
# Negotiation-support toolkit for learning landscapes

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# 34 | Forest, agroforest, low-value landscape or wasteland (FALLOW)

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Forest, Agroforest, Low-value Landscape or Wasteland (FALLOW) is a spatially explicit model that simulates the consequence of agents' land management decisions on overall landscape dynamics. It is useful for exploring how the changes in the landscape have an impact on carbon sequestration, biodiversity and watershed functions. FALLOW is particularly suited to simulate rural or peri-urban landscapes where land-based activities (that is, agriculture, forest extraction) are still the main livelihood. FALLOW proceeds in annual time steps at watershed scale.

## Introduction

Growing populations and market-based development accelerate changes in parts of the developing world. In areas where new land is no longer available and accessible, intensification may lead to conflicts. Trade-off analysis of the impact of land-use changes on livelihoods and environmental services can help evaluate options for current land-use and future management. If scenario analysis is based on a credible landscape simulation model, we can assess various options and their consequences for livelihoods, carbon stocks and water flows, with various incentives and rules to enhance environmental service provisioning.

FALLOW can be used to explore the likely trajectories and impacts of development strategies. FALLOW simulates the dynamics of land-use and land-cover changes that are local responses to external drivers, with various feedback loops (Figure 34.1), and assess the consequences of the resulting land-use mosaics on economic utilities (welfare and food security) and environmental services (for example, carbon stocks).

### FALLOW PORTRAYS SEVERAL LOCAL RESPONSES.

- How farmers adjust their expectations about the economic utility of each available option on land-based and non-land-based investments through learning.
- How farmers allocate their capital (labour, money and land) to each available option of investment.
- How farmers perceive the attractiveness or otherwise of a plot to expand a particular land-use system, with regard to some spatial factors determining potential benefits (soil fertility, suitability and attainable yield) and potential costs (transportation, maintenance and land clearing).
- Succession, growth, fire and land conversion.
- Laws of diminishing and increasing marginal utilities on soil fertility and land-use productivity.

The main external drivers incorporated in the model include:

- market mechanisms and relevant regulation interventions, articulated through commodity prices, costs and harvesting labour productivities;
- development programs, articulated through extension, subsidies, infrastructure (settlements, road, market, processing factories) and land use productivities; and
- conservation programs, articulated through forest reserves as prohibited zones for farmers.

## Objectives

FALLOW can be used to project landscape dynamics and the consequence of changes on ecosystem services and people's livelihoods.

## Steps

1. Installation of FALLOW, PCRaster and NutShell programs to run the model.
    a. The FALLOW model can be obtained from http://worldagroforestrycentre.org/regions/southeast_asia/resources/fallow-forest-agroforest-low-value-landscape-or-wasteland.
    b. PCRaster is open source environmental modelling software developed by Utrecht University, The Netherlands, targeted at the development and deployment of spatio-temporal environmental models: http://pcraster.geo.uu.nl/downloads/.
    c. NutShell is a Windows shell for PCRaster that facilitates the running of PCRaster commands and edits and runs PCRaster models (scripts): http://nutshellqt.sourceforge.net/.
2. Preparation of data
    a. FALLOW input data are categorized into three types: 1) spatial data; 2) arrays; and 3) time series . The spatial data required by FALLOW are information on initial land cover, information to differentiate qualities, such as soil fertility, slope, distance to market, roads and rivers and, if they exist, a suitability map for each agricultural system/livelihood option. FALLOW also requires information on profitability, input (labour and cash) and output (yield) for each livelihood option, which can be based on a farm survey. Landscape-level information, such as size of population, percentage of labour force and income per capita, are initial information required to run the model.
3. Development of scenarios
4. Run the model

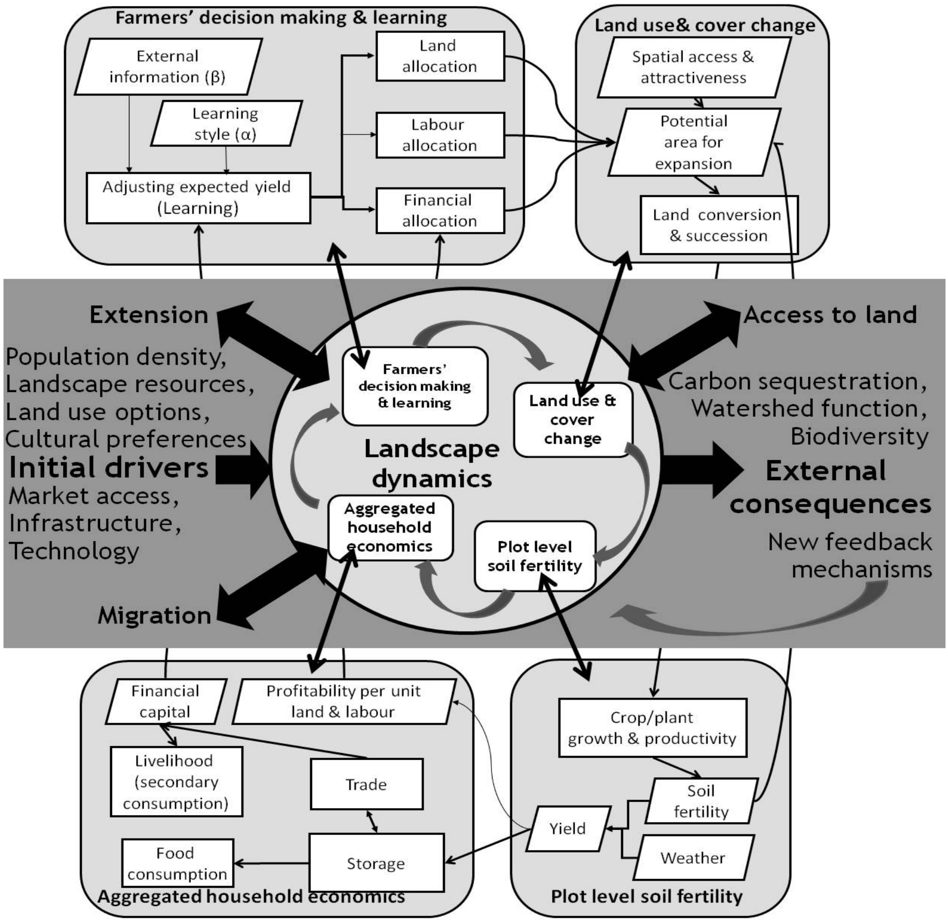


**Figure 34.1.** The four core modules of FALLOW that simulate dynamic changes in land-use and land-cover due to local responses to external drivers, with various feedback loops

## Case study: FALLOW in Upper Konto catchment

FALLOW model was used to explore the effect of land zoning on farmers' livelihoods and aboveground carbon sequestration in the Upper Konto catchment, East Java, Indonesia. The watershed presents a landscape of mixed agroforests and rice fields with forest remnants, which is typically found in Southeast Asia, where horticulture in a peri-urban setting lead to rapid land-use change and forest conversion. Conflicts over access to land have occurred in the past as two-thirds of the land was allocated as forests for production and conservation purposes. Thus, farmers could access only a third of the watershed for settlement and agricultural activities. We explored 1) the impacts of changes to the forest zone policy; 2) the potential of further integration of fodder production in forest areas; and 3) the impact of open access to all land on farmers' welfare and aboveground carbon sequestration in the entire landscape. We developed five scenarios representing the current situation ('business as usual' or BAU) and four hypothetical questions related to changes in land zoning, including access to harvest fodder (Table 34.1).

The FALLOW simulation was run for a 20-year period. We evaluated how the model performed in simulating the BAU scenarios. The spatial validation showed good results and we are confident the model can be used to explore scenarios (not depicted here, refer to Lusiana et al 2012). The model projected that under the current policy, forest cover will be maintained with intensive agriculture (horticulture) dominating the agricultural system. However, in terms of contribution to income, dairy cattle was the highest contributor, followed by agriculture and agroforestry.

**Table 34.1.** Scenarios (business-as-usual and prospective) of landscape dynamics in the Upper Konto catchment developed for FALLOW

| Scenarios | |
|---|---|
| I | Business as usual |
| II | Agroforestry access to plantation forest |
| III | No fodder harvesting allowed in plantation forest |
| IV | No planting of monoculture Napier grass |
| V | Open access to land |

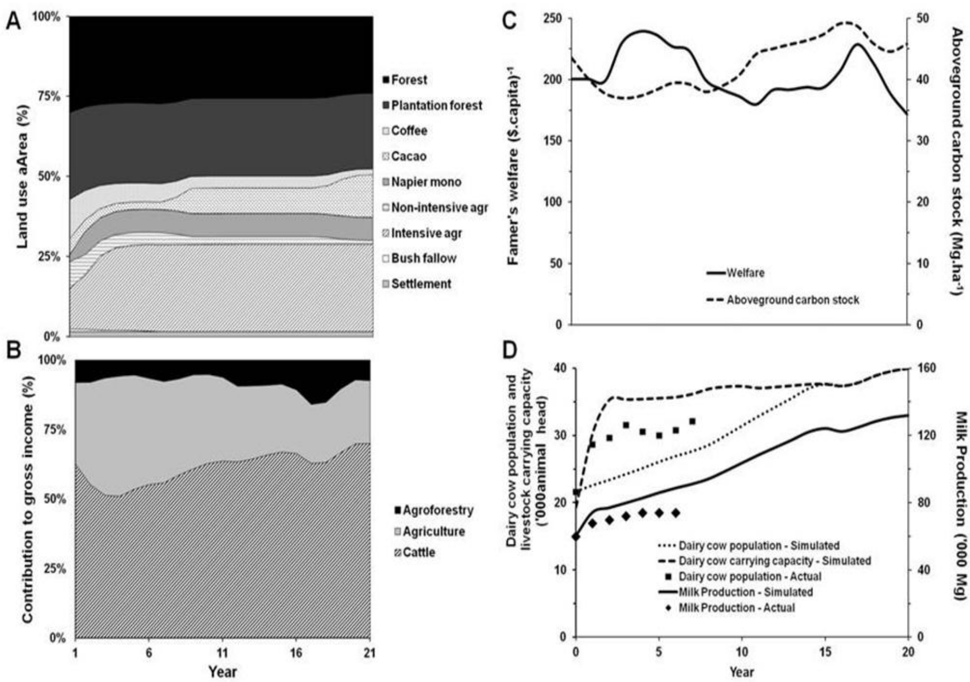


**Figure 34.2.** Business-as-usual scenario from FALLOW for the Upper Konto catchment

**Note:** (A) landscape dynamics (% area); (B) contribution of main livelihood options on catchment gross income (%)

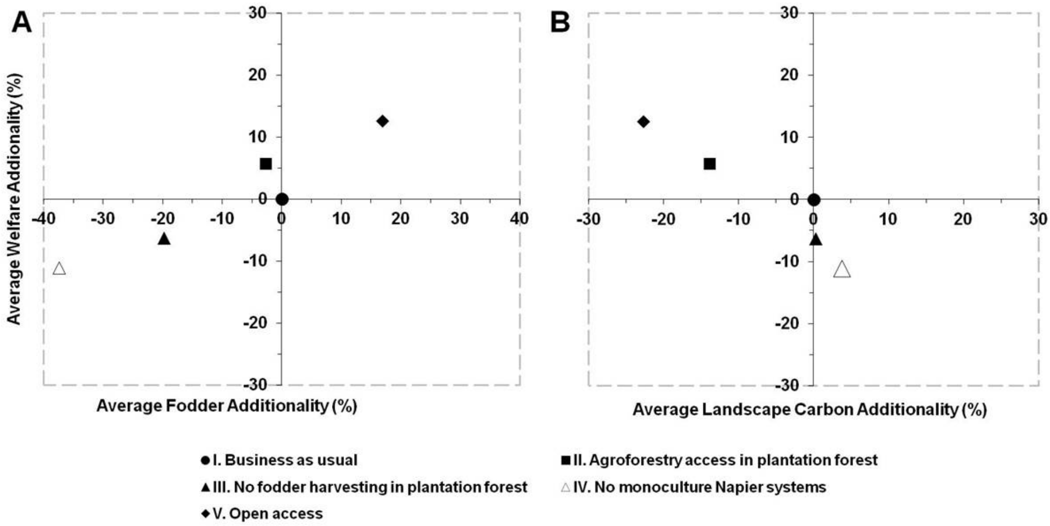


**Figure 34.3.** Trade-offs

**Note:** A) average fodder additionality versus landscape aboveground carbon stocks; and B) farmers' welfare versus landscape aboveground carbon stocks relative to business as usual. Results of prospective scenarios (I–V) of the FALLOW model averaged over 20 years

Comparing the four scenarios (II – V) with BAU (I) showed that welfare/income are positively correlated with availability of fodder. Increases in welfare were projected to be obtained through the open-access scenario (Figure 34.3A). However, the model suggested that the current policy appeared to be the best for balancing livelihoods and environmental objectives (Figure 34.3B). Although open access would increase welfare by around 33%, carbon stocks would be decline in the landscape by 23%.

## Key references

Lusiana B, van Noordwijk M, Cadisch G. 2012. Land sparing or sharing? Exploring livestock fodder options in combination with land-use zoning and consequences for livelihoods and net carbon stocks using the FALLOW model. *Agriculture, Ecosystems and Environment* 159:145–160.

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The landscape scale is a meeting point for bottom–up local initiatives to secure and improve livelihoods from agriculture, agroforestry and forest management, and top–down concerns and incentives related to planetary boundaries to human resource use.

Sustainable development goals require a substantial change of direction from the past when economic growth was usually accompanied by environmental degradation, with the increase of atmospheric greenhouse gasses as a symptom, but also as an issue that needs to be managed as such.

In landscapes around the world, active learning takes place with experiments that involve changes in technology, farming systems, value chains, livelihoods' strategies and institutions. An overarching hypothesis that is being tested is:

> Investment in institutionalising rewards for the environmental services that are provided by multifunctional landscapes with trees is a cost-effective and fair way to reduce vulnerability of rural livelihoods to climate change and to avoid larger costs of specific 'adaptation' while enhancing carbon stocks in the landscape.

Such changes can't come overnight. A complex process of negotiations among stakeholders is usually needed. The divergence of knowledge and claims to knowledge is a major hurdle in the negotiation process.

The collection of tools—methods, approaches and computer models—presented here was shaped by over a decade of involvement in supporting such negotiations in landscapes where a lot is at stake. The tools are meant to support further learning and effectively sharing experience towards smarter landscape management.


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