# FARMER INNOVATIONS AND BEST PRACTICES BY SHIFTING CULTIVATORS IN ASIA-PACIFIC

Edited by **Malcolm Cairns**
with the assistance of Bob Hill and Tossaporn Kurupunya

CABI

# Farmer Innovations and Best Practices by Shifting Cultivators in Asia-Pacific

FSC
www.fsc.org
MIX
Paper from
responsible sources
FSC® C013604

# Farmer Innovations and Best Practices by Shifting Cultivators in Asia-Pacific

*Edited by*

**Malcolm Cairns**

*with the assistance of Bob Hill and Tossaporn Kurupunya*

CABI

**CABI is a trading name of CAB International**

CABI
Nosworthy Way
Wallingford
Oxfordshire OX10 8DE
UK

Tel: +44 (0)1491 832111
E-mail: info@cabi.org
Website: www.cabi.org

CABI
200 Portland Street
Boston
MA 02111
USA

Tel: +1 (617)682-9015
E-mail: cabi-nao@cabi.org



A catalogue record for this book is available from the British Library, London, UK.



**Library of Congress Cataloging-in-Publication Data**

Names: Cairns, Malcolm, editor. | Hill, Bob (Science writer), contributor. | Kurupunya, Tossaporn, contributor.
Title: Farmer innovations and best practices by shifting cultivators in Asia-Pacific / edited by Malcolm Cairns with the assistance of Bob Hill and Tossaporn Kurupunya.
Description: Boston, MA, USA : CAB International, [2023] | Includes bibliographical references and index. |
Summary: "This book, the third of a series, shows how shifting cultivators from the Himalayan foothills to the Pacific Islands have devised ways to improve their farming systems. It considers the importance of swidden agriculture to food security and livelihoods, and its environmental significance across multiple cultures, crops and forest systems"-- Provided by publisher.

Identifiers: LCCN 2022055734 (print) | LCCN 2022055735 (ebook) |
ISBN 9781800620094 (hardback) | ISBN 9781800620100 (ebook) |
ISBN 9781800620117 (epub)
Subjects: LCSH: Shifting cultivation--Pacific Area.
Classification: LCC S602.87 .F372 2023 (print) | LCC S602.87 (ebook) |
DDC 631.5/818091823--dc23/eng/20230412
LC record available at https://lccn.loc.gov/2022055734
LC ebook record available at https://lccn.loc.gov/2022055735

ISBN-13: 9781800620094 (hardback)
9781800620100 (ePDF)
9781800620117 (epub)

DOI: 10.1079/9781800620117.0000

Commissioning editor: David Hemming
Production editor:James Bishop

Printed and bound in the UK from copy supplied by the authors by CPI Group (UK) Ltd, Croydon, CR0 4YY

# 18

# SHIFTING CULTIVATION AND REHABILITATION OF NATURAL FOREST ECOSYSTEMS

## In the Central Highlands of Vietnam

*Bao Huy**

### Introduction

Shifting cultivation, which is also known as swidden agriculture, or pejoratively as slash-and-burn farming, is an ancient farming practice that remains the dominant and traditional land use in the mountainous regions of Southeast Asia, providing a livelihood for most of the ethnic minorities that inhabit these upland regions (Cherrier et al., 2018; Li et al., 2014). It has been estimated that there are about 100 million shifting cultivators in this region (Christanty, 1986).

In Vietnam, more than 50 ethnic minorities practise shifting cultivation, in numbers second only to Indonesia in Asia (Sam, 1996). In Vietnam's Central Highlands, which are home to many ethnic minorities, shifting cultivation is the farming system of necessity because the groundwater table is about 20 metres below the soil surface, making the irrigation of wet-rice fields impracticable (Huy et al., 1998). Throughout the tropics, most of the stages of shifting cultivation are similar (Christanty, 1986). The upland farmers apply indigenous knowledge passed down by their ancestors in selecting forest sites, clearing the vegetation and burning it, intercropping, protecting their crops, harvesting and fallowing, as described by many authors (e.g. Thinh and Son, 1998; Nhung, 1998; Dao, 1999; Dung, 2000; Hung, 2004). The size of each swidden, or farming plot, is dependent on the size of a household and the number of labourers it can call upon. The main crops are upland rice, mixed with chillies, cucumbers and melons, and the schedule of cultivation is drawn from long experience. Rice yields are unstable because the crop is highly dependent on the forces of nature (Huy et al., 1998). The choice of land to cultivate is important because the indigenous farmers aim to protect upstream watershed areas, and when clearing the forest, they often retain big trees and the roots of others to

* Dr. Bao Huy, Professor, Consultancy for Forest Resources and Environment Management (FREM), No. 06 Nguyen Hong, Buon Ma Thuot, Dak Lak, Vietnam.

avoid soil erosion (Huy et al., 1998). The length of fallow periods depends on the area of arable land that is available to each village, and the time it takes for the soil to recover its fertility after cultivation. Land is usually allowed to lie fallow for between eight and 15 years. Thus, indigenous people apply a sustainable 'land-use plan' based on a cycle of forest-farm-fallow-forest, within the boundaries of each traditional village in the Central Highlands (Huy et al., 1998; Hung, 2004).

In recent decades, the traditional practice of upland cultivation in the Central Highlands has been disrupted by the introduction of industrial farming systems, using chemicals, and foreign exploitation of forest and land resources (Cuc, 1995; Huy et al., 1998, 2018). Specialized industrial monoculture crops such as coffee and rubber have replaced traditional shifting cultivation on sloping land, and these systems are facing problems from lack of water and soil erosion, as well as environmental pollution due to the use of chemicals and inorganic fertilizers (Huy et al., 2018). This transition has had a profound effect, as the increasing economic value of industrial crops such as coffee, cashews and rubber have seen these systems replacing the fallowed upland fields of shifting cultivators. The government has favoured and supported the march of these specialized monoculture systems rather than opting for a gradual evolution (van Noordwijk et al., 2008; Schmidt-Vogt et al., 2009), such as waiting for forest restoration, or using agroforestry to restore the natural forest ecosystem.

In an environment where agricultural production is being driven by globalization, shifting cultivation still plays an important role for indigenous people in terms of culture, economy, society and livelihoods, mainly in the subtropical and tropical zones of Southeast Asia, from the Chittagong Hill Tracts of Bangladesh, through Myanmar, Nepal and Bhutan to southwest China, northeast India, northern Thailand, the Lao PDR, Cambodia and Vietnam (Cherrier et al., 2018).

This study examines the recovery of forest structure and soil fertility and changes that occur over different fallow periods, as a basis for proposing improved upland-farming practices by ethnic minorities in the Central Highlands of Vietnam.

*Lithocarpus balansae* (Drake) A.Camus [Fagaceae]

A lofty broad-leaved evergreen of the beech family, this tree prefers to grow alongside streams at elevations from 400 to 1900 masl. Native to southeast China, Myanmar, Laos and Vietnam, it grows up to 30 m and dominates forest regrowth in Vietnam's Central Highlands after about eight years of fallow. It is one of the more dominant species in the area's primary forest.

## Materials and methods

### *The study site*

This study was carried out in Vietnam's Central Highlands, an eco-region with eight ecological zones. The Central Highlands (Figure 18-1) have the country's highest cover of tropical forests. Our study focused on the region's main forest type: evergreen broadleaf forest, and fallow lands within these forests, which are structurally complex, with mixed-species composition. The common species are from the Fagaceae, Myrtaceae and Lauraceae plant families

The elevation of evergreen broadleaf forests in the study area ranges from 700 to 1000 metres above sea level, with slopes of up to 30° in some areas. Mean annual rainfall is between 2000 and 2600 mm, with a dry season lasting for three months and mean annual temperatures ranging from 22 to 25°C. The forests grow on a main soil type of sedimentary rock (Chien, 1986; Hijmans et al., 2005; Fischer et al., 2008).

Shifting cultivators in the study area are of the native M'nong ethnic minority.

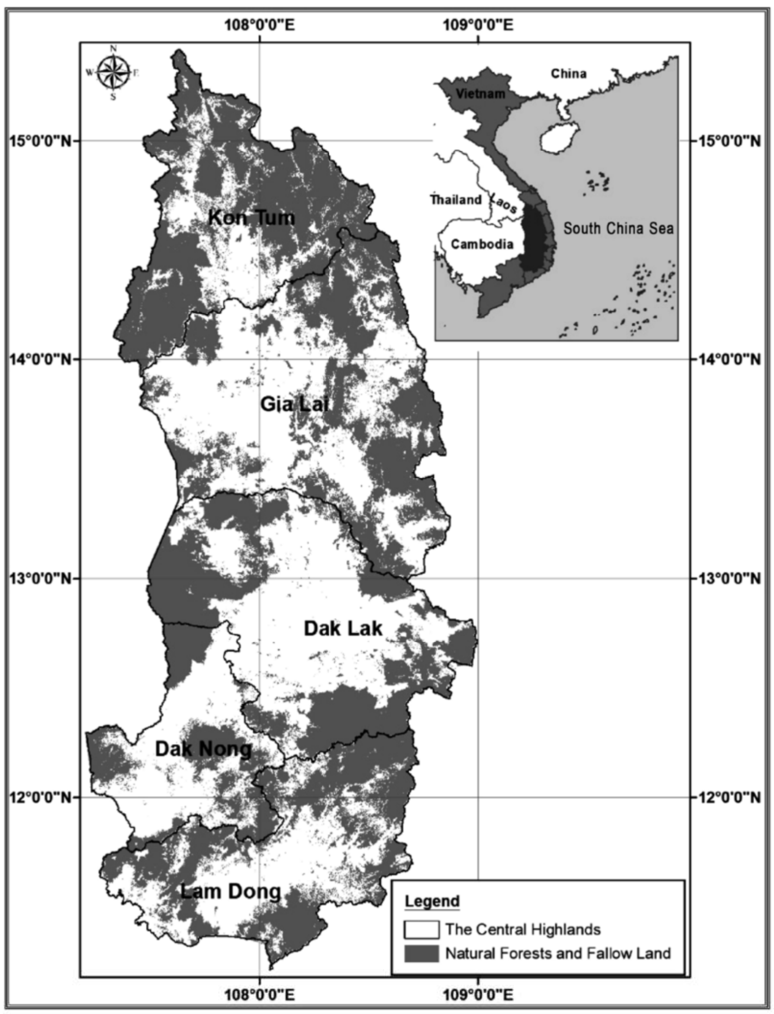


**FIGURE 18-1:** Natural forests and shifting cultivation fallows in the Central Highlands ecoregion of Vietnam.

### *Data collection and analysis*

A total of 15 nested circular plots were established in five fallow and forest areas. These areas consisted of fallows aged 2, 4, 8 and 10 years, and an area of primary forest. Three plots were established in each area, comprising two concentric circles, or subplots. Within a wider subplot, with a radius of 17.4 m and covering 1000 sq. m, all trees with a diameter at breast height (dbh) of 10 cm or more and a tree height (H) of 2 m or more were measured. Within a smaller subplot, with a radius of 5.64 m and an area of 100 sq. m, regeneration trees with a dbh of less than 10 cm and a tree height of 2 m or more were measured. Within each subplot, species, dbh and H were recorded.

We arranged distributions of height with intervals of 4 m and identified dominant forest-tree species by using an Importance Value Index ($IV_i$ %) (Curtis and McIntosh, 1950; Cottam and Curtis, 1956; Narayan and Anshumali, 2015) as follows:

(1) $$IV_i\% = \frac{N_i\% + BA_i\%}{2}$$

(2) $$N_i\% = \frac{N_i}{N}$$

(3) $$BA_i\% = \frac{BA_i}{BA}$$

Where $IV_i$% is the IV % indicator for the $i^{th}$ species; $N_i$% and $BA_i$% are density and basal area percentage for the $i^{th}$ species; $N_i$ (tree) and $BA_i$ (sq. m) are the density and basal area of the $i^{th}$ species; and N (trees) and BA (sq. m) are total tree density and basal area of the stand, respectively.

Three soil samples (0.5 kg each) were collected at a depth of 0 to 30 cm at representative locations within each plot. The soil properties were analysed, including humus and N% in the soil using the Tyurin and Kononova method (Kononova, 1966); $pH_{KCl}$, using the Meter method (Huang and Summer, 2012); $P_2O_5$ (mg/100 g soil), using the Oniani method, (Oniani et al., 1973); and $K_2O$ (mg/100 g soil) using the flame photometer method (Estefan et al., 2013).

For an overview and discussion of shifting cultivation in Vietnam, as well as that in Southeast Asia more generally, we undertook a literature review. We also surveyed and interviewed local people to describe their swidden practices and record their indigenous knowledge pertaining to the composition of integrated crop species, different durations of fallow, soil-fertility changes and forest restoration during different fallow periods, and trends of changing fallow-land use in conditions of market-driven agricultural development.

## Results

### *The farming systems*

There are common patterns to the shifting cultivation systems used by the ethnic minority groups of Vietnam. These include:

**Rotational shifting cultivation:** This form of swidden farming is common to most of the ethnic minorities (Figure 18-2). It involves two to four years of cultivating crops on a forest plot. When the productivity of the crops begins to decline, farmers clear new fields from the forest and the old fields are abandoned for natural regeneration of the forest and replenishment of soil fertility. The old fields can be returned to cultivation after a fallow period of seven to 15 years. In this way, cultivation is periodically rotated, or 'shifted', and land use is stable and lasting (Sam, 1994, 1996,1998; Huy et al., 1998; Hung, 2004). This type of shifting cultivation has many variations, with some farmers in remote areas distant from markets still using the same traditional methods (Hung, 2004, Huy et al., 1998). In some areas where fallowing is not observed because the government does not recognize farmers' land-tenure rights (Jong, 2007), there is partial application of agroforestry to prolong the period of cultivation (Huy, 2014, De Royer et al., 2016). In many other areas, where there is easy market access and high demand, the government has encouraged the transformation of shifting cultivation land into monoculture cropping systems (Huy et al., 2018; De Royer et al., 2016; Schmidt-Vogt et al., 2009; van Noorwijk et al., 2008).

**Pioneer shifting cultivation:** Farmers practise slash-and-burn cultivation until the land is exhausted and the productivity of crops decreases sharply. They then abandon the old fields and enter the forest to develop new fields. In some cases, when forest land is no longer available near a village, the entire village may move to a new site (Sam, 1994; Huy et al., 1998; Hung, 2004). This type of farming has been adopted by communities that use traditional shifting cultivation methods in areas where there is limited access to markets. Nowadays, this form of shifting cultivation is seldom applied because most ethnic minorities are expected to settle. At the same time, there is insufficient forest land available to support this form of shifting cultivation.

FIGURE 18-2: Landscape in the Central Highlands of Vietnam showing various phases of shifting cultivation.

*Photo:* Bao Huy.

**Shifting cultivation in combination with wet-rice cultivation:** This composite form of farming has been adopted by ethnic-minority communities who cultivate wet-rice fields in valleys and coordinate this with farming of upland fields in the surrounding hills. Many ethnic-minority groups, such as the Tay, Nung, Thai and Muong, practise this pattern of cultivation in Vietnam's Northern Mountainous Region and the practice is being adopted in the Central Highlands (Sam, 1994; Huy et al., 1998; Hung, 2004). The government of Vietnam has promoted this pattern of cultivation in the Central Highlands by building irrigation systems for indigenous communities to grow wet rice, while others have been trying to maintain shifting cultivation. This approach has not only decreased fallow areas, but has also had a deep impact on the customs and culture of indigenous shifting cultivators in the Central Highlands.

The common and traditional process of swidden farming followed by most ethnic-minority communities begins with choice of a forest site. The site is then cleared by slashing the vegetation and felling trees. After being allowed to dry, the slash is then burnt, and soon afterwards, the crops are sown. The crops are then tended and weeded as they grow and measures are taken to prevent attacks by animals and birds. Finally, the crops are harvested. After two or three years of this cultivation, the plot is allowed to lie fallow for 10 to 15 years (Huy et al., 1998). Vien (2007) described an alternative form of shifting cultivation typical of farmers in the north of Vietnam. In this case, rice was grown in swiddens for two or three years, followed by two years of cassava cultivation. The plots were then fallowed for five to 10 years. The entire shifting cultivation cycle of ethnic-minority farmers in the uplands of Vietnam covers about 10 to 12 years, on average. In this respect, it is similar to shifting cultivation systems practised in other Asian countries (Cherrier et al., 2018).

The swidden-farming process in the uplands follows a calendar of events that is highly dependent on the weather, and climatic conditions prevailing in mountainous areas within ecoregions. In the Central Highlands there are two distinct seasons: rainy and

*Cratoxylum cochinchinense* (Lour.) Blume [Hypericaceae]

This small deciduous tree grows to 18 m and, in the study site, is often found in the first four years of fallow. It is harvested as a source of food, medicine, dyes and wood. The young fruit is used as a spice for cooking and young shoots are eaten raw as a vegetable. The roots, bark and twigs are used as a treatment for colds and diarrhoea. The wood is very hard and highly valued.

dry. In the dry season, from January to April, there is strong sunshine, strong winds and almost no rain, so the burning of new fields takes place at the end of the dry season. Cultivation occurs only during the rainy season, from May to December (Dao, 1999; Huy et al., 1998; Dung, 2000).

Up until the 1970s, most indigenous farmers in the Central Highlands were engaged in rotational shifting cultivation. The farming system was stable because natural forest cover was extensive, population density was low, and the communities adhered strictly to customary rules of land tenure (Jong, 2007). There was no destruction of forests or environmental degradation (Hung, 2004). However, the population density accelerated rapidly because of migration – both legal and illegal – from the north of the country. Thus, demand for food production and industrial tree planting increased the pressure on dwindling land resources, and the time for which land was allowed to lie fallow after cultivation grew shorter. Without the opportunity for restored soil fertility, the land was burnt again for cultivation, leading to a vicious cycle in which the forest retreated and increasing areas of land became degraded (Thinh and Son, 1998; Sam, 1996, 1998; Huy et al., 1998; Dung, 2000; Hung, 2004).

The recovery of soil fertility after cultivation increases hand-in-hand with rehabilitation of forest vegetation in the fallow period. However, the length of time for which the land must lie fallow depends on the specific situation. Sam (1996) and Hung (2004) found that where swidden fields were in small clusters in the forest, the natural vegetation was restored very quickly in the fallow, taking from seven to 10 years for full regeneration. In cases where swiddens were cleared from bamboo-dominated forests, it took a long time – often more than 15 years – to restore a stable forest, and if swiddens were cleared in areas of low forest cover, then forest restoration was slow and fallows needed to last more than 20 years.

Indigenous knowledge of shifting cultivation and forest fallows offers a sound basis for solutions for forest ecosystem rehabilitation and improving livelihoods in different human-ecology contexts.

*Aporosa octandra* var. *malesiana* Schot [Phyllanthaceae]

A fast growing tree that is commonly found in the first eight years of fallow. Along with others in its genus, this tree accumulates aluminium and is restricted to acidic soils, which prevail in rainforests (Schot, 2004). The wood is hard and dark brown, suitable for house construction or furniture and the leaves can be used to dye cloth black.

### *Changes in soil properties during different fallow periods*

Shifting cultivation often occurs on sloping land, so after a few years of cultivating food crops, the soil deteriorates and the farmers fallow the land to restore its soil fertility for the next cultivation cycle. This study sought to evaluate the resilience of soil fertility over different fallow periods, and to compare this with the fertility of primary forest land. With three soil samples taken from each of 15 fallow and forest plots (as described earlier), 45 samples were analysed and their main properties were averaged. These properties included $pH_{KCl}$, Humus %, N %, $P_2O_5$ %, $K_2O$ %, $P_2O_5$ (mg/100 g soil) and $K_2O$ (mg/100 g soil) (Table 18-1).

Figure 18-3 shows that the accumulation of phosphorus (P) and potassium (K) content in soils taken from eight-year-old fallow land were nearly as good as those in primary forest. At the same time, the percentage of nitrogen (N), P and K in the soils approached the percentages in primary forest only after a fallow lasting more than 10 years. However, after 10 years of fallow, the $pH_{KCl}$ and humus content were still low compared to primary forest. The $pH_{KCl}$ value for 10 years of fallow was 4.21 compared to 5.50 in primary forest; and humus content was 5.35% in the 10-year-old fallow, while in primary forest it was 6.50%. Figure 18-4 shows how these differing fallow plots, and the primary forest, appeared to the research team.

### *The restoration of forest structure according to fallow time*

The dynamics of the distribution of tree height in fallows of different ages are shown in Table 18-2 and Figures 18-5 and 18-6. It is easy to see that the natural regenerative capacity of fallow land is very strong. After two and four years of fallow, the density of regenerating trees was between 14,000 and 23,000 trees/ha with a height (H) equal to or over 2 m. The density of trees with a diameter at breast height (dbh) equal to or over 10 cm then decreased sharply when the fallow period exceeded 10 years and gradually approached the density of primary forest (Table 18-2). The

**TABLE 18-1:** Soil-property indicators at a depth of 0 to 30 cm in fallow plots of different age, compared to primary forest.

| *Years of fallow* | *$pH_{KCl}$* | *Humus %* | *N %* | *$P_2O_5$ %* | *$K_2O$ %* | *$P_2O_5$ mg/100 g soil* | *$K_2O$ mg/100 g soil* |
|---|---|---|---|---|---|---|---|
| 2 | 3.86 | 3.67 | 0.13 | 0.12 | 0.02 | 2.50 | 8.82 |
| 4 | 3.90 | 4.49 | 0.17 | 0.09 | 0.02 | 3.30 | 11.24 |
| 8 | 3.92 | 5.04 | 0.22 | 0.11 | 0.03 | 3.55 | 12.01 |
| 10 | 4.21 | 5.35 | 0.23 | 0.06 | 0.05 | 3.89 | 12.35 |
| Primary Forest | 5.50 | 6.50 | 0.25 | 0.13 | 0.09 | 3.90 | 12.40 |

*Note:* Indicators were averaged from nine soil samples taken from three plots in each of the four fallow ages, plus primary forest.

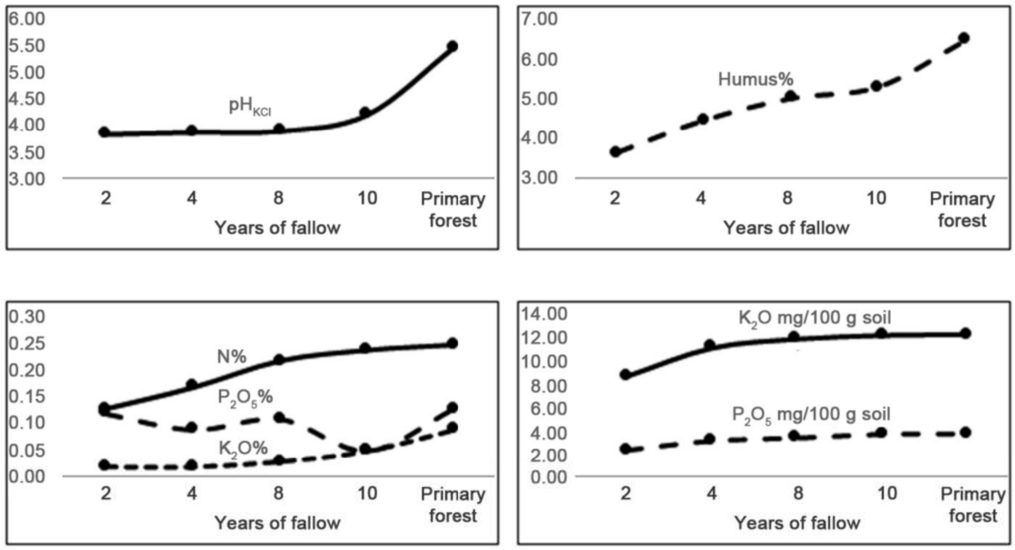


**FIGURE 18-3:** Trends of soil properties in different fallow periods, compared to those in primary forest.

**FIGURE 18-4:** Forest fallows of different age in shifting cultivation areas of Vietnam's Central Highlands, compared to primary forest. Top left: two-years-old fallow; top right: four-years-old fallow; above left: eight-years-old fallow; above right: more than 10-years-old fallow; left, primary forest.

*Photos:* Bao Huy.

**TABLE 18-2:** Distribution of tree height after different fallow periods compared to primary forest.

| *Tree height (m)* | *Number of trees/ha* | | | | |
|---|---|---|---|---|---|
| | *Two years of fallow* | *Four years of fallow* | *Eight years of fallow* | *Ten years of fallow* | *Primary forest* |
| 4 | 14012 | 18005 | 509 | 121 | 5 |
| 8 | | 5012 | 303 | 223 | 61 |
| 12 | | | 242 | 125 | 142 |
| 16 | | | | 97 | 123 |
| 20 | | | | 78 | 99 |
| 24 | | | | | 87 |
| 28 | | | | | 27 |
| 32 | | | | | 11 |
| Total trees/ha | 14012 | 23017 | 1054 | 644 | 555 |
| Average height ($\bar{H}$) (m) | 2.2 | 4.3 | 9.5 | 11.4 | 18.3 |

*Notes:* Numbers of trees per ha were averaged from data from three plots for each fallow period. At two and four years of fallow, trees with height equal to or greater than 2 m and a diameter at breast height less than 10 cm were counted; at eight and 10 years of fallow and primary forest, trees with height equal to or greater than 2 m and a diameter at breast height equal to or greater than 10 cm were counted.

average height ($\bar{H}$) of regenerating trees increased rapidly in the first stage and after 10 years of fallow, $\bar{H}$ was about 0.6 $\bar{H}$ of primary forest (Figure 18-6).

After 10 years of fallow, the height structure of the regenerating forest was approaching that of primary forest. Expressed in a graph (Figure 18-5), the height distribution in the 10-year-old fallow formed an apex to the left of that representing primary forest. The structure of the evergreen broad-leaved forest consisted of three layers of tree canopy: a lower canopy with a height of less than 12 m, an ecological layer with a height of 12 to 28 m and a canopy overpass with a height of more than 28 m. Figure 18-5 shows that after 10 years of fallow, the regenerating forest had formed two main forest layers: an understorey and an ecological layer, and the ecological circumstances of the forest were thus gradually rehabilitated.

### *Restoration of tree-species component after different periods of fallow*

There were significant changes to the tree-species component of the fallows as they became older. The dominant tree species, with an importance value index (IV) greater than 5%, in the two-year-old fallow were mostly pioneer trees that were small, soft, sunlight-demanding and fast-growing. These included species such as *Aporosa octandra* var. *malesiana*, *Cratoxylum cochinchinense*, *Dillenia ovata* and *Grewia paniculata*. After four years of fallow, large timber species with economic value emerged among the dominant tree species, including *Dalbergia cochinchinensis*,

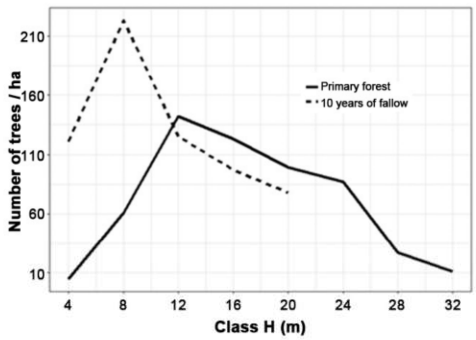


**FIGURE 18-5:** Distribution of tree height after 10 years of fallow and in primary forest.

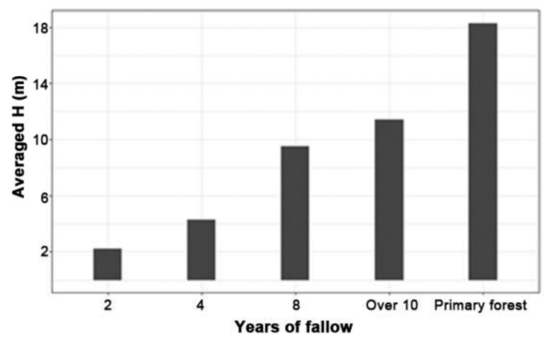


**FIGURE 18-6:** Average tree height of stands in fallows of different age, compared to primary forest.

*Melicope pteleifolia* and *Lagerstroemia calyculata*. These species were able to regenerate because of the forest ecological environment created by the earlier pioneer species. At this stage of fallow, the dominant-tree-species component included both the sunlight-demanding pioneer species group and large valuable trees. In the period from eight to 10 years of fallow, most of the sunlight-demanding pioneer species had been excluded from the dominant-tree-species component by the large timber trees, and by the time the fallow reached 10 years of age, the dominant tree species came closer to the dominant-species component in the primary forest, and included *Lithocarpus* spp., *Persea odoratissimus*, *Schima crenata*, *Syzygium odoratum*, and *Walsura* sp. At this stage, the dominant-species component was stable (Table 18-3).

As the duration of the various fallows grew longer, the number of dominant tree species increased and reached a peak concentration in the eight-years-old fallow. The number of dominant tree species then decreased, due to space competition and the change in ecological conditions, which became unsuitable for most of the sunlight-demanding pioneer species. When the fallow exceeded the age of 10 years, the number of dominant tree species with an importance value index (IV) greater than 5% decreased to the lowest point and came close to that of primary forest (Figure 18-7).

## Discussion

### *Restoration of soil fertility and natural forest during periods of fallow*

The restoration of soil fertility during the fallow period was due to the regeneration of forest vegetation, and the organic relationship between these two elements. This study was conducted in areas of evergreen broadleaved forest with periods of drought not exceeding two to three months – an environment that facilitates the rapid restoration of forest vegetation, thereby promoting improvement of soil fertility during the fallow.

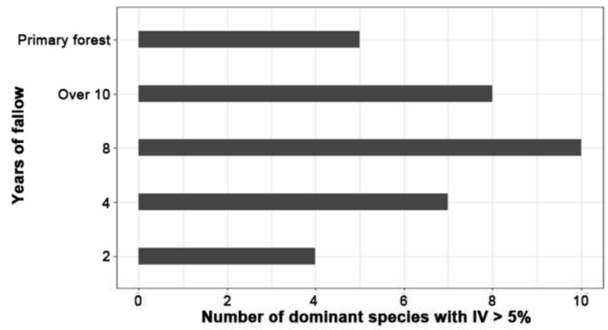


**FIGURE 18-7:** Distribution of dominant tree species after different periods of fallow, compared with the dominant tree species in primary forest.

**TABLE 18-3:** Changes to the dominant tree species after different fallow periods, and comparing these with primary forest.

| *Dominant tree species with IV > 5%* | | *IV% in different fallow periods and in primary forest* | | | | |
|---|---|---|---|---|---|---|
| *Botanical names* | *Vietnamese name* | *2 years* | *4 years* | *8 years* | *10 years* | *Primary forest* |
| *Albizia lebbekoides* | *song ran* | | | 6.34 | | |
| *Aporosa octandra* var. *malesiana* | *thau tau* | 16.07 | 10.87 | | | |
| *Cratoxylum cochinchinense* | *lanh nganh do ngon* | 7.14 | 5.43 | | | |
| *Dalbergia cochinchinensis* | *trac* | | 8.70 | 5.12 | | |
| *Dillenia ovata* | *so* | 7.14 | | | | |
| *Melicope pteleifolia* | *dau dau 3 la* | | 5.43 | 7.23 | | |
| *Microcos tomentosa* | *co ke* | 5.36 | 7.61 | | | |
| *Lagerstroemia calyculata* | *bang lang* | | 5.43 | 5.82 | 5.12 | |
| *Lithocarpus* spp. | *de* | | | 32.92 | 20.34 | 16.17 |
| *Persea odoratissima* | *khao* | | | 5.17 | 12.45 | 15.23 |
| *Schima crenata* | *cho xot* | | | 10.34 | 9.03 | 12.45 |
| *Semecarpus annamensis* | *sung* | | | | 5.88 | |
| *Syzygium odoratum* | *tram la nho* | | | 5.65 | 5.45 | 6.00 |
| *Vitex pinnata* | *binh linh* | | | 5.23 | 5.12 | |
| *Walsura* sp. | *nhan rừng* | | 6.52 | 6.23 | 7.34 | 5.14 |
| Total of dominant tree species | | 4 | 7 | 10 | 8 | 5 |

*Notes:* IV = importance value index. Average IV percentage values were calculated from data from three plots for each fallow period.

Christanty (1986) pointed out that the length of the fallow period was the most important factor to ensure the success of shifting cultivation; and that there were some additional ways of improving the rehabilitation of soil fertility and prevention of soil erosion on sloping land that could be incorporated at different stages of the shifting cultivation cycle. This study found that with a fallow period of at least 10 and preferably 15 years, the soil properties recovered and the structure and dominant-tree-species composition of the fallow forest almost stabilized, and the fallow was gradually approaching the status of primary forest. These findings support the indigenous knowledge of shifting cultivators in the Central Highlands. Along with the application of rotational cultivation, they use upland fields and forests sustainably and, after the cultivation phase, close their swiddens for an appropriate fallow period of 10 to 15 years (Figure 18-8). These results are also consistent with those of Vien (2007), Dao (1999), Huy et al. (1998) and Cherrier et al. (2018), although they differ from those of Christanty (1986), who found that in the tropics generally, a fallow period of 20 to 25 years was needed for forest rehabilitation.

It follows that the original forest ecosystem in the Central Highlands could be rehabilitated through the adoption of simple silvicultural measures such as zoning and protection of forest fallows. Some substantial alternatives should be considered to improve soil fertility and forest rehabilitation alongside the continued practice of shifting cultivation. These might include controlling the crop/fallow ratio in forest corridors that are about 100 m wide and oriented in an east-west direction, replacing natural fallows with planted fallows, and practising agroforestry, or maintaining continuous ground cover through minimum tillage during fallow periods (Christanty, 1986).

*Lagerstroemia calyculata* Kurz [Lythraceae]

Crepe Myrtle is a common forest species at low altitudes in Vietnam, and the trees are widely planted in many countries as ornamentals, showing vivid displays of pink or pale violet flowers. The trees grow up to 30 m, and are thought to have gained dominance in parts of Vietnam's Cát Tiên National Park simply because the relatively poor quality of the wood allowed them to survive repeated logging.

### *Sustainable management of fallow land and application of agroforestry for rehabilitation of forest ecosystems*

Although fallow land occupies millions of hectares in Vietnam, as in many other countries in Southeast Asia, fallow land is not recognized by either the forest-land classification system (Jong, 2007) or the forestry sector's system of measures for forest restoration (De Royer et al., 2016). Driven by misconceptions about its impacts on forests, most governments in Asian countries have long been trying to ban traditional shifting cultivation, while indigenous peoples fight to keep their ancestral fallow lands. In many cases, they must farm their swiddens illegally (Cherrier et al., 2018). Therefore, communities that rely on customary fallow land for their livelihood are less likely to receive official land-use rights from their governments (Jong, 2007). Challenged by an increasing population due to in-migration from the north of the country as people seek better-quality land to cultivate, and pressure from market forces that drive the development of commodity cropping, indigenous people are hard-pressed to protect their customary fallow land. For these reasons, fallow lands are not effectively managed.

**FIGURE 18-8:** A M'nong farmer cultivating his swidden in Dak Nong province, Central Highlands, Vietnam, in 2018.

*Photo:* Bao Huy.

Consistent with the findings of Watters (1971), shifting cultivation remains a realistic solution for sustainable farming in the humid tropics, provided there is sufficient forest and forest land; where the population pressure is not high; and where

*Syzygium odoratum* (Lour.) DC. [Myrtaceae]

An evergreen species common in mountainous broad-leaved forests in China and Vietnam, growing to 20 m tall with a diameter at breast height up to 30cm. This study reported its appearance as a dominant species in eight-year-old fallows, with an importance value close to that in primary forests. Better known species from the same genus include cloves (*S. aromaticum*) and roseapples (various *Syzygium* species).

fallow periods are either long enough to restore soil fertility or upland shifting cultivation systems can be improved by adopting agroforestry practices (Huy and Hung, 2011; De Royer et al., 2016). This could be the basis for sustainable forest land use and livelihoods, while preserving the culture of ethnic minorities in the uplands. These findings are consistent with those of Cherrier et al. (2018), who urged the generation of a common understanding about the significance of shifting cultivation for safeguarding the livelihoods of local people and protecting the forest environment. At the same time, these authors called for efforts to minimize the misconceptions of governments and researchers regarding shifting cultivation and the need for lengthy fallows. Adding to these voices, Kleinman et al. (1995) argued that slash-and-burn agriculture was ecologically sustainable because it did not depend on outside inputs, such as fossil-fuelled energy for fertilizers, pesticides and irrigation.

Over recent decades, a major challenge to the sustainable use of fallow land has been the Vietnam government's willingness to support the rapid expansion of monoculture cropping systems such as coffee, pepper, rubber, cashews and acacia into areas of fallow land – even the conversion of natural forests into industrial cropping systems (De Royer et al., 2016; Huy et al., 2018). The use of fallow-forest land, or conversion of dipterocarp forests, for industrial monocultures has been a demonstration of environmental degradation and economic failure in the Central Highlands. In many cases, monoculture systems failed to survive because of ecological hardship, but the conversion destroyed the forest ecosystem by robbing the soil of its vegetative cover and exposing it to severe conditions of drought and fire in the dry season and waterlogging in the rainy seasons. The soil nutrients were thus eroded (Huy et al., 2018). Cruz (2015) also pointed out that converting shifting cultivation land to other uses negatively affected biodiversity and soil fertility because of excessive land use.

The replacement of shifting cultivation with highly intensive monoculture systems generally increases the income of farmers in the short term, but it has negative effects on society and indigenous cultures at different levels. From an environmental point of view, the shift to other land-use systems results in deforestation, long-term biodiversity loss, increased weeds, reduced soil fertility and accelerated soil erosion (van Vliet et al., 2012). In addition, the expansion of monocultures reduces the carbon stocks of the forest (Ziegler et al., 2011). Therefore, despite the global trend towards intensive land uses, shifting cultivation still plays an important role in mountainous regions as a safeguard of diversity that avoids the risks of monocropping systems.

Other experiences in Vietnam – and elsewhere in Southeast Asia with tree-rich fallow lands – have suggested that crop species, when used in agroforestry systems, along with forest-enrichment planting (Huy et al., 2018), can help to rehabilitate the forest ecological environment (Sabogal, 2007). Agroforestry systems also demonstrate economic resilience, thanks to a diversity of short- and long-term species, along with the creation of effective carbon pools and provision of essential environmental services such as watershed protection and measures against soil erosion on sloping hills (De Royer et al., 2016; Huy, 2014; Huy et al., 2018). Swidden areas could thus be recognized as a forest type attracting payments for environmental services and from schemes such as Reducing Emissions from Deforestation and Forest Degradation (REDD+) in Vietnam (Moeliono et al., 2016).

*Schima crenata* Korth. [Theaceae]

This forest species is widespread throughout China and Southeast Asia at altitudes between 700 and 1000 masl. Growing to 20 m, it is harvested for its timber. It has a strong importance value in eight- and ten-year-old fallows and a dominant place in primary forest. There have been calls for research into its life history, population and harvest trends to avert possible habitat threats from agricultural expansion.

## Conclusions

Following the cultivation of swidden crops in evergreen broad-leaved forests in the Central Highlands of Vietnam, fallow periods that last for more than 10 years are likely to recover and stabilize soil fertility, forest structure and the composition of dominant tree species. If, after 10 to 15 years of fallow, there is no further use for the fallowed land, a measure of forest protection would ensure successful rehabilitation of the original forest ecosystem. Alternatively, swidden-based agroforestry systems would be an appropriate approach to harmonizing the maintenance of traditional shifting cultivation with the current tendency to intensify the use of fallow land by converting it to monocultures of commodity crops.

The economic significance of monocultures of global commodity crops is seriously compromising the important role of shifting cultivation systems in the uplands of Vietnam. The expansion of monoculture cropping poses a serious threat to swidden farming systems that ensure the livelihoods and well-being of local people while conserving their traditional knowledge and cultures.

Diversification of food crops that improve the use of fallow land, combined with income from forest trees, can improve the livelihoods of indigenous people while simultaneously rehabilitating the forest environment. This is an important current action for the Central Highlands of Vietnam. However, it can only be achieved by incorporating local ecological knowledge in the management of shifting cultivation fallows and using forest-agricultural science and technology advances to rehabilitate the forest ecosystem and develop agroforestry systems on degraded land.

## Acknowledgements

This study was partly funded by the Department of Science and Technology, Dak Lak province, Vietnam, with the participation of colleagues from the Faculty of Agriculture and Forestry, Tay Nguyen University, Vietnam.

## References

Cherrier, J., Maharjan, S. K. and Maharjan, K. L. (2018) *Shifting cultivation: Misconception of the Asian Governments*, Reviews, the Food and Agriculture Organization of the United Nations, Bangkok

Chien, N. V. (1986) *Sub-ecoregions in the Central Highlands of Vietnam*, Scientific and Technical Publishing House, Hanoi

Christanty, L. (1986) 'Shifting cultivation and tropical soils: Patterns, problems and possible improvements', in G. G. Marten (ed.) *Traditional Agriculture in Southeast Asia: A Human Ecology Perspective*, Westview Press, Boulder, CO

Cottam, G. and Curtis, J.T. (1956) 'The use of distance measures in phytosociological sampling', *Ecology* 37(3), pp.451-460

Cruz, A., (2015) *The Past, Present and Future of Swidden Agriculture*, World Agroforestry Center (ICRAF), Nairobi, available at blog.worldagroforestry.org/index.php/2015/05/07/the-past-present-and-future-of-swidden-agriculture/, accessed 1 May 2018

Cuc, L.T. (1995) 'Rehabilitation of degraded land in the midlands of Northern Viet Nam', in L.T. Cuc and A.T. Rambo (eds) *Some Issues in Human Ecology in Viet Nam*, Agricultural Publishing House, Hanoi

Curtis, J. T. and McIntosh, R. P. (1950) 'The interrelations of certain analytic and synthetic phytosociological characters', *Ecology* 31(3), pp.434-455

Dao, B. M. (1999) *Traditional Cultivation of Ethnic Minority Groups in Central Highlands*, Social Science Publishing House, Hanoi

De Royer, S., Ratnamhin, A. and Wangpakapattanawong, P. (2016) *Swidden-fallow Agroforestry for Sustainable Land Use*, Policy brief No. 68, Agroforestry Options for Asean series No. 2, Bogor, Indonesia; World Agroforestry Center (ICRAF), Southeast Asia Regional Program, Jakarta, and Asean-Swiss Partnership on Social Forestry and Climate Change

Dung, T. T. (2000) 'Assessment of the status of shifting cultivation on the Buon Ma Thuot plateau and recommendations', PhD dissertation to the University of Natural Science, Hanoi

Estefan, G., Sommer, R. and Ryan, J. (2013) *Methods of Soil, Plant, and Water Analysis. A Manual for the West Asia and North Africa Region*, third edition, International Center for Agricultural Research in the Dry Areas (ICARDA), Beirut, Lebanon

Fischer, G., Nachtergaele, F. O., Prieler, S., Teixeira, E., Toth, G., van Velthuizen, H., Verelst, L. and Wiberg, D. (2008) *Global Agro-Ecological Zones Assessment for Agriculture* (GAEZ, 2008), International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria and the Food and Agriculture Organization of the United Nations, Rome

Hijmans, R. J., Cameron, S. E., Parra, J. L., Jones, P. G. and Jarvis, A. (2005) 'Very high resolution interpolated climate surfaces for global land areas', *International Journal of Climatology* 25 (1965-1978)

Huang, P. M., Li, Y. and Summer, M. E. (2012) *Handbook of Soil Sciences: Resource Management and Environmental Impacts*, second edition, CRC Press, New York

Hung, V. (2004) 'Management of fallow lands of shifting cultivation in Dak Lak province, Viet Nam', Ph.D. Dissertation to Viet Nam Academy of Forest Sciences, Hanoi

Huy, B. (2014) '$CO_2$ sequestration estimation for the Litsea-Cassava agroforestry model in the Central Highlands of Vietnam' in *Compendium of Abstracts of World Congress on Agroforestry*, 10-13 Feb 2014, New Delhi, India, Indian Council for Agricultural Research and World Agroforestry Center (ICRAF) Global Initiatives.

Huy, B. and Hung, V. (2011) 'State of agroforestry research and development in Vietnam', *Asia-Pacific Agroforestry Newsletter (APANews)* 38(2011), pp.7-10

Huy, B., Hoa, N.V. and Dinh, N. D. (1998) *Assessment of current forest land management to recommend sustainable forest land use in Dak Lak province, Viet Nam*, Technical Report, Department of Science and Technology, Dak Lak province, Vietnam.

Huy, B, Tri, P. C. and Triet, T. (2018) 'Assessment of enrichment planting of teak (*Tectona grandis*) in degraded dry deciduous dipterocarp forest in the Central Highlands, Vietnam', *Southern Forests: a Journal of Forest Science* 80(1), pp.75-84, DOI: 10.2989/20702620.2017.1286560

Jong, W. D. (2007) 'Understanding forest landscape dynamics', in J. Rietbergen-McCracken, S. Maginnis and A. Sarre (eds) *The Forest Landscape Restoration Handbook*, Earthscan, London, pp.49-56

Kleinman, P. J. A., Pimentel, D. and Bryant, R. B. (1995) 'The ecological sustainability of slash-and-burn agriculture', *Agriculture, Ecosystems and Environment* 2(52), pp.235-249

Kononova, M. M. (1966) *Soil Organic Matter: Its Nature, Its Role in Soil Formation and Soil Fertility*, second English edition, Pergamon Press, London

Li, P., Feng, Z., Jiang, L., Liao, C., and Zhang, J. (2014) 'A review of swidden agriculture in Southeast Asia', *Remote Sensing* 2014 6(2), pp.1654-1683, doi:10.3390/rs6021654.

Moeliono, M., Thuy, P. T., Dung. L. N., Brockhaus. M., Wong., G. Y., Kallio. M. and Tien, N. D. (2016) 'Local governance, social networks and REDD+: Lessons from swidden communities in Vietnam', *Human Ecology* 44(4), pp.435-448

Narayan, C. and Anshumali (2015) 'Diversity indices and importance values of a tropical deciduous forest of Chhotanagpur plateau, India', *Journal of Biodiversity and Environmental Sciences* 7(1), pp.358-367

Nhung, M. L. T. (1998) *Indigenous Knowledge in the Central Highlands of Viet Nam*, Tay Nguyen University, Buon Ma Thuot, Dak Lak province, Vietnam

Oniani, O. G., Chater, M. and Mattingly, G. E. G. (1973) 'Some effects of fertilizers and farmyard manure on the organic phosphorus in soils', *Journal of Soil Science* 24, pp.1-9

Sabogal, C. (2007) 'Site-level strategies for managing secondary forests', in J. Rietbergen-McCracken, S. Maginnis and A. Sarre (eds) *The Forest Landscape Restoration Handbook*, Earthscan, London, pp.97-107

Sam, D. D. (1994) 'Shifting cultivation in Vietnam: Its social, economic, and environmental values relative to alternative land use', *Forestry and Land Use*, No. 3, International Institute for Environment and Development, London

Sam, D. D. (1996) *Overview of Shifting Agriculture in Vietnam*, Agricultural Publishing House, Hanoi, Vietnam

Sam, D. D. (1998) 'Swidden agriculture and sustainable forest management in Viet Nam', in *Proceedings of a Workshop on Sustainable Forest Management and Forest Certification*, Department of Forestry, Ministry of Agriculture and Rural Development, Vietnam

Schmidt-Vogt, D., Leisz, S. J., Mertz, O., Heinemann, A., Thiha, T., Messerli, P. and Dao, T. M. (2009) 'An assessment of trends in the extent of swidden in Southeast Asia', *Human Ecology* 37(3), pp.269-280

Schot, A. M. (2004) *Systematics of* Aporosa (*Euphorbiaceae*), Blumea supplement 17, Leiden University branch, National Herbarium of the Netherlands, p.53

Thinh, N. D. and Son, C. T. (1998) *Traditional Regulations of Ede and M'nong Ethnic Minority People*, National Political Publishing House, Hanoi, Vietnam

van Noordwijk, M., Mulyoutami, E., Sakuntalakewi, N. and Agus, F. (2008) *Swiddens in Transition: Shifted Perceptions on Shifting Cultivators in Indonesia*, World Agroforestry Center (ICRAF) Southeast Asia Regional Program, Bogor, Indonesia

van Vliet, N., Mertz, O., Heinimann, A., Langanke, T., Pascual, U., Schmook, B., Adams, C., Schmidt-Vogt, D., Messerli, P., Leisz, S., Castella, J. C., Jørgensen, L., Thomsen, T. B., Hett, C., Bruun, T. B., Ickowitz, A., Vu, K. C., Yasuyuki, K. and Ziegler, A. D. (2012) 'Trends, drivers and impacts of changes in swidden cultivation in tropical forest-agriculture frontiers: A global assessment', *Global Environmental Change* 2(22), pp.418-429, doi.org/10.1016/j.gloenvcha.2011.10.009

Vien, T. D. (2007) 'Indigenous fallow management with *Melia azedarach* Linn. in Northern Vietnam', in M. F. Cairns (ed.) *Voices from the Forest. Integrating Indigenous Knowledge into Sustainable Upland Farming*, Resources for the Future Press, Washington, DC, pp.435-444

Watters, R. F. (1971) *Shifting Cultivation in Latin America*, Food and Agriculture Organization of the United Nations, Rome

Ziegler, A. D., Fox, J. M., Webb, E. L., Padoch, C., Leisz, S. J., Cramb, R. and Vien, T. D. (2011) 'Recognizing contemporary roles of swidden agriculture in transforming landscapes of Southeast Asia', *Conservation Biology* 25(4)