Shortened bush-fallow rotations and sustainable rural livelihood

Summary
In Ghana, increased population pressure and the need to cultivate greater land area have resulted in reduced fallow periods. As a consequence, the restoration of soil fertility is insufficient to allow recovery of secondary forest and rejuvenation of exhausted soils. Fallows are of ecological, economic and social importance to rural people and to the nation at large.

A majority of farmers depend on fallowing, using little or no fertilisers to improve impoverished soils. This implies that farm production (and income) will consistently decline over the years. Several promising technologies have been developed in the last decade to address these issues. On-farm trials have demonstrated the value of maize-legume relays, permanent plantain, cocoa-shade trees, planted tree fallow, and yam-legume relays in improving yields and restoring soil fertility.

Description
Bush fallowing (or slash and burn agriculture) is the practice of clearing small plots of land to cultivate for a few years (generally two to five) and then leaving the land under natural vegetation for much longer periods, usually greater than five years to restore soil fertility (but in traditional systems over one human generation 25 to 30 years). It still remains the most common agricultural land-use practice in Ghana and much of West and Central Africa. Nutrients are returned to the topsoil during the bush fallow period as a result of the accumulation of vegetative matter. Trees and shrubs are deeper rooting than grasses, hence they access nutrients from lower levels, so that restoration of fertility is much more rapid under forest fallow than grass fallow.

The biological efficiency of this practice depends on the duration of the fallowing phase, and the structure, composition, biomass and functioning (especially mineral nutrient cycling) of the fallow vegetation. Traditional fallow systems are ecologically sound. Some authors consider the practice a rational farming system that reflects indigenous knowledge accumulated through centuries of trial and error, with an intricate balance between product harvested and ecological resilience and an impressive degree of agrobiodiversity. However, falls takes several years to restore soil fertility while natural vegetation becomes established and reaches a peak of biological productivity, ecosystem functioning and nutrient cycling. Due
to a need to cultivate greater land area to produce more food, the long fallow periods have shrunk to a few years and the restoration of soil fertility is insufficient to allow recovery of secondary forest and rejuvenation of exhausted soils. The principal reason commonly attributed to this change is increasing population and its attendant decline in land available for shifting cultivation. Consequently, fallow periods are shortening while cropping periods lengthen, leading to rapid degradation of the environment. More generally, the practice is no longer sustainable as crop yields are declining while labour required to control weeds is increasing and overall household food security and rural livelihoods are being threatened. Weed infestation is one of the main reasons, if not the major reason, along with soil fertility decline for smallholder farmers to abandon cropped land.

1. Bush-fallow rotations

In long fallow lands, there is a rapid growth of the early ligneous seed stock, which overtakes that of grasses. By contrast, the cropping system with fallowing of less than six years (a “shortening” fallowing system) was rapidly dominated by herbaceous weed species of various groups. Meanwhile, in short-cycle fallow (that is, systems with many cycles of one to five years of fallow per cultivation) the weed community appeared to be constituted mostly of grasses, along with *Chromolaena odorata*. This plant is called Siam Weed, a perennial shrub native of South and Central America, and is a serious pest in the humid tropics of South East Asia, Africa and Pacific Islands. For further information on this weed species see below under e-Resources. Shortening fallows eliminate many stages of natural vegetation succession, which would normally result in secondary forest species, resulting in their replacement by weedy herbaceous species which are thereafter present in the soil seed bank in greater quantities, resulting in greater weediness of subsequent cropping cycles. A farmer tends to abandon a stand when he or she finds it easier to obtain subsistence production by clearing and cropping a new stand than weeding the existing one.

Fallow play a crucial role in sustaining rural livelihoods. The fallow vegetation serves a number of purposes, the least of which may be restoration of soil fertility from the farmer’s perspective, including being a source of wood (timber, poles, fuelwood, craft/carvings) and non-wood (food, medicines, fodder, thatch) products and protecting soil from climatic agents like rain, wind and solar radiation. The longer the fallow the more productive it is likely to be as a source of these products and services. Thus, fallows provide a means for rural people to generate natural resource-based incomes. Shortening fallows result in scarcity in wood and non-wood fallow products, and thus the loss of opportunity of supplementing farm income with these products. The social benefits of fallows for food and medicine, as well as biodiversity and other environmental benefits, also decline. Consequently, fallows are generally of ecological, economic and social importance to rural people and to the nation at large. However, most farmers depend mainly on fallowing, using little or no fertilisers, either organic or inorganic (expensive or not easy to come by) to improve impoverished soils. This implies farm production and income will consistently decline over the years. Nonetheless, several promising technologies have been developed in the last decade to address these issues, using participatory methods. On-farm trials...
of these interventions/technologies were established in study villages, including maize-legume relays, permanent plantain, cocoa-shade trees, permanent plantain and planted tree fallow and yam-legume relays.

2. Outcomes
A number of interventions for the improvement of bush fallows were developed and tested. These included maize-legume relays, permanent plantain, cocoa-shade trees, planted tree fallow, and yam legume relay.

The effects on maize yield showed an increase of up to 40 percent over the control for maize-legume relays with maize grain yields in control plots of between 2 to 3 tonne per ha. However, the farmers’ evaluation indicated that positive effects on weed suppression and moisture conservation as a result of legume cover had been realised and were equally, if not more important, outcomes. Farmers were hopeful of an increase in the yield of a succeeding maize crop in the coming season as they anticipated decomposition of the legume biomass and conserved moisture would improve soil fertility. They also anticipated a reduction in the labour for clearing the legume fallow as compared to the Panicum, Cenchrus and Rottboellia grass and/or Chromolaena fallow on the control plot. Preliminary estimates indicated this to be the case.

The permanent plantain, cocoa-shade tree and planted tree fallow experiments were not expected to yield results until the following season, although farmers anticipated positive results judging from the good growth and establishment of the plants. Farmers gave as much importance on the positive effects in reducing labour requirements and provision of food from dual-purpose legumes, as they did on their aggregate concept of soil fertility, comprising strength, crop yield, moisture-holding capacity (where a fertile soil is regarded as one that is moist, not water logged), and on which the standing crop has dark green leaves and is likely to give a good yield.

3. Lexsys and Leginc
Lexsys is a tool that assists with the selection of legumes for incorporation into tropical cropping systems. The first version of Lexsys was released in 1993 - 1994 and has been subjected to several iterations to develop further versions (See section 7: Further reading).

A related support tool, Leginc provides information for integrating legumes into cropping patterns based on data from Ghana. The tool asks a series of questions for the user to respond to. A list of legume species with potential for the required purposes is then produced and revised according to the responses given. A suitable way (or ways) of integrating one of these legumes into cropping patterns is also suggested. An information sheet is produced as an example of how one of these legumes has been integrated into a cropping pattern in Ghana, where pictures of the legumes and their seeds are available.

3.1 Other Leginc information sheets
- Green manure e.g. Mucuna for vegetables.
- Long duration legume e.g. long duration Mucuna, to mulch a vegetable crop.
- Long duration legume for weed suppression on plantations e.g. Pueraria phaseoloides.
- Long planted fallow e.g. Sesbania or Gliricidia.
- Maize followed by a green manure e.g. Mucuna, for dry season vegetables.
• Major season fallow e.g. short duration Mucuna, followed by minor season maize.
• Major season maize followed by a minor season fallow e.g. short duration Mucuna.
• Major season maize followed by a minor season fallow e.g. short duration Mucuna, followed by dry season vegetables.
• Major season maize relayed with a fast-growing cover crop e.g. long duration Mucuna, followed by dry season vegetables.
• Major season maize relayed with fast growing cover crop e.g. long duration Mucuna.
• Major season maize simultaneous or relay planted with a slow growing cover crop e.g. Canavalia ensiformis, followed by dry season vegetables.
• Major season maize simultaneous or relay planted with slow growing cover crop e.g. Canavalia ensiformis.
• Plantain and maize relayed with slow growing cover crop e.g. Canavalia ensiformis.
• Plantain intercropped with a creeping legume e.g. Canavalia ensiformis for weed suppression.
• Plantain intercropped with an erect legume e.g. Flemingia macrophylla for mulch.
• Short duration legume e.g. short duration Mucuna, to mulch a vegetable crop.
• Short duration major season legume e.g. short duration Mucuna to mulch a vegetable crop Short planted fallow e.g. Mucuna or Pueraria.

Enquiries for Lexsys and Leginc can be sent by email to lexsys@bangor.ac.uk or leginc@bangor.ac.uk, whilst copies of these systems are also available through these addresses. An alternative mail address is:
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4. Health and safety
The researchers, their institutions or this website cannot be held responsible for any damage resulting from the use of the materials or methods described here. The application or use of treatments, processes and technologies is the sole responsibility of the user.

5. DFID disclaimer
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International Ltd or Tina Rowland, Random X Solutions Ltd.

7. Further reading

7.1 e-Resources
• Chromolaena odorata, Biocontrol in the Tropics: URL.
• Contact details for DFID research project teams

8. Agro-ecological zones
• Tropics, warm

9. Objectives fulfilled by the project
9.1 Resource use efficiency
The use of technology allows for improved soil fertility, increase in farm production and income.