Swidden Agriculture: Ancient Systems in Transition

Sustaining Food Security & Historic Disturbance Regimes
Swidden farming, also know as shifting cultivation or milpa in Latin America, is conventionally defined as “an agricultural system in which temporary clearings are cropped for fewer years than they are allowed to remain fallow” (Sanchez, 1976). While certainly correct, this definition reflects a Western or modern emphasis on the relatively short period when annual food and other crops are grown. Swidden can also be thought of as forest farming, since the fallow period is typically long, managed and often cultivated as well, although with perennial species rather than annuals.

Irrespective of the emphasis, swidden is a rotational form of agriculture that applies natural vegetative processes as a means of replenishing soil fertility and controlling invasive weeds. The practice evolved independently throughout the world and varies in response to site-specific ecological, socio-economic and cultural conditions. Swidden systems have proven to be productive and sustainable adaptations to challenging environmental conditions that feature high labor productivity at low population densities (Cairns, 2007). Swidden agriculture, often pejoratively called slash and burn, has had a poor reputation and been actively suppressed from colonial to contemporary times.

In this powerpoint, I consider swidden practices utilizing the framework developed by the classic swidden researcher, Dr. Hal Conklin (1957). He differentiated two shifting cultivation systems: 1) integral, which he described as productive, sustainable, carefully regulated and managed through social norms, cultural traditions and religious practices and that incorporated rich traditional ecological knowledge and practice and 2) incipient, which are more intensive, destructive and unsustainable practices often used by recent migrants who lack site-specific TEKP and have little management capacity. I consider explanations for the breakdown of integral swidden systems, and what contemporary agriculture, conservation and development efforts might learn from these age-old forest farming practices.
Swidden Cycle (integral/long fallow)

Cultivation: fallow lengths and specific practices in integral swidden systems vary with site-specific soil, climatic and related biophysical factors and the socioeconomic needs and cultural traditions of farmers. In the humid tropics where soils are highly weathered and decomposition rates rapid, 1-2 yrs of cultivation, followed by 15-20 yrs of fallow are required to maintain productivity and avoid establishment of invasive weeds.
Key characteristics of integral swidden systems include:

- a short cultivation period followed by a long fallow, 1-2 yrs
  cultivation: 15-20 yrs fallow is common in the humid tropics
- cultivation: fallow lengths vary with soils, climate & elevation

- in temperate high elevation Bhutan a 3:4 yr cycle with grass & shrub
  fallow was used to cultivate barley, buckwheat & vegetables on a
  sustainable basis for centuries

In integral swidden systems farm parcels tend to be small (0.25 – 1.0 ha) which is about the same size of natural (i.e., wind throw) tree fall gaps in tropical forests. Secondary vegetation that has established over the 15-20 year fallow is cleared by hand and some trees are retained due to their large size or value for fruit, timber and other uses. Swidden cultivation and fallow products may be consumed directly by households or marketed for cash income.

Farmer beneath a large *Ficus* sp. retained in a swidden field, San Vicente
Drying

A primary objective in swidden is to convert nutrients accumulated in biomass during the fallow to a form (i.e., ash) that can be taken up by crops. The first step is to cut the secondary growth and allow it to dry before the arrival of the rainy season when crops are planted. The timing of these activities varies with local climatic conditions and unique local adaptations abound. For example, in per-humid environments, such as New Guinea where there is no dry season, farmers are unable to burn. Instead they cut and mulch (i.e., compost) to release nutrients in biomass.
**Burn**

The burning practices of integral swidden cultivators are sophisticated, carefully managed and reflect generations of accumulated traditional ecological knowledge and practice (TEKP). Burns are timed to coincide with the anticipated arrival of the wet season. Decisions of when and how to burn on any given day take into account humidity, temperature, wind, and other factors. In San Vicente, swiddens are burned in the late morning when humidity is low, but before afternoon heat and winds develop. The objectives are to: 1) prepare a clean planting bed, 2) release nutrients in the biomass and make them available to crops as ash, 3) reduce insects, fungi & diseases, and 4) eliminate weeds. A good fire is quick, hot and consumes all leaves and small branches (where the majority of nutrients are stored), but is not so hot that it volatilizes nutrients or burns valuable soil organic matter.

Men are reportedly responsible for burning in most swidden systems, but women are capable as well; San Vicente

Immediate post-burn condition well-suited for planting; note that only leaves and small twigs were consumed
Soil responses to burning:

- increase exchangeable cations (Ca, Mg)
- increase pH
- decrease Al

Duration of effects vary with:

- soils
- climate
- inputs (fallow)
- cultivation & management practices

Fig. 10.8  Dynamics of exchangeable bases and soil acidity upon clearing and burning an Ultisol from Yurimaguas, Peru, and an Alfisol from Kade, Ghana. Source: Adapted from Nye and Greenland (1964), North Carolina State University (1974), and Seubert (1975).
Planting

Planting occurs immediately after burning and the arrival of rains. This ensures that nutrients released from biomass are taken up by crops, rather than being lost to runoff, leaching or uptake by regrowing secondary vegetation. Crop selection and management practices are as varied as the world’s cultures and environments and reflect household needs, preferences and labor availability; cultural and religious traditions; economic opportunities; local environmental conditions and many other factors. In Central America farmers have cultivated maize, beans & squash (the “3 sisters”) since at least the time of the classic Maya. Intercropping these three annuals optimizes the use of space and light (beans are supported by maize, squash makes a complete ground), reduces erosion and runoff risks, fixes nitrogen, and produces foods that are nutritious and a complete source of protein. A wide variety of vegetables and perennial crops may be incorporated at the time of planting or later during cultivation and fallow periods.

Planting in swidden systems is done with the use of a dibble stick (a heavy wooden pole). Holes are punched in the ground, seeds deposited, and the soil sealed with one’s foot. The absence of plowing maintains an intact and functional soil organic mat, minimizes erosion and runoff, and facilitates secondary vegetation regrowth.

young corn, San Vicente; note extensive roots & stump which will coppice/sprout and the intact root mat
Management

Swidden management practices, including the location and size of fields, the duration and composition of fallows, and many other factors, were historically managed and regulated by community norms and village elders, and informed by TEKP. Integral swidden systems are “integrated” with local social, cultural and religious traditions. They also reflect household needs, interests, available labor; economic and market opportunities; land availability; government policies; and many other factors.

At the most basic level, the objectives of swidden cultivators are to: 1) maintain a productive and sustainable agricultural system through managing soils and vegetation, 2) meet household food and income needs, and 3) minimize the risk of crop failures by planting a diversity of annual and perennial crops in space and time.

Absolam weeding invasive *Imperata cylindrica* grass, San Vicente
Weed management

Weeds rarely establish or adversely affect crop yields in integral, long fallow swidden systems. A short cultivation : long fallow prevents establishment of grasses, composites and other weed species. Fields are fallowed when yields begin to decline and weeding requirements increase. If cultivation periods are lengthened or fallows shortened, disturbance associated invasive species can quickly establish.

Throughout Southeast Asia, excessive cultivation, shortened fallows, logging and other disturbances have led to widespread establishment of exotic invasive weeds. One of the most problematic species is *Imperata cylindrica*, a grass of African origin. Why might a grass from Africa be particularly well adapted to anthropogenic disturbances?

<table>
<thead>
<tr>
<th>Plant succession following disturbance in hillside farms</th>
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<tbody>
<tr>
<td>Vegetation 7 weeks after disturbance</td>
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<tr>
<td>Forest</td>
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<td>-------</td>
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<tr>
<td>Number of species present</td>
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<tr>
<td>Tree species present</td>
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<tr>
<td>Exotic weed species</td>
</tr>
<tr>
<td>Exotic weed dominance (%)</td>
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<tr>
<td>Ground cover (%)</td>
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</tbody>
</table>

1 based on Holm et al. (1979).

Siebert (1987)
Crops

Swidden farmers typically plant a wide variety of crop species and varieties, including annuals and perennials. This may include rattan, fruit, timber & other tree species. High species/varietal diversity reduces the risk of crop failure due to insects, diseases or fungi, and yields products that meet a variety of domestic and market needs. For example, farmers in Southeast Asia cultivate many different rice varieties due to their variable drought, insect and disease tolerances and desirability for specific uses, including brewing alcohol (arak).

Plants are intensively and sequentially intercropped to provide multiple and continuous yields during cultivation and fallow periods. Rattan (Calamus caesius) was formerly cultivated as a swidden fallow crop in Indonesian Borneo. It provided a lucrative cash crop when fields were next ready for cultivation or the parcel could be retained as a rattan garden for decades, depending on household needs and cane market prices.

swidden 1 yr after planting (sweet potato, banana, sugar cane, beans), San Vicente
Crops

Swidden farmers cultivate crops for direct household consumption and for market/cash income.

bananas, San Vicente

cinnamon relay intercrop, Kerinci
Labor

Labor inputs in swidden systems vary with gender, age, experience, crops cultivated, and cultural practices and traditions. Land clearing, planting and other farming practices can be performed individually or collectively. In general, the labor required in long fallow swidden systems is low in comparison to incipient shifting cultivation or permanent farming systems because little time or effort is required in weeding.

women’s work group

planting corn, San Vicente
Swidden fallow vegetation includes:

- natural secondary succession
  - species composition varies with cultivation intensity, previous disturbance, presence of species, and many other ecological factors

- intensively cultivated parcels
  - highly variable, reflecting household needs, interests, labor availability, market access and opportunities, knowledge, and many other factors

2 yr old secondary forest, Sulawesi

rattan seedlings to swidden fallow, Borneo
Soil responses to cultivation:

- vary with cultivation and fallow lengths and burn intensities

General effects over time include:

- $< \text{pH}$, nutrients & organic matter

- $> \text{weeds}$
  - yields decline
  - land fallowed
  - vegetation regrowth
  - nutrient accumulate in biomass, weeds suppressed

<table>
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<th>Soil responses to cultivation in San Vicente swiddens</th>
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<tr>
<td><strong>Hillside farms</strong></td>
</tr>
<tr>
<td><strong>Ca</strong> (meq per 100 g)</td>
</tr>
<tr>
<td>After burning</td>
</tr>
<tr>
<td>1 year cultivation</td>
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<tr>
<td>2 years continuous cultivation</td>
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<tr>
<td>5 years continuous cultivation</td>
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</tbody>
</table>

Hillside farms designated after burning and after 1 year cultivation represent mean of 55 soil samples from 11 farm parcels; 2-year and 5-year continuous cultivation sites represent means of 5 soil samples in one farm. Standard deviations in parentheses.

Siebert (1987)
Summary attributes of integral swidden systems

• adapted to nutrient limited sites (esp. acid, infertile tropical soils)

• wide climatic adaptability (seasonally dry $\rightarrow$ perhumid)

• vegetation includes:
  - crops – highly variable, site-specific, production for hh & market
  - fallow – bush (3-5 yr) $\rightarrow$ forest (15-20 yr), site & climate dependent
  - weeds – minimal if long fallow

• native flora, ecosystem processes & regeneration paths maintained

• natural/biological control of insects & disease pathogens

• high biodiversity conservation value (habitat & connectivity)

• use & management:
  - relatively low capital & labor
  - knowledge & experience intensive (TEKP)
  - regulated via social norms, cultural traditions & religious practices
Integral long fallow swidden systems are now largely a memory. Inhabitants of a few remote areas in Amazonia and Southeast Asia may still practice integral swidden, but elsewhere these systems have disappeared as a result of cultural change, lack of available land, emerging market opportunities, destructive logging practices, establishment of large plantations, government policies, and competition with recent migrants who lack the requisite TEKP. Integral swidden practices have been replaced by what Conklin called incipient shifting cultivators, or what others refer to as slash and burn.

Incipient slash and burn farming is characterized by:

- a lack of knowledge and experience (TEKP),
- continuous and/or more intensive cultivation,
- large clearings with few/no trees retained,
- no or short fallows, and
- repeated burning

Incipient slash and burn is unsustainable, results in widespread establishment of invasive weeds and often creates a wave or front of forest conversion.
Summary attributes of incipient slash & burn:

- destructive & unsustainable, leads to extensive forest conversion
- facilitates establishment of exotic invasive species (e.g., *Imperata cylindrica*)
- widespread/global (tropical) phenomena
### Integral swidden vs. Incipient slash & burn

<table>
<thead>
<tr>
<th>Integral swidden</th>
<th>Incipient slash &amp; burn</th>
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</thead>
<tbody>
<tr>
<td>• long-term residents</td>
<td>• recent migrants</td>
</tr>
<tr>
<td>• rooted in culture, religion, traditions</td>
<td>• not rooted in culture</td>
</tr>
<tr>
<td>• extensive TEKP</td>
<td>• little/no TEKP</td>
</tr>
<tr>
<td>• self regulated/managed</td>
<td>• largely unregulated</td>
</tr>
<tr>
<td>• long fallow</td>
<td>• short/no fallow</td>
</tr>
<tr>
<td>• sustainable</td>
<td>• unsustainable</td>
</tr>
<tr>
<td>• land extensive</td>
<td>• land intensive</td>
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</tbody>
</table>

San Vicente

Sulawesi
The many different factors and underlying forces responsible for tropical forest conversion and degradation have been debated for decades. Literally hundreds of books and articles have been written on the subject. In my opinion, Geist & Lambin (2002) provide one of the most thoughtful and useful analyses. Based on an analysis of 152 empirical studies, they suggest that it is important to differentiate between proximate causes (e.g., specific activities one observes in the field) and underlying driving forces (i.e., the socioeconomic, political and other factors that allow or facilitate actions observed in the field).

Geist and Lambin (2002) conclude that:
• no universal cause:effect relationships explain forest conversion/degradation
• causes & driving forces are highly variable, site specific and diverse
• key proximate causes include:
  - agricultural expansion
  - logging
  - infrastructure development (e.g., roads, dams, etc.)
• key underlying driving forces include:
  - economic opportunities
  - national & global policies
• population growth & swidden cultivation have been overemphasized as a cause of tropical forest conversion and degradation
Underlying driving forces of incipient shifting cultivation

- lack of access to land, resources, or alternative/preferred livelihoods

- state & international development policies:
  - frontier development (e.g., Amazon)
  - transmigration (e.g., Indonesia)
  → displace resident populations, migrant practices inappropriate & unsustainable due to lack TEKP

- unintended consequence of government failure to address socioeconomic problems elsewhere (e.g., land tenure inequity in Brazil)

Javanese transmigrant, Sulawesi
Integral swidden systems can be thought of ecologically as historic anthropogenic disturbances whose specific attributes are reflected in and may be important to retaining contemporary forest species composition, structure and ecosystem processes. Ecological disturbance attributes can be described in terms of their (modified from Uhl, 1990):

- **Type** – e.g., small gaps (tree falls) or light burn (integral),
- **Size** – impacts biophysical conditions (e.g., regeneration & microclimate)
- **Intensity/duration** – e.g., fire temperature, years of cultivation, etc.
- **Frequency** – return interval (sustainable: 15-20 yrs), if shorter degradation
- **Distance** - from undisturbed vegetation

Differences between integral and incipient swidden practices can be compared by describing their specific disturbance attributes and associated effects.
Comparing natural & anthropogenic disturbances

- type
- size/scale
- intensity
- duration
- frequency

- effects are interactive, cumulative and uncertain due to natural & unpredictable environmental (e.g., climate) & social (e.g., economic) changes

Figure 2.1. A classification of both small- and large-scale natural and anthropogenic disturbances with respect to (a) scale; (b) duration; and (c) frequency.

Uhl (1990)
Regeneration of biomass following disturbance

Integral swidden with 15 yr fallow → Incipient slash and burn

Uhl (1990)

the most severe case, the only hope for tree establishment is by long-distance dispersal of seeds. Climatic variability in precipitation and temperature, as well as human influences, can speed or slow these processes.
Regeneration in integral and incipient swidden systems

Integral long fallow swidden systems

Incipient short fallow swidden systems

Uhl (1990)
Integral swidden practices have been opposed and suppressed by both colonial and post-independent governments around the world. Colonial and nation states directly and indirectly suppressed integral swidden systems by:

- ignoring traditional land & resource rights in legal documents & cadastral surveys
- granting concessions for logging & export cash crop plantations on ancestral lands of swidden cultivators which eliminates the viability of land extensive long fallow swidden practices
- encouraging migration to avoid socioeconomic problems & land tenure inequities elsewhere (e.g., Brazil) or to provide plantation labor or pursue national development policies (e.g., transmigration in Indonesia)

State opposition to integral swidden agriculture reflects:

- ignorance, particularly re. its productivity, sustainability and resilience
- bias towards ‘modern’ industrial, agriculture
- cultural/racial/development bias - many swidden societies are minorities
- desire to control populations for purposes of taxation and for cultivation export cash crops
The breakdown of integral swidden systems, many of which have proven to be productive and sustainable for centuries, results in profound social, economic and cultural change. Some of the more significant changes include:

- increased labor (due to weeding)
- reduced crop yields (due to declining soil fertility and weeds)
- increased risk of crop losses

Declining agricultural productivity and sustainability can lead to:

- reduced household food & livelihood security
- increased poverty
- need for income/alternative livelihoods, often as wage laborers where plantations have displaced swiddens
- increased conflict over declining forest/land resources, particularly where recent migrants compete with indigenous peoples
- migration to new forest sites where available or to urban slums
- breakdown of cultural traditions & community governance
Comparison of integral & incipient swidden cultivation in terms of social & ecological resilience (Berkes, et al., 2003)

The breakdown of natural & social adaptive cycles in incipient systems results in:
- loss of capital: nutrients, productivity, knowledge, management capacity
- loss of ecological and social/cultural diversity, memory and redundancy

The cumulative effect is reduced capacity (ecologically and socially) to adapt to unpredictable, but inevitable ecological and social change. System reorganization after disturbance/change has reduced capital, diversity, memory and redundancy upon which to rebuild. As a consequence, system resilience and productivity are decline and a downward degradation spiral may ensue.

incipient slash & burn
- low resilience & reduced adaptive capacity due to loss of nutrients, TEKP, etc.
Historical legacies of swidden agriculture

• ancient & pervasive – throughout much of tropics
• example of co-evolution of natural & social systems
• major influence on contemporary biodiversity, species composition, distribution, structure and on ecosystem functions & processes
• increases landscape heterogeneity & proportion early successional vegetation
• integral systems are rich source of TEKP for developing productive & sustainable agricultural practices
Discussion topics and questions:

1) Sustainability (ecological)
   a) what constrains agricultural production in the tropics?
   b) how do swidden systems sustain crop yields?
   c) how do swidden practices vary under different soil and climatic conditions?
   d) in recent decades long fallow swidden systems have changed/broken down; what effect has this had on soils, flora, fauna, landscapes and ecosystems functions?

2) Relationship to biodiversity
   a) what direct and indirect effects do integral and incipient swidden systems have on flora & fauna?
   b) what has been the effect of eliminating/curtailing historic swidden practices on biodiversity?

3) Sustainability (social/cultural)
   a) what social, cultural and religious mechanisms/institutions sustain swidden systems?
   b) why have swidden systems broken down?
   c) what social & economic effects have resulted from the breakdown of integral swidden systems?


4) What role do land/resource tenure/property rights play in sustaining swidden systems?
   a) how are property rights defined & by whom?
   b) how can property rights be enforced?

See: Peluso & Vandergeest (2001)
5) Swidden and the future
   a) where and under what circumstance might swidden practices be relevant in the future?
   b) consider tradeoffs between sustainability, productivity, stability and resilience in swidden vs. “modern”, intensive agriculture


6) What alternatives exist to historic swidden systems and how might their productivity & sustainability be enhanced?
   a) improved fallow management
   b) expanded market access and incorporation of cash crops
   c) agricultural research/development & extension assistance
   d) REDD+ and other payments for environmental services
   e) learning from the past (e.g., Amazonian dark earths)

7) Other issues:
   a) compare the role and importance of social and ecological resilience in swidden vs. modern agriculture practices

   See: Berkes et al. (2003)

   b) compare household food/livelihood security in swidden vs. modern agricultural systems

   See: Belsky (1993)
Recommended readings:


