Farmer-developed forage management strategies for stabilization of shifting cultivation systems.

By Peter Horne

Forages for Smallholders Project

PO Box 6766,

Vientiane LAO PDR

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Peter Horne

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Abstract

Increasing population pressures in shifting cultivation areas of Laos have resulted in shorter fallow times between subsequent rice crops (down from 15+ year fallows to 4-6 year fallows). With shorter fallow periods, soil fertility declines, crop yields decline, weeding requirements increase and the area that can possibly be cultivated by each family becomes smaller. The net result is reduced food security (in some areas farmers can only produce enough rice to feed their families for 6 months of each year). Farmers in this situation are forced to rely more heavily on other sources of income or food. Livestock, especially cattle and buffalo, often provide the major source of cash income in rural households in shifting cultivation areas. Livestock are also increasingly valuable as the only source of fertiliser (manure) that can be used to maintain or increase soil fertility in small irrigated areas or homegardens.

With declining traditional feed resources, some farmers are beginning to manage existing forage resources as part of their swidden systems. In addition, some introduced forage species have potential to improve fallows (both as feed and as green manure), but until now they have not been used by farmers. Using several case studies, this paper describes both farmer-initiated and potential forage strategies and addresses the question "how can the best features of both be brought together?".

Keywords: forages, shifting cultivation, livestock production, Laos, participatory technology development

Table of Contents

1 Introduction

The shifting cultivation systems of northern Laos have been the focus of a substantial amount of study in recent years (see, for example, [1], [3], [4], [7], [21]). The broad dynamics of change in these systems have been reasonably-well understood for a long time. Under the combined pressures of increasing population and reduced length of fallow cycles (that lead to more-severe weed problems and lower yields), shifting cultivation is becoming less sustainable.

This has stimulated concern by both the Lao government and foreign aid donors to stabilise[1] shifting cultivation. The main objectives of stabilisation have been to:

1. alleviate rural poverty and reduce livelihood risk
2. minimise environmental degradation and risk of degradation (soil erosion and a perceived threat from shifting cultivation to old-growth forests) and
3. eradicate cultivation of opium poppy (Papaver somniferum).

[1] The term "stabilisation" is preferred to "intensification", as stabilisation of shifting cultivation may include intensification but other options are available (as will be explained in the paper)

2 Approaches to Stabilisation of Shifting Cultivation in Laos

Several different approaches to stabilisation of shifting cultivation in Laos are being used. Although, in practice, the distinction between these approaches becomes blurred, they can still be broadly described as:

2.1 Systems analysis.

In a 1993 meeting on the status of shifting cultivation in Laos, a recommendation was made that "better understanding...(of the systems was needed)... before testing and demonstrating alternatives" [21]. The approach is that through systems-wide studies, the key components of the systems can be targeted for development.

The problem with this approach is that shifting cultivation systems are characterised more by their differences than their similarities. Immense variability and complexity in land capability, land use pattern and population pressure exists even across short distances and within villages. One study in northern Thailand, for example, identified five different household strategies or land-use patterns in one village of northern Thailand alone, for dealing with soil erosion problems in their shifting cultivation fields [20]. In addition, shifting cultivation in most parts of northern Laos (in particular Luang Phabang and parts of Xieng Khouang and Vientiane) occurs in places characterised by unreliable climates and poor soils. The complexity of livelihood systems in shifting cultivation areas has evolved partly to cope with the risk that this variability imposes. As a result of this inherent complexity, we will never be able to characterise these systems adequately to satisfy scientific requirements for "certainty before action".

2.2 Introduction of new agricultural technologies.

The approach taken by many "action-research" oriented groups for stabilising shifting cultivation (including government departments, NGO's and foreign aid projects) has been to take models that have been successful in other countries and apply them in Laos. Of particular interest has been the sedentarisation of agriculture in some former shifting cultivation areas of northern Thailand, where the climate, soil and cultural conditions are not dissimilar to upland areas of northern Laos. This stabilisation has been largely due to the introduction of semi-commercial agricultural technologies, including production of fruit, irrigated rice, hybrid vegetable seed and vegetable crops. This, in turn, has been facilitated by the introduction of fertilisers, pesticides, irrigation and expanding rural road infrastructure to allow marketing of the agricultural products [12]. Large, long-term inputs have been required from both from government and foreign aid donors [13]

Most of these technologies (eg. fruit trees, field crops, agroforestry systems based on teak) have been demonstrated to work in Laos. There are generally few technological problems in applying these innovations. However, there are two significant socioeconomic problems:

- **Lack of access to markets.**

The rural population of northern Laos is sparsely distributed, mostly throughout the rugged, mountainous regions. Unlike northern Thailand the existing rural road network in Laos is unable to provide easy access to market for most of these people. In 1990, a study found that only 57% of the district centres in Laos (excluding provincial centres) have year round access by road and 17% have no access even in the dry season [19]. For many farmers, the nearest road may be one day's walk or more from their village. Even if the network were to be expanded through the mountainous regions, the sparsely distributed rural population means that the number of people gaining easy access to these roads will remain small for the foreseeable future.

- **Lack of capital**

If there is access to markets, then a lack of capital at farm level often limits the capacity of small farmers to buy into these semi-commercial technologies.

As a result, these introduced technologies are likely to remain limited to those areas around rural feeder roads, especially where development projects are active and providing access to credit and planting materials. This situation is similar to northern Thailand, where after more than 20 years of intensive effort "the success of national and foreigner-assisted development efforts... has only been marginal" [12].

2.3 Strengthening of indigenous agricultural technologies

As described above, introduced, semi-commercial technologies will be limited in area of impact for the foreseeable future by poor market access. However, this does not mean there are no alternatives to assist stabilisation of shifting cultivation and reduction of livelihood risk in remote areas. Farmers in remote areas frequently demonstrate that substantial improvements are possible, simply by the innovations they have made already within their existing agricultural practices. The fact that innovations are being made at all is an indicator of the importance of that activity to farmers. Furthermore, other farmers may not have developed innovations but do have a clear idea of the problem they face with their existing technologies and what they would like to do to resolve it.

By working with these farmers it is possible to strengthen the indigenous technologies and innovations through changes or additions that the farmers themselves develop and evaluate in partnership with development organisations, projects and government agencies. The important point is that there is a role for both indigenous knowledge and introduced innovations, but only when evaluated on-farm with full involvement of farmers. This participatory technology development approach (as described in detail by [9]) is being used by the Lao Department of Livestock and Fisheries and the Forages for Smallholders Project to develop forage technologies in shifting cultivation areas of northern Laos.

Many indigenous strategies and technologies for stabilisation of shifting cultivation are being described at this meeting. The strategies that will be the focus of this paper are those aimed at improved feeding of ruminant livestock in shifting cultivation areas, especially cattle and buffalo. In some cases the indigenous strategies for improved feeding of livestock are completely adequate from the farmers' perspective (as in the case of storing/reserving rice-straw for dry season feeding). In other cases (such as cultivation of forage species) there are real opportunities to work with farmers in improving their current strategies (either with new species or with new ways of incorporating them into the farming system). The reason for these opportunities stems partly from the high degree of motivation of many farmers to improve feeding strategies because of the significant role of livestock in these shifting cultivation systems.

3 The role of livestock in stabilising shifting cultivation

Whilst acknowledging the complexity and diversity of shifting cultivation systems, some generalisations can be made to illustrate the substantial role of ruminant livestock in stabilising these systems. In the remoter areas of northern Laos, rice shortages are common (either annually or as a result of frequent but irregular climatic catastrophes). These shortages can last for 4-6 months or more. Traditionally, farmers have dealt with these shortages by drawing on their natural capital in forests (hunting and gathering), growing other less-preferred food crops (especially maize and cassava) or by buying rice. They often have little to sell to buy the rice, except their labour, opium, some forest products (medicines and herbs) and livestock (cattle, buffalo, pigs, goats and chickens). The government is discouraging the production of opium and forest resources are becoming increasingly unavailable through restricted access, increasing population pressures and resettlement of villages away from their traditional forest resource areas. This leaves farmers with an increasing reliance on livestock as a source of cash income.

Some of the benefits that farmers receive from raising ruminant livestock [8] are that ruminant livestock:

1. have an assured market with relatively stable prices
2. can be raised independent of infrastructure needs (cattle and buffalo can be walked long distances to market. In one recent example, some Hmong farmers walked their 20 bulls from Xieng Khouang 350 km to market in the capital, Vientiane).
3. provide a high profit for relatively low labour input
4. store wealth that can be used at any time
5. utilise natural resources (grass, rice straw, tree leaves) that are otherwise wasted
6. provide a valuable source of manure for maintaining fertility of irrigated rice fields and homegardens. In some areas this is sold by livestock owners to lowland farmers.

Offsetting these benefits are the almost-ubiquitous problems of disease, livestock causing damage to crops and limited feed resources. However, the benefits are so substantial that in almost all areas, despite the drawbacks, farmers continue to raise livestock to reduce livelihood risk.

Traditional feed resources for livestock in shifting cultivation areas are becoming scarce or degraded because of:

1. increased populations of livestock in any one area resulting in an over-utilised feed resource (grassland, rice straw, forests)
2. expansion of agriculture into traditional grazing lands

3. reforestation of grazing land, reducing productivity of native grasses
4. limitations being placed on access for cattle to graze in forest lands.

This limitation has been predicted for many years (for example, [2], [11]). However, the significant point now is that farmers themselves are recognising this problem and, in some cases, are trying to do something about it. Three short case studies are presented here to illustrate this and show the diversity of the feeding problem and the kinds of innovations that farmers are practicing to try to alleviate it.

Case Study 1: Phousy village, Pek District, Xieng Khouang

Phousy is a village of 36 households of lowland Lao (Lao Loum) people located in the semi-remote forested hills of Xieng Khouang Province. Since 1996, Phousy village has been assisted to plan its future development by the German government (GTZ) funded Nam Ngum Watershed Management and Conservation Project.

The villagers have traditionally relied on a mixture of shifting cultivation and irrigated rice for their livelihood. During the [Vietnam] war, the area of Phousy village was heavily bombed. The villagers fled, returning only after the situation became safe. Both the forests on the hills surrounding the village and the rice paddies had been destroyed by bombing and fire. The stream that irrigated the paddies and provided fish, an important food source in this village, flooded in the wet season and stopped flowing during the dry season. The villagers had little choice but to resort to shifting cultivation to survive.

However, they could not cultivate all of the hills and they noticed that, as the forest started to grow back, the stream flooded less frequently in the wet season and flowed more often during the dry season. They wished to allow more forest regeneration and reduce their dependence on the labour intensive and relatively unproductive shifting cultivation, so they began to reclaim their rice fields. As their cattle and buffalo numbers grew, they were able to use the manure to increase the fertility of the lowland soils and to expand the area of paddies. By 1993, all but 5 households in the village were able to stop shifting cultivation completely.

During the wet season, the cattle have to be sent to grazing lands in the mountains more than 5km away so they won't damage the rice paddies. This results in the loss of much manure, which is now a valuable cash earner in the village and recognised by the villagers as an essential input for paddy rice farming. They wanted to keep their animals penned closer to home as often as possible, but were limited by the available feed resource (little more than rice straw) near the village. They also wanted feed at the end of the dry season to condition their buffaloes ready for ploughing.

Two farmers heard of a forage trial that was being conducted forty kilometres from the village by the district agriculture office. One farmer went to the trial and collected a few cuttings of *Brachiaria ruziziensis* ("ruzi") to plant on former shifting cultivation fields near his barn. From 1m2 he now has expanded to a small plot of 200 m2 and three other farmers have joined in. Other farmers in the village wished to join in the expansion but there was not enough planting material. This year, the four farmers plan to expand their areas of ruzi again using vegetative cuttings. There should then be enough seed and vegetative planting material for the other farmers to participate.

Case Study 2: Nam Awk Hu village, Xieng Ngeun district, Luang Phabang.

Nam Awk Hu is a village of 47 households made up mostly of Hmong people. The Hmong are highlanders, renowned for their livestock raising abilities and long involvement in highland shifting cultivation. They settled this village in 1973 as refugees from the war in Xieng Khouang. The village and shifting cultivation fields are about 3km from a major road at an altitude of 800m but the grazing lands and cash crop land are at an altitude of 1200m. Rice yields from the shifting cultivation fields around the village have declined almost threefold (from ~3t/ha) since the village was settled. Shifting cultivation fields in the better soils of the highlands have become overrun with *Imperata cylindrica* and mostly abandoned, except for small plots of intensively-managed cash crops. Rice shortages are beginning to occur in about half of the families of the village.

In response to the rice shortages, people sell their labour, the few cash crops they can grow and, most important, livestock to buy rice. The 170 cattle owned by 31 of the households in the village are kept permanently fenced in the highland grazing areas and managed as a single herd. As an indication of the importance of cattle to these villagers, each villager keeping cattle has been required by village rule to provide a roll of barbed wire for fencing. Once every 3-4 days the cattle must be walked down from the highlands to the river for water (a total distance of about 18km and an 800m drop in altitude).

As dependence on cattle has increased, the herd size has increased and the feed resource in the grazing land has become inadequate, especially in the dry season. The cattle raisers group instigated a requirement that each owner should plant an area of elephant grass (*Pennisetum purpureum*) on abandoned shifting cultivation fields near the grazing land, to be used as cut-and-carry feed supplementation during the dry season. This has been used successfully for more than 15 years, but the farmers have not expanded the areas sown beyond the better soils in locally-moist areas because of the susceptibility of elephant grass to the long dry season.

Case Study 3: Houay Hia village, Xieng Ngeun District, Luang Phabang

Houay Hia is a village of 76 households of Lao Theung (middle altitude) people. The village has been settled in this area for more than a hundred years but has recently relocated to be near a major road. They rely totally on shifting cultivation for their livelihood. As the population of this and neighbouring villages has increased in recent times, the land area available for shifting cultivation has become limited. Shorter fallow times have resulted in large reductions in rice yields (down to less than 800kg/ha). As a result, more than 75% of the families in this village suffer a rice shortage of 4-5 months.

In response to the rice shortage the villagers sell their labour, where possible, and livestock (almost all families have 3-4 goats and 1-2 cattle). However, as there is no fixed location for grazing, the livestock roam freely, sometimes up to 10km away. This regularly causes disputes as animals damage other farmers' upland rice fields and also results in the regular loss of animals through disease, accident and theft.

The strong dependence on livestock to provide income to buy rice has led these farmers to try to establish a dedicated grazing area near their new village location. However these fallow fields, which used to have many species of palatable plants, are now covered by unpalatable weeds, predominantly *Chromolaena odorata*. The villagers have been seeking planting material of forage species that could be grown both on these fallow fields and near their houses, to supplement their grazing animals and keep them closer to the village.

These case studies and experience from other villages in Southeast Asia illustrate that:

- there is usually little flexibility available for farmers in shifting cultivation areas to develop strategies to cope with ruminant livestock feeding problems, apart from

    i. moving livestock between wet and dry season grazing areas,
    ii. storing/reserving rice straw for dry season feeding and
    iii. cultivating grasses on fallow land to provide cut feed for penned animals.

- The first two of these strategies are already well developed throughout the region with few opportunities for adaptation. However the third strategy (managing forages) is rapidly emerging and has significant potential for development in partnership with farmers. The interest at village level is mostly centred on (a) cultivating forage species to provide cut feed for penned animals and (b) improving grazing areas for the use of communally managed herds of cattle at strategic times

- the reasons for this interest are highly variable (eg. in only three case studies, the farmer motivation included wet season supplementation of cattle, dry season supplementation of buffaloes and cattle, increased manure availability for using on irrigated rice fields, control of animal damage to crops and minimisation of animal losses)

- in many instances, the motivation for managing the feed resource is strong but innovation is limited simply by a lack of access to information and planting material.

- success in development of forage technologies does not depend on the quantity of planting material distributed initially but on the careful selection of farmers who have a real problem that they want to solve in partnership with development workers (see, for example, Case Study 1). If this is then combined with a broad range of robust technologies, the chances of successful adoption are much higher [9]. For example, the upland areas of Bali are now renowned for the widespread use of the shrub, *Gliricidia sepium* as a living fence and source of dry season fuel, but this species was only introduced in 1970 as a hundred cuttings. The key was that the farmers had a real problem that they recognised themselves and the species was robust and easy to manage.

4 The role of introduced forages in stabilising shifting cultivation.

Through a partnership of farmers and development workers, introduced forage species are currently being developed into technologies that can help stabilise shifting cultivation in northern Laos. This is happening in two ways:

4.1 Comparing indigenous feeding strategies (such as cutting and grazing) with the same strategy using introduced species

Regional evaluations of more than 70 forage species at five locations in Laos have identified eight broadly-adapted and robust species that are now being evaluated by approximately 100 farmers in three northern provinces for their potential in cut-and-carry or grazed systems. These species are:

- *Brachiaria brizantha* (currently cv Marandu with other lines soon to be tested)
- *Brachiaria decumbens* cv Basilisk
- *Brachiaria humidicola* CIAT6133
- *Brachiaria ruziziensis* cv Kennedy
- *Andropogon gayanus* cv Kent
- *Panicum maximum* T58
- *Paspalum atratum* BRA9610
- *Stylosanthes guianensis* CIAT184

At this stage, evaluations are informal, without replication, to encourage both a greater number of farmers to participate and farmer innovation. Should innovations emerge that have promise they will be both encouraged by farmer-to-farmer visits and studied in more detail in formal, replicated trials on-farm. This process is illustrated by the participatory forage evaluations conducted in Makroman village, East Kalimantan, Indonesia

Case Study 4: Makroman Village, Samarinda, East Kalimantan, Indonesia

Makroman is a village of transmigrants who moved to the area from Java 20 years ago. When they arrived the rolling, uplands were newly cleared and the moderately fertile soils were ready for cropping. However, the area was large and they were unable to cultivate it all. Gradually *Imperata cylindrica* spread until now the village is located in a "sea" of *Imperata*. The farming system of this village is a mixture of irrigated rice production, dryland cropping and livestock production. In 1994, some small, informal forage trials were planted with 10 farmers in Makroman. Although many species looked promising to the development workers, at the end of these trials no farmers were interested to continue planting these forages as they did not consider the benefits to be great enough when compared with the traditional (and zero-input) grazing resource (the *Imperata* area). However, one farmer, with the support of the extension worker, had previously tried oversowing a small area (100m^2) of corn with the legume *Centrosema pubescens* CIAT15160, when the corn was two weeks old. He was surprised to find that the crop grew quite well, without needing the chemical fertiliser he would normally have to apply. He also did not have to weed the crop as was his usual practice. When he harvested the crop, the ears of corn were larger than his usual crops and he was able to sell the harvest for a substantially increased profit, partly because he did not have to buy any fertiliser. Since then he has greatly expanded the area and each time he replants with corn (now six successive crops), he has not had to do any land preparation because the soil is still moist and friable underneath the mulch of *Centrosema*. Thirty neighbouring farmers, seeing these benefits, have asked for seed to try the same oversowing practice. This seed is being provided but at the same time, the innovation is going to be studied in more detail (in partnership with several farmers) in replicated trials on-farm to quantify and better understand the benefits.

4.2 Developing new ways of incorporating introduced forages within existing shifting cultivation systems

Farmer-managed trials are either in progress or commencing this year in northern Laos for farmers to evaluate and adapt three potentially-useful innovations suggested by researchers from experience elsewhere. These are

i. forage tree species for fencelines

Livestock damage to crops is a major and constant concern for farmers in the upland areas of northern Laos (eg. [5]). Farmers already are using some living fences (mainly *Jatropha curcas*) to either keep their animals fenced in or to fence animals out of their fields. In other areas, especially those managed by Hmong people, a huge amount of effort is spent building solid, semi-permanent fences from wood, wire and bamboo. Living fences incorporating *Gliricidia sepium*, *Leucaena leucocephala* (on better soils) and *Calliandra calothyrsus* (in the higher areas) have large potential to ease (from a technical perspective to ease this burden and provide supplementary feed. However, these need to be evaluated by farmers and development workers together to both elicit the technical advantages and limitations but also the farmers' criteria for accepting or rejecting the technologies.

ii. Stylosanthes guianensis CIAT184 oversown into upland rice.

Oversowing upland rice with *Stylosanthes guianensis* is not a new innovation (see for example, [10], [15], [16], [17] and [18]). It has the potential to (i) improve subsequent fallows or (ii) provide benefits (reduced weeding, improved fertility) for the subsequent rice crop. The use of forage legume species for fallow fields in shifting cultivation areas has been the subject of much detailed and promising research (see for example, [14]). Although the potential benefits over weed fallows (reduced weeding requirements, improved soil fertility, easy establishment after a round of weeding and reduced risk of erosion) are well documented (for example, [6]) there has been little adoption by farmers. There are many reasons for this, but probably the two most important are that:

- all of the work in Laos so far has been on research stations or in researcher-managed trials with the expectation that the technologies can then be "extended" to farmers. There is a need to establish informal oversowing trials with farmers to discover what aspects of oversowing appeal or do not appeal to farmers, and also gain an insight into what treatments should be investigated in subsequent formal trials.

- sowing fallow fields with forages means then being able to protect them from uncontrolled grazing by animals. Fallow improvement with the farmers of Hoauy Hia village would almost certainly fail because of the lack of sturdy fencing. However, in Hmong areas where individual fallow fields are often sturdily fenced, the potential is much higher.

Informal (and formal) trials with farmers have commenced with oversowing *Stylosanthes guianensis* CIAT 184 in upland rice fields after the first round of weeding. This species has demonstrated particular potential in other trials because of its rapid establishment, low impact on rice yields (if sown late enough) and ability to grow well on poor soils. Several other legume species are being considered for this purpose also.

iii. *Centrosema pubescens* oversown into maize.

In several areas of northern Laos, farmers have complained about the burden imposed by weeding maize fields. This is especially true in areas of poor soils where the growth of the maize is slow enough to not be able to outcompete weeds. Following on from the success of the farmers in Makroman village, Indonesia (Case Study 4), several legume species (including *Centrosema pubescens, Stylosanthes guianensis* CIAT184 and *Chamaecrista rotundifolia* cv Wynn) are being evaluated in informal trials oversown into young maize with farmers in northern Laos. A case study illustrates the need for this kind of technology:

Case Study 5: Pianglouang village, Pek District, Xieng Khouang

Pianglouang is a mixed Hmong and Lao Loum village located on the treeless Plain of Jars. The 14 Hmong families were resettled into this village 3 years ago. They have no access to forest or paddy land (all of which is already utilised by the Lao Loum hamlets) and they do not yet have livestock for sale. That is, they do not yet have any of their traditional sources of income or native food to help them through a time of crisis. They rely totally on their upland rice fields and maize for survival. The soils are of moderate to poor fertility so growth of maize is slow. The critical time for weeding the maize crop is during the first six weeks but this is also the time that the farmers are busiest in the upland rice fields, so weeding of the maize is minimal. As a result, yields are poor. The problem has become so severe that, despite the need for maize in the village, these farmers will abandon their maize fields this year if they cannot find a simpler way to control weeds. They are one group evaluating legume cover crops oversown into the maize.

5 Conclusions

For the most part, farmers in shifting cultivation areas of northern Laos are strongly dependent on ruminant livestock for the security of their livelihoods. Diminishing feed resources for these animals have resulted in some farmer groups taking steps to manage the feed resource (particularly through planting introduced forage species). Others recognise the problems but have had no access to information or planting materials to develop their own forage technologies. Both groups of farmers provide an opportunity for development workers to strengthen the local feeding technologies, both through the introduction of new, robust forage species for comparison with their existing species and through the evaluation of new ways of incorporating forages into the existing farming system.

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