Farmer Management of Fallow Vegetation in S.E. Asia: Options and Implications to Soil Fertility †

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EXTENDED ABSTRACT

INTRODUCTION:

Biological management of soil fertility by swidden cultivators is probably as old as agriculture itself. Despite the impressive heterogeneity of farmer practices, a unifying aspect that defines swiddening is the use of a fallow phase to rejuvenate soil properties through natural processes. Contemporary pressures for land use intensification, however, have stimulated farmers to innovate a wide spectrum of strategies to manage fallow land more productively, collectively referred to in this paper as ***'Indigenous Fallow Management'*** (IFM). Although there are definitional questions as to what actually constitutes a 'fallow', these are secondary to the more salient issue of identifying biophysically workable and socio-culturally acceptable solutions that enable farmers to stabilize highly stressed swidden systems, improve their productivity, and thereby increase the human carrying capacity of S.E. Asia's uplands. Lengthy fallows that assured regeneration of secondary forest and adequate rehabilitation of soil properties have generally been relegated to a luxury of the past.

As farmers increasingly seek pathways to 'short-circuit' the conventional swidden cycle by enhancing the biological and/or economic productivity of the fallow period, careful management of soil fertility becomes critical to the long term sustainability of these modified systems. This paper outlines a framework for categorizing IFM typologies practiced in the region and suggests key researchable issues relating to soil fertility. It attempts to create a bridge between farmer practices in fallow management - and the research activities of biophysical scientists posed to play a critical role in: validating these indigenous technologies; elucidating their underlying processes; identifying technical refinements; and defining the extrapolation domain for extension of the most promising technologies to similar upland areas where declining swidden systems are endemic.

METHODS AND MATERIALS:

ICRAF recently took the lead in organizing a regional workshop on '*Indigenous Strategies for Intensification of Shifting Cultivation in S.E. Asia*'. Near seventy papers and posters were presented in what was probably the first systematic examination of the entire spectrum of shifting cultivators' responses to pressures to manage fallow land in more productive ways. Since serious research attention to IFM is relatively new, most of the papers were descriptive and characterized fallow management systems without the benefit of solid quantitative data on how the technologies actually work and the benefits offered. This initial diagnostic work did serve to identify a new generation of more focussed research issues aimed at understanding the 'what', 'where' and 'how' of these systems, and then developing a protocol of management recommendations to inform farmer decision-making. This paper draws from those case studies and the author's own field research.

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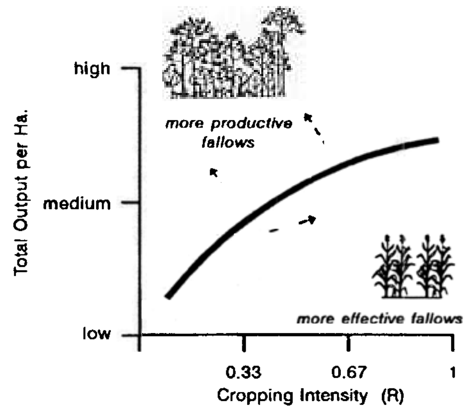
RESULTS AND DISCUSSION:

Indigenous strategies to manage fallow land may generally be classified as innovations to achieve (see Fig. 1):

Figure 1
Evolution of Intensifying Swidden Systems



- more '***effective***' fallows - where the biological efficiency of fallow functions is improved, and the same or greater benefits can be achieved in a shorter time frame;

- more '***productive***' fallows - in which fallow lengths stay the same or actually lengthen as the farmer adds value to the fallow by introducing perennial economic species; and

- combinations of the two trends, where a degree of both biophysical and economic benefits may be accrued.

The implications to land use of these two major pathways towards swidden intensification are obviously profound. More effective or accelerated fallows often provide an intermediate step in a transition to permanent cultivation of annual crops. Alternatively, in more productive fallows, the phase of reopening and cultivation of annuals may eventually be foregone altogether as the farmer chooses to protect perennial vegetation, allowing it to develop into semi - or permanent agroforests. Both raise important questions related to soil fertility.

Figure 2 proposes a working draft of distinguishable typologies of IFM; they are conceived as a continuum without rigid boundaries - but that gradually meld from one modality to the next. Conventional definitions of swiddening would exclude both the '*Agroforests*' and '*Seasonal Fallows*' poles of this spectrum, considering them as alternative land uses that have evolved from swidden modifications. They are included here under the rubric of 'managed fallows' to more holistically portray the full progression of swidden intensification. Each has its evolutionary origins in swidden cultivation and basic elements of cyclical fallowing and periodic reopening for annual cropping continue to be recognizable.

Although the notion of IFM invokes broader research questions that cut across these categories, each fallow management typology presents unique soil fertility issues that could usefully be investigated by the BMSF Network (see Table 1). Despite the current paucity of quantitative data, farmer testimonies hint strongly that IFM technologies can contribute solutions to swidden degradation problems and need to be more clearly understood. Compelling examples range from the centuries old *Alnus nepalensis*-based fallows in N.E. India that have enabled Naga farmers to intensify their swidden cycle to 2 years cropping : 2 years fallow (a 1:1 ratio) while reportedly maintaining crop yields ... to swiddenists' more recent experimentation with *Chromolaena odorata* and other invasive *Asteraceae* as spontaneous green manure crops. While there has been little published on the agronomic properties of *Tithonia diversifolia*, its wide use by farmers as a green manure/compost across Asia, Africa and Central America strongly suggests that the scientific community needs to learn more about what farmers already know.

An IFM Network has been formed to build on the momentum of the recent workshop and provide the framework for a collaborative regional focus on farmer-derived technologies that permit more productive use of fallow land. From the institutions participating in the workshop, a core group of five were invited to collaborate in a set of linked, parallel research projects aimed at better understanding IFM strategies, validating their performance, identifying technological refinements, and elucidating under what conditions they are an appropriate response to swidden intensification pressures. These institutions are based in northern Vietnam, northern Laos, southwest China, northeast India, and the northern Philippines - encompassing the major areas in the region where collapsing swidden systems are endemic. Their research will draw from the spectrum of IFM strategies identified in the region and select a basket of priority systems for more careful study. These key systems will be chosen: 1) to be representative of the wider range of managed fallow systems used by S.E. Asian farmers; 2) as systems that appear to potentially be winners in permitting swidden intensification within a wider extrapolation domain; and 3) have already received some preliminary research attention from NARS or other local researchers. This is a very timely and exciting field of overlapping interest between the IFM and BMSF Networks and should provide rewarding opportunities for collaborative work.

Fig. 2. Spectrum of Indigenous Approaches to Modify 'Fallow' Vegetation in S.E. Asia

POLYCULTURES
GOAL: Harvest of tree products.

CONTINUUM

MONOCULTURES
GOAL: Rehabilitate soil properties after cropping period.

AGROFORESTS

LATEX-BASED:
- *Havea brasiliensis* - widespread

RESIN-BASED:
- *Shorea javanica* - Krui, Sumatra, Ind.
- *Toxicodendrom vernicifera* /
- *Pinus yunnanensis* - west Yunnan, China
- *Styrax tonkinensis* /
- *S. benzoides* - northern Laos
- *Styrax benzoin* /
- *S. paralleloneurus* - North Sumatra

FRUIT/NUT-BASED:
- *Durio zibethinus* - Kalimantan, Ind.
- coconut palm - Menado, Sulawesi, Ind.
- commercial fruit orchards - widespread

OTHERS:
- *Amomum compactum* - northern Laos
- *Amomum subulatum* - Himilayan foothills
- *Piper nigrum* (pepper) - widespread in Ind.
- *Camellia sinensis* - S. China / N. Thailand
- *Coffea spp.* - widespread
- *Zanthoxylum limonella* - northern Thailand
- *Borassus sundaicus* - Roti & Savu Islands, Ind.

MIXED SYSTEMS:
- Kenyah / Iban fallow enrichment - Kalimantan, Ind.
- Ifugao woodlots - Ifugao, Phil.

PERENNIAL-ANNUAL CROP ROTATIONS
(cyclical taungya system)

TIMBER-BASED:
- *Cunninghamia lanceolata* - southern China
- *Paraserianthes falcataria* - Mindanao, Phil.
- *Melia sp.* - N.W. Vietnam
- *Tectona grandis* - Laos - N.E. India
- *Gmelina arborea* - widespread
- *Eucalyptus spp.* - widespread
- *Pinus wallichiana* - Bhutan
- *Santalum sp.* - central Laos
- cedar - Kwangtung, China
- *Alnus nepalensis* - S./S.W. Yunnan, China

NON-TIMBER:
- *Cinnamomum burmanii* - Sumatra, Ind.
- *Aquilaria sp.* - central Laos
- *Broussonetia papyrifera* - northern Laos
- *Giganthochloa levis* - Mindoro, Phil.
- other bamboo spp. - Timor, Ind. - southern China - northern Vietnam
- *Calamus caesius* - Kalimantan, Ind.
- *Calamus sp.* /
- *Plectocomia himalayana* - southern China
- 'Talun kebun' (mixed) - West Java, Ind.

INTERSTITIAL TREE-BASED IMPROVED FALLOW

SIMULTANEOUS:
- *Alnus nepalensis* - Nagaland, India - S./S.W. China
- *Leucaena glauca* / *Gliricidia sepium* - Naalad, Cebu, Phil.
- *Leucaena leucocephala* - Amarasi, Timor, Ind - Sikka, NTT, Ind. - South Sulawesi, Ind. - Mindoro, Phil.
- *Sesbania grandiflora* / *Leucaena leucocephala* - Sumba/Flores/Timor, Ind.
- *Erythrina sp.* / *Desmodium sp.* / *Hybiscus sp.* - Flores, Ind.
- *Albizzia chinensis* - Sumba, Ind.
- *Acacia villosa* - Timor, Ind.
- *Ficus spp.* (fodder) - eastern Bhutan
- *Pinus kesiya* - northern India

SUCCESSIVE:
- *Tephrosia purpurea* - north Vietnam
- *Sesbania spp.* - Isabela/Cagayan, Phil. - Yap, S. Pacific
- *Alnus nepalensis* - southwest China
- *Casuarina oligodan* - New Guinea
- *Alnus japonica* - N. Luzon, Phil.
- *Parasponia rugosa* /
- *Schleinitzia novo-guineensis* - Papua New Guinea
- *Hibiscus tiliaceous* - Yap, S. Pacific

RETENTION / PROMOTION OF PREFERRED VOLUNTEER SPP.

ECONOMIC UTILITY:

Food
- bamboo shoots
- native vegetables & other wild food plants

Fiber
- construction materials, e.g., planting *Corypha ulan* Lan. & other palm spp. before abandoning swidden to provide roofing materials for field hut construction in next cropping phase
- harvest of poles useful for house or hut construction
- *Imperata cylindrica* & other spp. of thatch-grass for roof construction

Fodder
- *Imperata cylindrica* & other native forages
- **Fuel**
- **Medicinal Herbs**

Stimulants
- *Nicotiana tabacum* (tobacco)
- *Piper beetle* (beetle leaf)
- + spp. providing shade, pleasant smells, nectar for honey production, attracting wildlife for hunting, etc.
  - all widespread in subsistence swidden communities

ECOLOGICAL FUNCTIONS:
- - selective felling to retain 'mother trees' & accelerate recovery of secondary forest
- - protect existing coppices: limit cropping period, fire management & avoid tillage

SHRUB-BASED ACCELERATED FALLOW

NON-N FIXING:

Compositae spp.
(N-accumulating?)
- *Austroeupatorium inulifolium* - West Sumatra, Ind.
- *Tithonia diversifolia* - Mindanao, Phil.
- *Chromolaena odorata* - Luang Prabang, Laos - Nusa Tenggara, Ind. - Kalimantan, Ind. - Yunnan, China - northern Thailand - widespread below 1000 m asl

Other
- *Mallotus barbatus* - northern Thailand
- *Ricinus communis* - Timor, Ind.
- *Tecoma stans* - Timor, Ind.

N-FIXING:
- *Mimosa invisa* - Leyte, Phil. (spiny) - northern Thailand (spineless)
- *Cajanus cajan* - Mindoro, Phil.

VINY LEGUMES AS SEASONAL FALLOWS

LEGUME ROTATIONS:
- *Phaseolus calcaratus* - northern Vietnam - northern Thailand
- *Amphicarpaea linearis* - Hainan Island, China
- *Flemingia vestita* - N.E. India
- *Dolichos lablab*
- *Vigna sinensis* - northern Thailand
- *Calopogonium mucunoides* - Leyte, Phil.
- *Pachyrhizos tuberosis* - northern Vietnam

- increasing integration of legume components into cropping sequence + ruminant livestock

Table 1. Researchable Issues Relating to Soil Fertility and Conservation in Managed Fallows

IFM Category	Key Questions that BMSF Research Can Address
Cross-Cutting	•Measure and compare with control plots (nonadoption), the efficiency of the IFM practice in performing the ecological functions associated with fallowing, e.g., weed suppression, soil rejuvenation, disruption of pest & disease cycles, erosion prevention, etc. •Need to model nutrient flows within IFM systems as an indication of their long term sustainability; •Many of these managed fallows are almost monospecific; what are the implications of this in view of the widely held wisdom that biodiversity equals stability? •At what scale can monospecific fallows be diffused without creating the conditions for economic / ecological collapse? •A popular notion suggests that incorporation of indigenous flora in managed fallows will ensure a more robust and sustainable system, and conversely, exotic spp. will be more vulnerable to ecological collapse; how much empirical evidence is there to support this belief? •Potential to use IFM as biological intervention to eradicate *Imperata* and other troublesome weeds from fallow land. •Potential for incremental modification of fallow vegetation into contour hedgerows to provide soil conservation benefits.
Herbaceous Legumes as Seasonal Fallows	•Why is the *Mucuna revolution* unfolding in West Africa and Latin America not being repeated in the S.E. Asian context? •Prospects for integration of viny legumes (as cover crops, green manures or improved short-term fallows) into varied upland farming systems with aims to conserve, rehabilitate and improve soil fertility on sloping agricultural land. •Identification of most suitable soils (i.e., excessive fertility seemingly results in luxurious vegetative bean growth - but no flowering/fruiting)
Shrub-Based Accelerated Fallows	•The indicator vs. improver debate: Do *Chromolaena odorata* and other *Asteraceae* actually improve soil properties (improver), or simply establish in the most fertile soil (indicator)? •If *Asteraceae spp*. are efficient 'nutrient sponges', can short term fallows based on these shrubs be sustainable - or are we simply enabling more efficient 'mining' of the soil? •Is slash-and-mulch a viable option to slash-and-burn - that might offer superior soil protection and OM accumulation, and reduced nutrient loss due to volatization / runoff / leaching? •Need a more complete understanding of the ecology of fallow succession in order to understand how farmers can intervene to ensure that *Asteraceae* shrubs dominate and displace hard-to-control weeds commonly associated with soil degradation. •Potential to 'prime' the fallow system with judicious applications of inorganic fertilizers; •Verification of reported nematicidal / allelopathic properties; P accumulation by *Tithonia diversifolia*.
Interstitial Tree-Based	•Identification of N-fixing spp. able to persist and regenerate under conditions of cyclical cutting & burning. •Management protocol for pollarding (age, season, height, species), burning practices (to maximize stump survival), and management of coppices on interstitial tree stumps (pruning) during phase of annual cropping to reduce labor costs & competitive effects with adjacent crops - but maximize benefits both above ground (accelerated canopy formation when the field is fallowed; suppression of light-demanding weeds; firewood/fodder production) and below ground (maintenance of deep root system enabling nutrient capture from a deeper soil profile). •Can invading *C. odorata* co-exist in a successional balance with *A. villosa*, *L. leucocephala*, & other managed leguminous tree fallows? Might this combination provide the dual benefits of N-fixation (leguminous trees) and conservation of labile pools of soil nutrients (C. odorata), rapidly absorbing them & storing them in the accumulating biomass until the fallow is re-opened and they can be directed for crop utilization?
Perennial-Annual Rotations	•Understanding the impact of introduced trees on soil properties during the fallow period: - identifying which spp. have positive, negative or value-neutral net impacts on soils and quantifying these; - if the bulk of biomass is exported from the fallow through timber harvest, what are the implications of reduced burning and ash deposition to soil properties and subsequent crop yields? •Clarifying interactions between trees and annual crops during the fallow phase: - identifying and measuring which tree spp. have beneficial agronomic properties and may be manipulated to boost yields of food crops - and which impose a net competitive effect and can be expected to reduce crop yields; - testing tree densities and other management variables that optimize beneficial returns while minimizing costs.
Agroforests	•Opportunities to fine-tune complex agroforests (germplasm & management) and enhance their productivity without sacrificing the critical elements that make them attractive to farmers, i.e., low labor requirements, low risk, and no need for outside technologies or credit,. •Identification of synergistic associations between component spp., e.g., N-fixing/non-N-fixing tree combinations, shade trees over perennial [illegible] tree architectures to maximize utility of vertical space through multiple stories, etc.