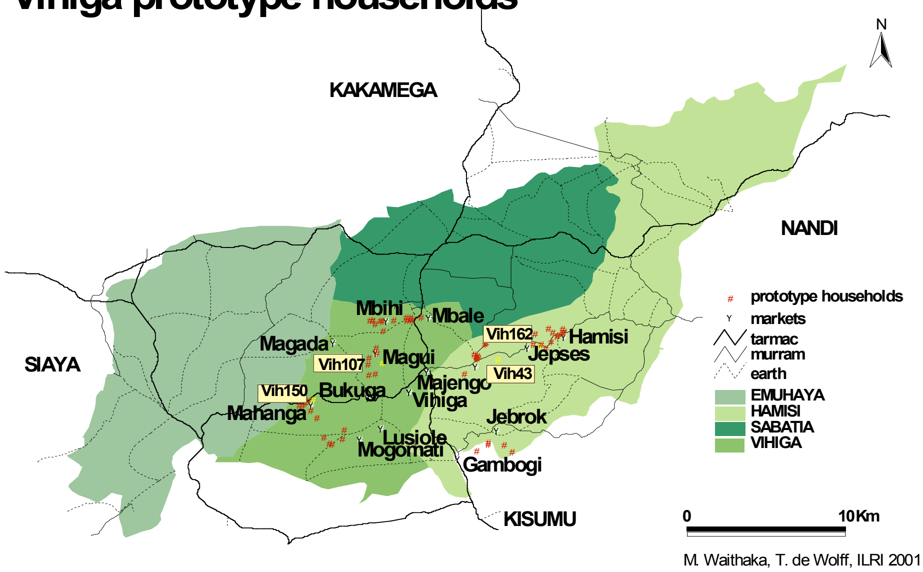
Project outputs

- **Methods and tools for characterising smallholder systems**
- **Methods to define recommendation domains that incorporate key socio-economic variables**
- **Improved ability to target technical and policy interventions through better understanding of what drives household decision-making**
- **Options for smallholders in the study regions that can help them to meet their objectives in the face of change**

Vihiga District, Western Kenya

- Average household size of 4.7 persons living on 0.5 ha
- Most farms deficient in P and K, soils are acidic
- Cattle manure is of low quality
- Fertilizer use is very low
- Most households have maize deficits of 200-400 kg per year (so shortages 6-10 months of the year)
- Most households are mired in poverty: average total annual income is US$ 197 (80% is wages and remittances)

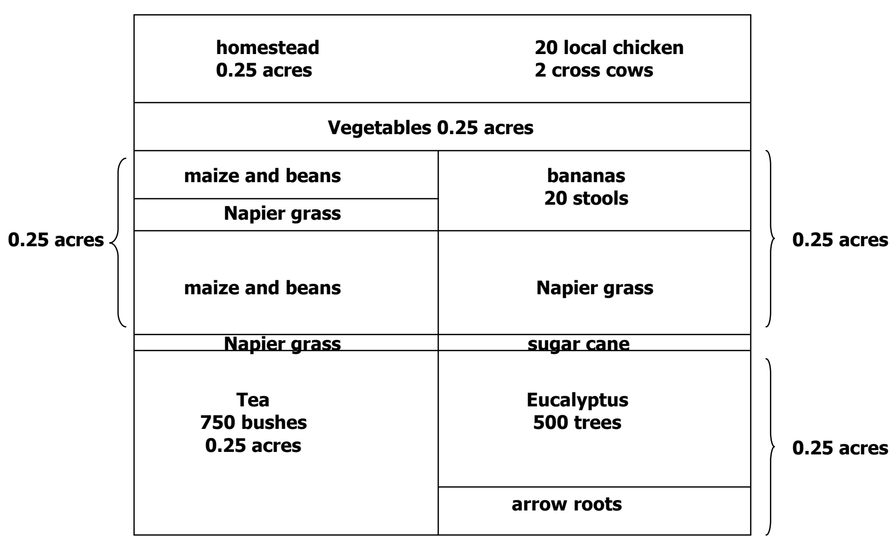
Vihiga prototype households



Livestock modelling

- **Animal Model (Ruminant)**
  - Predicts intake, digestion and animal performance of individual ruminants
  - Programmed in Delphi
- **Herd model**
  - Simulates herd dynamics
  - Developed in SB Model Maker
- **Household model**
  - Integrates biological, social and economic aspects of smallholder farming systems
  - Mathematical programming model (so has an objective function, a set of production activities, a set of constraints)
  - Written in XpressMP

Farm in Gavudunyi, Western Kenya
(1.5 acres)



What are the impacts of changing crops in plots on household objectives (subsistence, energy, soil, fuel, cash) ?

Can let the model choose:

- **Grow more intercropped maize and beans instead of bananas and vegetables**
- **Household satisfies its maize and bean requirements and sells surplus**
- **With extra income, bananas and vegetables are bought for food security**
- **Overall household expenditure decreases, but more spent on animal feed (concentrates + Napier)**
- **Cows fed in the same way as now (Napier + more concentrates)**

Or can combine models and farmers

Coastal Kenya

Tanzanian highlands

→ participatory modelling, and farmers choose options themselves

Options currently being tested and monitored by farmers in Vihiga

- ❖ High-quality manure ready for use

- ❖ Cattle urine pits made, and being used in Napier plots

- ❖ Tea and Napier plots established, kale nurseries thriving

Where is this work going?

- Monitoring of farmers' testing of options in Vihiga, Kiambu and Kilifi will continue until early 2005
- Up-scaling of results for the whole East African region (depending on resources)
- Attempt a quantitative assessment of the efficacy of prototyping as a method for systems characterisation and technology targetting
- Whole-farm datasets being collected from sites in Latin America, West Africa, East Africa, and Asia for various purposes
- So what's the lesson? All the stakeholders matter – smallholders heavily involved from the start

Four brief examples

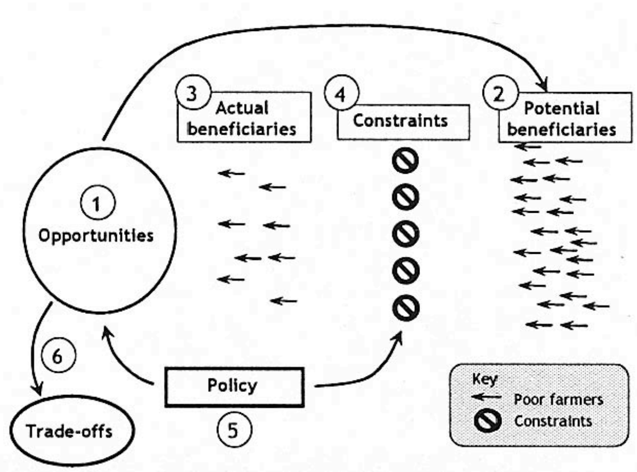
Example 4: A tool to screen policy alternatives for differential impacts on beneficiary groups, based on a very simple systems dynamics diagram, which may have some impact in due course

"EXTRAPOLATE (EX-ante Tool for RAnking POLicy AlTErnatives): A tool for assessing impacts of policy changes on the poor"

FAO-PPLPF, ILRI

Thorne, Thornton, Robinson, Dijkman

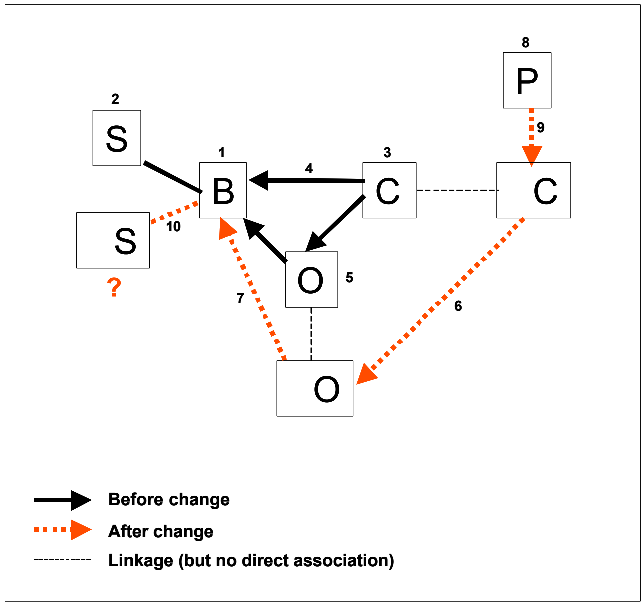
A model for pro-poor policy analysis

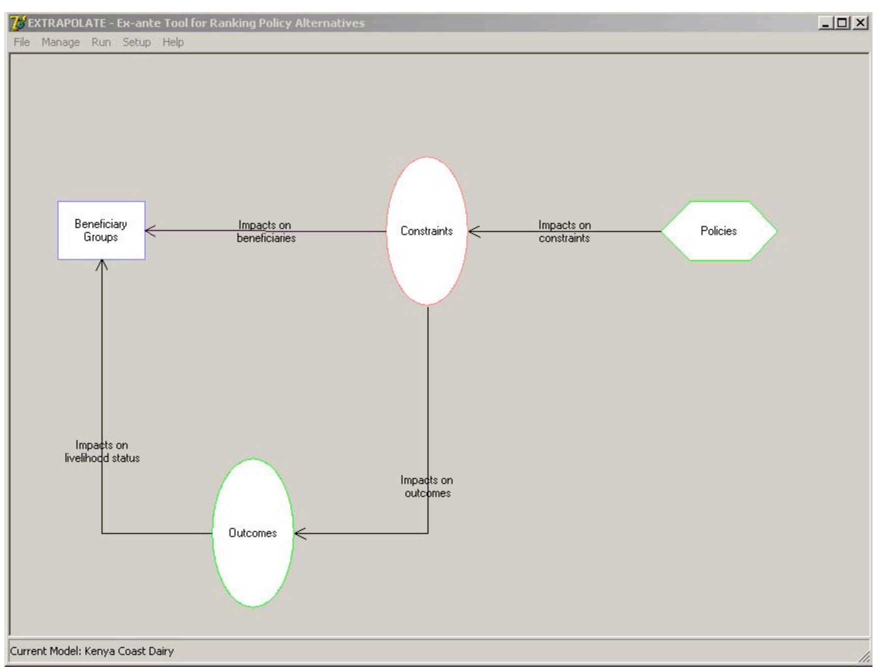


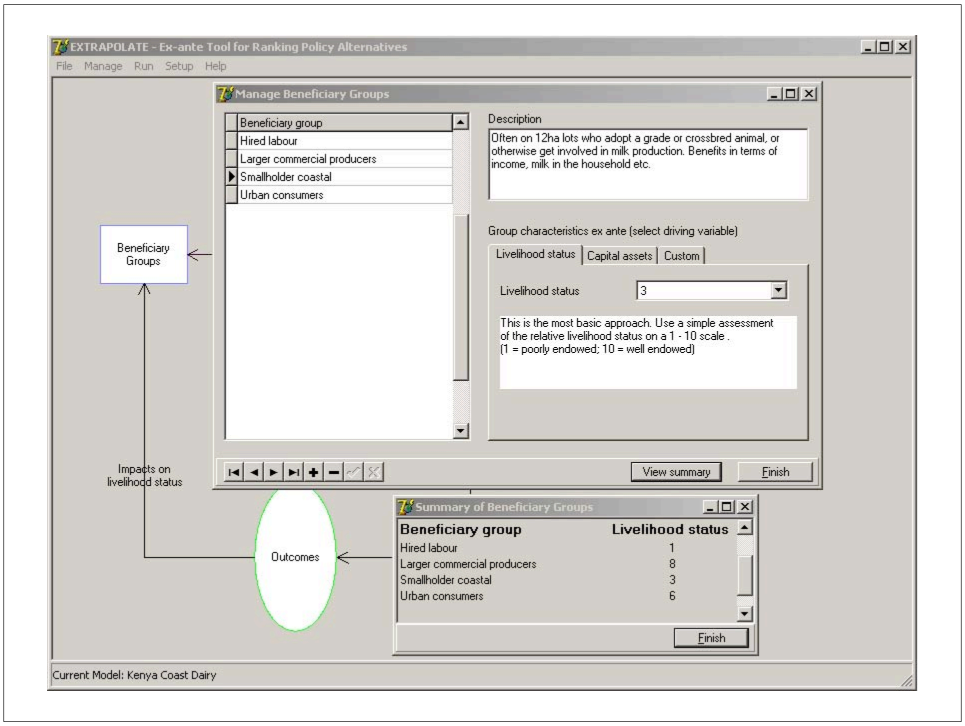
The framework of EXTRAPOLATE

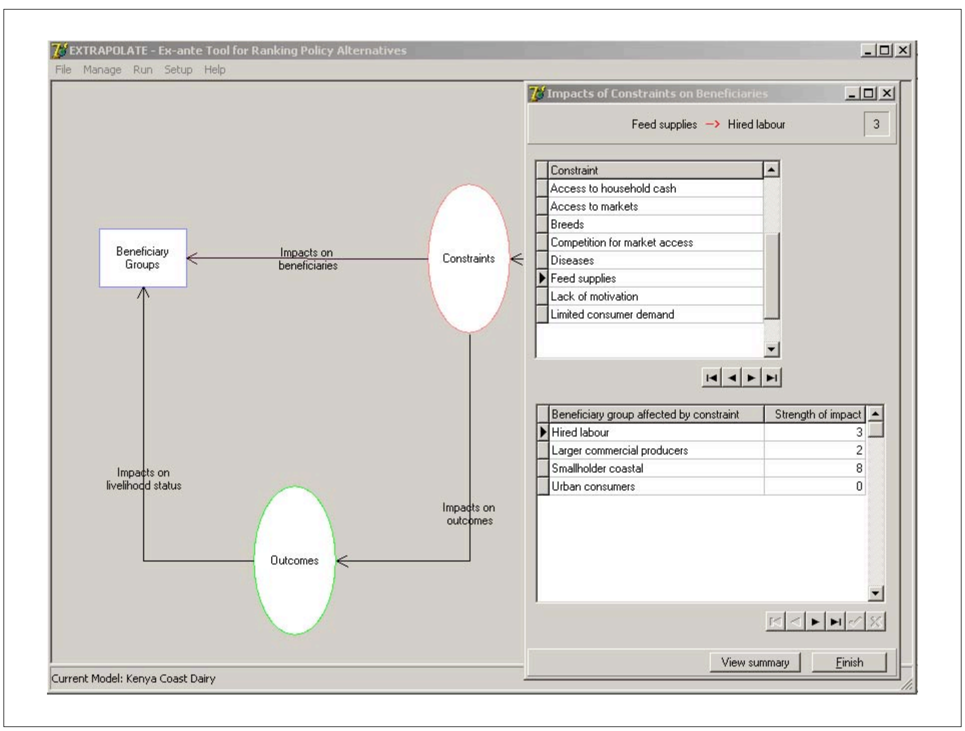
Beneficiaries (B) have a livelihood status (S), which depends on the constraints they face (C) and the outcomes that result (O).

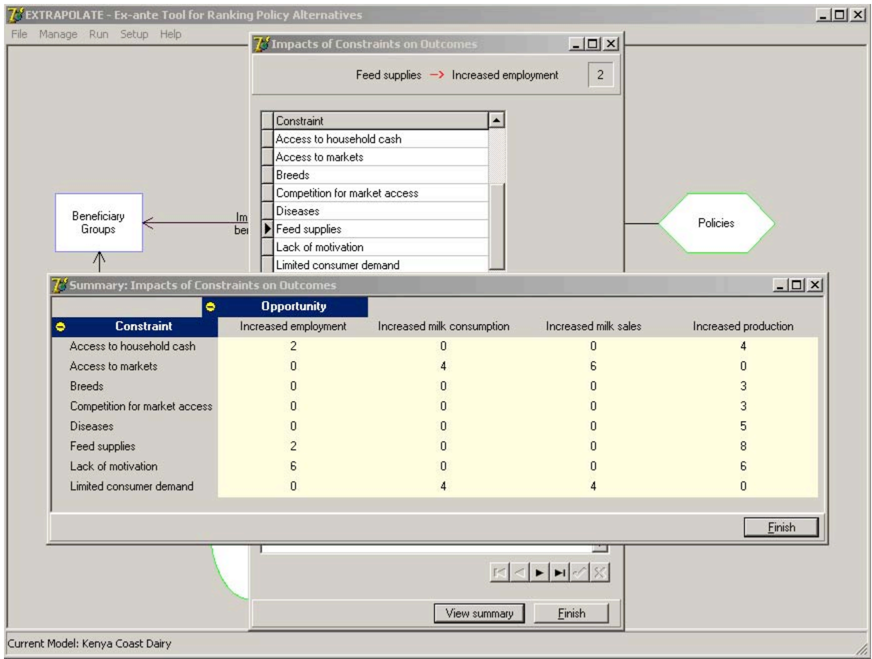
A policy change (P) modifies the one or more of the constraints (_C), which modifies the outcomes (_O), which has an impact on livelihood status (_S).

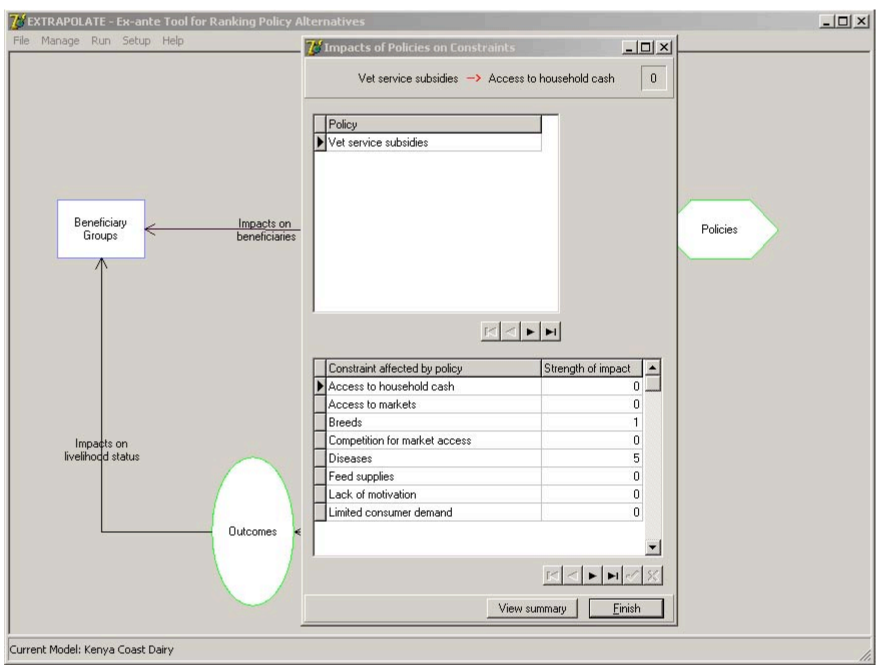


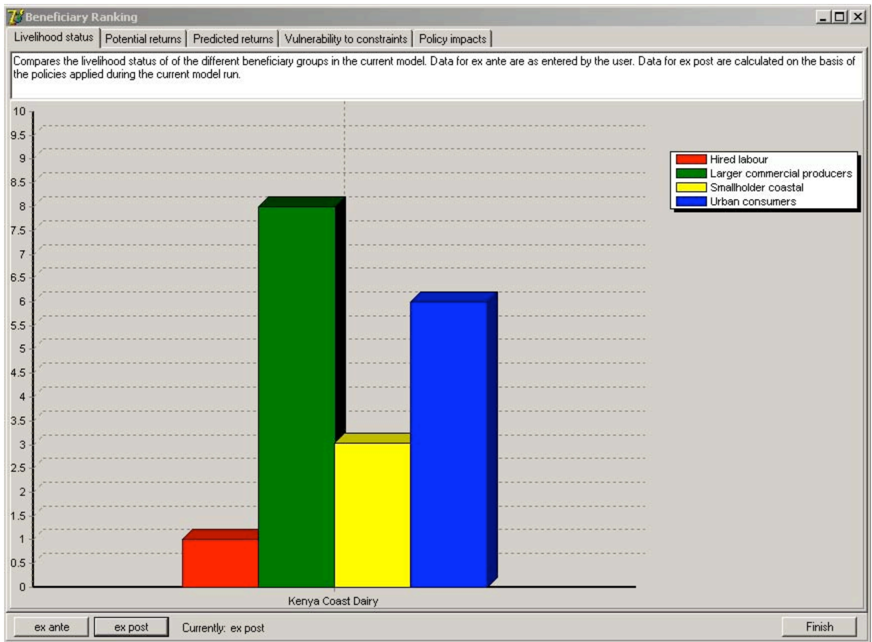



EXTRAPOLATE - Ex-ante Tool for Ranking Policy Alternatives
File Manage Run Setup Help
Manage Beneficiary Groups
Beneficiary group
Hired labour
Larger commercial producers
Smallholder coastal
Urban consumers
Description
Often on 12ha lots who adopt a grade or crossbred animal, or otherwise get involved in milk production. Benefits in terms of income, milk in the household etc.
Group characteristics ex ante (select driving variable)
Livelihood status
Capital assets
Custom
Livelihood status 3
This is the most basic approach. Use a simple assessment of the relative livelihood status on a 1 - 10 scale.
(1 = poorly endowed; 10 = well endowed)
View summary
Finish
Beneficiary Groups
Impacts on livelihood status
Outcomes
Summary of Beneficiary Groups
Beneficiary group Livelihood status
Hired labour 1
Larger commercial producers 8
Smallholder coastal 3
Urban consumers 6
Finish
Current Model: Kenya Coast Dairy

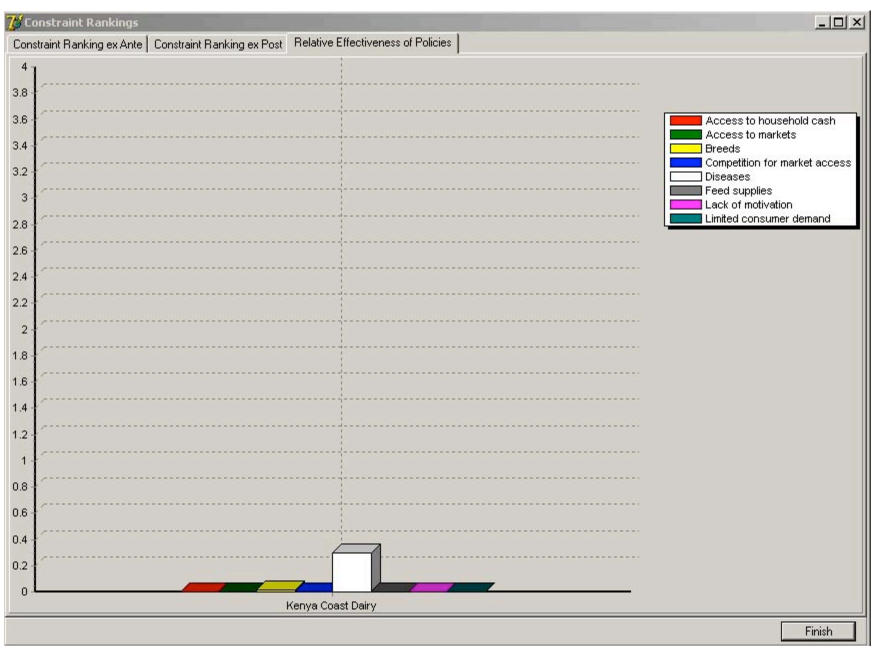

EXTRAPOLATE - Ex-ante Tool for Ranking Policy Alternatives
File Manage Run Setup Help
Impacts of Constraints on Beneficiaries
Feed supplies → Hired labour 3
Constraint
Access to household cash
Access to markets
Breeds
Competition for market access
Diseases
Feed supplies
Lack of motivation
Limited consumer demand
Beneficiary group affected by constraint Strength of impact
Hired labour 3
Larger commercial producers 2
Smallholder coastal 8
Urban consumers 0
View summary
Finish
Beneficiary Groups
Impacts on beneficiaries
Constraints
Impacts on livelihood status
Impacts on outcomes
Outcomes
Current Model: Kenya Coast Dairy


EXTRAPOLATE - Ex-ante Tool for Ranking Policy Alternatives
File Manage Run Setup Help
Impacts of Constraints on Outcomes
Feed supplies → Increased employment 2
Constraint
Access to household cash
Access to markets
Breeds
Competition for market access
Diseases
Feed supplies
Lack of motivation
Limited consumer demand
Beneficiary Groups
Policies
Summary: Impacts of Constraints on Outcomes
Opportunity
Constraint | Increased employment | Increased milk consumption | Increased milk sales | Increased production
Access to household cash | 2 | 0 | 0 | 4
Access to markets | 0 | 4 | 6 | 0
Breeds | 0 | 0 | 0 | 3
Competition for market access | 0 | 0 | 0 | 3
Diseases | 0 | 0 | 0 | 5
Feed supplies | 2 | 0 | 0 | 8
Lack of motivation | 6 | 0 | 0 | 6
Limited consumer demand | 0 | 4 | 4 | 0
Finish
View summary
Finish
Current Model: Kenya Coast Dairy


EXTRAPOLATE - Ex-ante Tool for Ranking Policy Alternatives
File Manage Run Setup Help
Impacts of Policies on Constraints
Vet service subsidies → Access to household cash 0
Policy
Vet service subsidies
Beneficiary Groups
Impacts on beneficiaries
Policies
Impacts on livelihood status
Outcomes
Constraint affected by policy | Strength of impact
Access to household cash | 0
Access to markets | 0
Breeds | 1
Competition for market access | 0
Diseases | 5
Feed supplies | 0
Lack of motivation | 0
Limited consumer demand | 0
View summary
Finish
Current Model: Kenya Coast Dairy



Beneficiary Ranking
Livelihood status
Potential returns
Predicted returns
Vulnerability to constraints
Policy impacts
Compares the livelihood status of of the different beneficiary groups in the current model. Data for ex ante are as entered by the user. Data for ex post are calculated on the basis of the policies applied during the current model run.
Hired labour
Larger commercial producers
Smallholder coastal
Urban consumers
Kenya Coast Dairy
ex ante
ex post
Currently: ex post
Finish



Constraint Rankings
Constraint Ranking ex Ante
Constraint Ranking ex Post
Relative Effectiveness of Policies
Access to household cash
Access to markets
Breeds
Competition for market access
Diseases
Feed supplies
Lack of motivation
Limited consumer demand
Kenya Coast Dairy
Finish

Where might EXTRAPOLATE go?

- Still highly experimental (being tested in Senegal, Kenya and Uganda as part of FAO Pro-Poor Livestock Policy Initiative)
- Developing an on-line library of policies (summary characteristics)
- Adding in spatial components (map beneficiaries, constraints, etc. as far as is possible)
- Will add in dynamics (multiple time periods), so constraints and outcomes/opportunities can change through time
- EXTRAPOLATE will only be useful if it is tested and found to be useful by people as a rapid screening tool

Presentation outline

- The supply side of dynamic simulation models
- The demand side
- How can supply be matched to demand?
- **What needs to be done in the future?**

What is the role of systems research and modelling within the agricultural development milieu?

- The problems of agriculture and the poor are systems problems
  - Household enterprises cannot be treated in isolation: well-being depends on more than the sum of the parts
- If we want research to target the poor, it is no good looking at aggregate responses over large areas with large numbers of people over long periods of time
  - *Local* and *short-term* impacts affect poverty and well-being (bio-physically, economically, socially, politically)

But this is not enough ...

If models (and research for development) are to be useful and effective, then stakeholders have to be intimately involved:

- Are the appropriate people being involved in research teams?
- Are all the key players involved, even if it becomes a political mire?
- Is end-user participation sufficient to enhance the probability of project success?

There are many biophysical issues still to be dealt with in modelling crop-livestock systems, such as ...

- Complex crop management practices
  - intercropping, leaf stripping, thinning, …
- Impacts of feed quality and intake on excreta quality
- Quality changes associated with manure storage
- Interactions between C/L systems and use of communal grazing resources
- Anti-nutritional compounds in feeds
- Role of scavenging animals in mixed systems

But the issues of participation, involvement, and understanding the dimensions of smallholders' problems are increasingly important ...

- Understanding the nature of household decision making, and what it takes to make it more effective
- Understanding the flow of information between actors
  - How can new or different knowledge help
  - How can researchers build on indigenous knowledge that has been accumulated over many years
- Promoting the concept of participation: now some good examples of modelling in participatory research, but much more needs to be done

May need a rethink of some apparently familiar modelling issues ...

- The location of the system boundary – what makes biophysical sense vs. information flows and spheres of influence
- The nature of the model itself – complexity of component processes vs. simply-represented key interactions
- The nature of validation – is it good science vs. does it do what seems to be needed?
- The data problem – the enormity, often, of assembling input data for complex models vs. getting model results even if based on “expert opinion”
- Interpretation of model output – complex messages with many provisos vs. quick messages in innovative formats

Modelling and research for development benefit greatly from constant monitoring and evaluation ...

... and balance