Agricultural Extension for Uplands

Chapter for State Agricultural Institute National Curriculum, Myanmar

MYANMAR INSTITUTE FOR INTEGRATED DEVELOPMENT

MOALI
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Ryan Sherman, Alexander Fenwick and Trevor Gibson.

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About this chapter

This chapter is designed to introduce State Agriculture Institute (SAI) students to upland agriculture from the perspective of nutrition sensitive agricultural extension. While the examples are drawn primarily from upland Chin State in Myanmar, many of the issues discussed are common to uplands throughout Southeast Asia.

The key messages and study questions throughout the text are intended to encourage a wide understanding of upland farming systems. The boxes look more deeply at relevant issues with recent examples from Chin State. Teachers may wish to use these as prompts for discussion and examination.

Finally, while this chapter is not a technical instruction manual, it does contain many relevant examples with technical information. We have also included a detailed bibliography for students wishing to look more deeply into a particular subject of interest, along with a few choice instructional materials for technical information in the Annexes.

Annex 1 offers a step by step overview of Sloping Agriculture Land Technology (SALT), a proven approach to cropping on hilly terrain.

Annex 2 presents Myanmar Institute for Integrated Development (MIID)'s training manual for nutrition sensitive home gardening in upland Chin State in both the Hakha and Myanmar languages.

Annex 3 is for students who pursue a specialization in a crop that is well-suited to uplands. It presents cultivation guides for the crops prioritised by Chin State's Department of Agriculture.

Additional resources, including videos, further readings, and the full bibliography of this chapter are also available at myanmaruplandsagriculture.info.

1. Agriculture in Uplands

1.1 What are Uplands?

Before introducing upland agriculture, we should begin by explaining uplands themselves. In ordinary usage, the term **uplands** refers to those lands elevated above adjacent lands in a larger geography. Uplands is also often used as a modifier for describing things related to these elevated areas such as people (as in upland ethnic minorities), ecologies, (such as upland habitats), and human behaviours (such as upland agricultural practices).

While this general usage may seem straightforward, formulating a precise definition of uplands can be surprisingly difficult. Many large flat plains in the world (such as Jianghan Plain in China and the Great Plains of North America) are notable for their relatively high elevations. Likewise, regions near coastal areas with great topographic variation might share many characteristics with mountainous uplands despite a relatively low elevation. The term *tablelands* is often used to describe plateaus, yet you may come across literature that treats plateau areas as uplands. *Highlands* is another term often used to describe mountainous areas—it is sometimes used interchangeably with *uplands* but often denotes areas higher and more mountainous than uplands.

These overlapping and inconsistent usages need not be a problem. The term uplands does not denote an exact set of features or lands within a specific elevation range. Rather the terms *uplands* and *lowlands* are most useful when contrasting two adjacent areas of different elevations with important topographical, social, historical or agricultural differences.

These are not always big differences. Within the Central Dry Zone of Myanmar for example, the terms *lowlands* and *uplands* are sometimes used to distinguish between relatively small shifts in elevation yet each with distinct cropping systems. These lowlands are characterized by rice-based systems - and the systems of the adjacent uplands by traditional row crops such as groundnut, pigeon pea, and sesame.

So what makes uplands *uplands*? Rather than try to come up with a precise definition, a much more useful approach for our purposes will be to identify general characteristics often associated with uplands that are relevant to rural development and upland agriculture.

General geographic characteristics of uplands in Southeast Asia include:

- Elevated above drainage basins and alluvial plains (flat areas created by sediment deposited by rivers coming from higher lands over a long period of time)
- High-relief topography: uneven landscapes with many hills, cliffs, and steep ridges
- Smaller and faster flowing streams characterized by rocky sediments and exposed bedrocks
- Lower populations
- Ethnic minority populations often perceived as remote and difficult to reach by lowlanders
- Highly diverse agricultural systems in challenging farming conditions, in which topography often limits the size of the plots
- A greater proportion of the population engaged in farming near the subsistence level
- More variable weather and generally lower temperatures than nearby lowlands

By contrast, lowland systems are characterized by:

- Land that is generally lower and flatter than an adjacent area
- Larger rivers with slower flowing waters
- Historically where **mechanization**, consolidation, and monocrop systems first appeared
- Finer sediments and richer soils
- Higher rates of flooding
- Higher populations with numerous growing population centres
- Smaller proportion of the population engaged in subsistence farming

Key Message: 'Uplands' is a relative term used to distinguish higher, more mountainous areas from lower surroundings. Upland regions in Southeast Asia are often characterised by isolation and diversity in farming systems, whereas lowlands are generally more uniform.

1.2 Types of Uplands Farming Systems

Food and nutrition insecurity are disproportionately high in Myanmar's uplands

Child stunting is caused by poor nutrition over many years and is therefore a good way to measure the extent of poor nutrition in food insecure areas. A child is said to have stunted growth if he or she is much shorter than the average for his or her age (two standard deviations shorter). While populations will inevitably have a few very short children due to natural variation of height in populations, food insecure areas see much higher percentage of stunted children due to nutritional deficiencies during key growth periods.

In Myanmar, stunting rates show that poor nutrition is a challenge across the country. The Myanmar 2015-16 Demographic and Health Survey found that 29% of children nationally are stunted[1], while showing signs of chronic malnutrition. This is why promoting nutrition in the first 1000 days of life (from conception to a child's second birthday) is a priority for many organisations involved in public health in Myanmar.

Although many more malnourished children live in lowland areas in Myanmar (because of those areas' larger populations), a higher percentage of children in upland areas are affected by malnutrition-related stunting, for example in Chin State (41%) and Kachin State (36%).

With the efforts of government agencies and development organizations, much vital information about deficiencies and constraints has been collected on Myanmar in recent years.

This information should inform how agricultural extension agents plan their activities, promoting nutritious crops and combining extension activities with nutrition education will help project participants plan for the best possible nutrition regimes for their families. For example, vitamin A and Iron deficiencies suggest an emphasis on growing or getting access to fresh greens is needed. Likewise, protein deficiencies suggest efforts should be taken to increase poultry, fish, and pig production capacities and to grow pulses where appropriate.[2]

[1] Myanmar. "Demographic and Health Survey: 2015-16." Myanmar Ministry of Health and Sport and DHS Program. 2017: 11.
[2] LIFT. "Leveraging Essential Nutrition Actions To Reduce Malnutrition (LEARN) Project." 2012.

The diversity and mixture of farming strategies found in upland contexts is a natural consequence of the **heterogeneity** (being composed of many diverse parts) of uplands environments. A heterogeneous environment is one made up of many dissimilar parts and features with much variation that may change from year to year. Farmers in upland systems must contend with landslides and water runoff that can greatly alter the land's topography. Differential access to water resources, fertile soils, flatter areas, and hours of sunlight will affect which crops should be grown on a given patch. Suitable space and access to water and pastureland will determine how many and what kinds of animals can be kept.

Upland agriculture in Southeast Asia is therefore characterized by diverse systems adapted to heterogeneous environments. Upland people depend on a wide range of livelihood options to achieve food security and reduce vulnerability to unpredictable conditions. Livelihood practices will be a combination of multiple strategies adapted to household needs and local geography.

Below are several different kinds of farming systems found in upland contexts. For simplicity, each practice is discussed as a static, self-contained system, but remember that the farming strategies of an upland farmer will often change and overlap.

1.2a Permanent Farming

Permanent farming (also known as permanent agriculture, sedentary agriculture, and permanent cultivation) emphasizes the continuous cultivation of plots of land, season to season and year to year. Plots cultivated via permanent farming methods rarely lie fallow. These fields are usually clearly marked with a locally (if not officially) recognized **smallholder** owner who lives nearby. The term "smallholder" refers to a farmer who owns a family farm (a smallholding) that grows a mixture of subsistence crops and cash crops to support the household.

Permanent farming is often contrasted with agriculture in which land is cultivated temporarily. This approach to agriculture is known as shifting cultivation and is the topic of the following section.

Intercropping is an agricultural practice which involves planting two or more crops in the same field. While also found in shifting cultivation, intercropping is a prominent feature of much upland permanent agriculture. This approach is recommended as a strategy to improve soil health, manage pests, reduce erosion, increase productivity on limited land, and provide services to other crops, such as partial shade. For upland systems, intercropping can also be used as a strategy to strengthen soil structure on hillsides (see section 2.1).

The **continuous cultivation** of permanent farming is often associated with **crop rotation**, although this practice is less common in Southeast Asian uplands. Farmers practicing crop rotation will alternate which crops are planted on a given plot of land, often by season or year. Although not as widely practiced in Southeast Asia, crop rotation is an important aspect of some Southeast Asian crop systems such as when a dry season vegetable crop is grown between rice crops.

Finally, permanent cultivation illustrates a fundamental principle of cropping systems, the direct relationship between soil fertility and crop yields. In cropping systems in which land is continuously cultivated, soil will become less fertile and yields will decrease if the soil is not improved with interventions such as fertilizer inputs. These interventions are discussed in section 2.

Key Message: Permanent cropping takes many forms in uplands but always features continuous cultivation of land, a cropping strategy that requires inputs to maintain soil fertility and high yields.

1.2b Shifting cultivation

Many upland areas in Southeast Asia are dominated by a traditional agriculture method known as **shifting cultivation**—one of the oldest and most widely practiced agricultural systems.

Shifting cultivation is so named because farmers who practice shifting cultivation will move their plots from place to place. Under this system, a plot of land is cultivated for about one to three years until most of the useful nutrients have been extracted and the land is no longer **fertile**. The plot's low fertility state after several years of cultivation is known as **soil exhaustion**. For a farmer, the most obvious sign of soil exhaustion will be a significant decrease in crop productivity. The fruits or vegetables and grain yields will be smaller and fewer in number and the crops will not have grown as high as the year before.

At this point, a farmer practicing shifting cultivation will clear a new plot and abandon the previous plot. The abandoned land is then said to lie **fallow**. For several years it will not be cultivated and will tend toward a natural state as it becomes overgrown with wild plant species. During regeneration, farmers will often still find uses for the uncultivated plot as a source of useful forestry products available during different stages of the regrowth.[3] After lying fallow for many years, eventually the nutrients build up again in the soil (see section 2.1) and a farmer may then return to the plot again to clear the vegetation and begin farming.

A shifting cultivation system is therefore land cleared and cultivated for a relatively short time and then left fallow for a much longer time. In Chin State, this uncultivated period has traditionally been as many as 15 years but more recently 6 to 9 years.[4] For the Lawa of Thailand or Kayin of Myanmar, fallow periods of shifting cultivation plots have lasted as long as 12 years.[5] As it reverts to its natural state, the farmer moves to another plot. Once the natural fertility of the soil is restored, the farmer may return and cultivate the land again.

One common form of shifting cultivation depends on the cutting down (slashing) and burning of the trees or woody plants in the new field. A field that has been cleared in this manner is known as a swidden. This agricultural method is known as 'slash and burn' or swidden agriculture.

Fire is an efficient and inexpensive way to clear woody vegetation for crop production. Burning plants reduces the risk of infestations of pests and weeds while concentrating important nutrients in the topsoil, especially nitrogen,[6] but also calcium, potassium, phosphorus, and magnesium. It requires low inputs (beyond labour) and capital (only hand tools). In areas of low population density, traditional shifting cultivation with long fallow periods is regarded by most tropical

[3]Schmidt-Vogt, Dietrich. "Relict Emergents in Swidden Fallows of the Lawa in Northern Thailand," Cairns, Malcolm. Voices from the Forest. Washington, DC: Resources for the Future, 2007: 38.
[4]Fayon, Stephane. Alternative to Shifting Cultivation: Slash and Mulch in Northern Chin State, Myanmar. CORAD—GRET. 2018. 5.
[5]Schmidt-Vogt, Dietrich, "Relict Emergents…" 38
[6]Giardina, C. P., R. L. Sanford, and I. C. Døckersmith. 2000. Changes in Soil Phosphorus and Nitrogen During Slash-and-Burn Clearing of a Dry Tropical Forest. Soil Sci. Soc. Am. J. 64:399-405.

agriculturalists as an adequate way to manage soil fertility. [7]

While much of the world's food production has transitioned to industrial-scale farming, slash-and-burn systems are still practiced by millions of people in upland rural communities across South and Southeast Asia and are often regarded as an expression of cultural identity. In Vietnam, some estimates put the number of people practicing upland shifting cultivation as high as 3 million across 50 ethnic groups. [8]

Slash-and-burn agriculture is sometimes depicted as a destructive practice, a criticism with some merit. Burning plant cover often involves the destruction of large parcels of forested land. While populations remain low, land is able to recover and permanent damage to forests is minimal. Yet as population densities increase, more land must be burned and fallow periods become shorter with less time for regeneration. Forest biodiversity is lost. Agricultural land becomes less fertile. In uplands, loss of plant cover can also lead to serious erosion,[9] which leaves the land useless for both forest and farming.

Slash-and-mulch is an alternative to slash-and-burn which has been experimented with in Chin State by the Choklei Organization for Rural Agricultural Development (CORAD) with good results. This technique seeks to reduce the stresses on plots of land at risk by intensified slash-and-burn practices. Rather than burn regrowth and crop residues, plant material is collected and spread out on the soil as mulch before the rainy season. In this way, soil moisture is better retained and soil stresses that lead to problems such as erosion and water quality loss are reduced.[10] While the initial crop yield will not be as high, soil quality and crop yields will steadily improve over subsequent years.

Farmers participating in CORAD's experiments with slash-and-mulch reported that although slash-and-mulch required more labour, the method produced positive results:

"The soil is darker, easy to dig, easy to pull out the weeds—there are fewer weeds compared to slash-and-burn plots. Sometimes micro-organisms and earthworms could be found at the test plot that showed the soil structure is changing [to become more fertile]."[11]

Key message: Shifting cultivation takes advantage of natural soil fertility and burning to maintain a high yield production system. When over-practiced, shifting cultivation can result in environmental degradation.

[7] Nair, "An Introduction to Agroforestry," 60.
[8] Sam, Do Dinh. Shifting Cultivation in Vietnam: its social, economic and environmental values relative to alternative land use. Ministry of Forestry. 1994
[9] Sarma, Kiranmay. Impact of Slash-And-Burn Agriculture on Forest Ecosystem in Garo Hills Landscape of Meghalaya, North-East India. Journal of Biodiversity Management & Forestry, 2013: 3.
[10] Fayon, S. Alternative to Shifting Cultivation...
[11] Dr Peter Lian, correspondence.

Changing patterns of shifting cultivation around Hakha, Chin State

In Chin State, like many upland areas in Southeast Asia, shifting cultivation has been practiced since ancient times. In addition to being a type of land use, many people consider shifting cultivation an expression of upland cultural identities.[12]

Since colonial times, changes in the way that shifting cultivation shapes the landscape around Hakha have been observed. For example, fallows are far shorter now (just a few years) than in the early colonial era (a generation or more). Shifting cultivation plots are also generally closer to the village and the trend is towards permanent farming with home gardens increasingly prevalent.

It is easy to attribute this change to the **outmigration** that characterised Chin State's late 20th and early 21st century history. As many young people moved away from rural areas, the labour force for shifting cultivation has diminished. However the story may be more complex than this.

It is worth noting that demographic changes, as an influence on the geography of shifting cultivation, were already being recorded in the colonial era.

Recent research[13] has brought social, political and even cultural drivers of change to light. The introduction of fixed village boundaries by the British colonial regime and the later suppression of millet cultivation by missionaries (itself to discourage the brewing of millet wine) are examples. The rise in cultivation of rice is also a factor.

Another factor driving upland Chin State towards permanent farming is the advent of sufficient market linkages for cash crop production[14] and Chin State's closer coupling with the wider region in the 21st century. Connections to markets have been shown to be strong drivers of transitions from shifting to permanent cultivation worldwide.[15]

Therefore the real question is not what caused the decline and change in shifting cultivation practice in Chin State, but why does it persist at all?

One answer is that shifting cultivation is a low-input land use. It therefore represents low risks for farmers who live in poverty, and involves minimal investments. It might be best understood as a default land use for farmers with minimal access to inputs, who operate in vulnerable or changing livelihood circumstances.

[12]Aryal, Kamal Prasad, and E. E. Kerkhoff. "The Right to Practice Shifting Cultivation as a Traditional Occupation in Nepal." Kathmandu, Nepal: International Labour Organization, 2008.
[13]Frissard, C. and Pritts, A. "The Evolution of Farming Systems and Diet in Hakha Township, Chin State, Myanmar." LIFT: Yangon. 2018. Boutry, M; Allaverdian, C; Tin Myo Win and Khin Pyae Sone . Persistence and Change in Hakha Chin Land and Resource Tenure. GRET: Yangon (2018)
[14]Frissard and Pritts. "The Evolution of Farming Systems. 2018.
[15]Nair. "An Introduction to Agroforestry." 1993: 48.

1.2c Agroforestry

Agroforestry is a land-management approach which incorporates trees or shrubs into cropping systems. Agroforestry can be considered a special kind of intercropping.

Trees and shrubs provide excellent cover for areas exposed to high winds and heavy rains. They also help make the soil less susceptible to erosion and lower the effects of heat stress in the summer. Incorporating trees among crops or at the perimeter of plots can be critical in stabilizing hillsides.

Agroforestry has also been championed as a strategy for sustaining biodiversity in cropping systems by helping maintain soil cover year round, providing habitats for insects and animals, increase microbial activity in the soil and improving soil quality. Advocates for agroforestry maintain that an agroforestry plot will be more resistant to crop-targeting pests and diseases, requiring fewer applications of pesticide and fungicide.

Alley-cropping is an approach to agroforestry that has received much attention in recent years.[16] In this approach, crops are planted between hedgerows of trees or shrubs. The trees or shrubs offer protection from wind and erosion and are often a leguminous species to improve soil fertility.[17]

However, agroforestry systems are highly complex and require long-term planning. Not only must the right trees and shrubs be matched well to the specific crops, but farmers must account for proper spacing, timing, and planting combinations that maximize complementary interactions. If not done properly, trees and bushes might end up competing with crops for soil nutrients and water. They may crowd out crops and diminish access to sunlight. In short, they may cause more problems than they solve. Agroforestry systems therefore require participatory approaches, much local knowledge and patience to develop well.

Taungya is a well-known agroforestry intercropping system pioneered in Myanmar and practiced throughout Southeast Asia. In a taungya system, farmers plant tree seedlings alongside food crops and continue to produce crops while the trees grow. The saplings greatly benefit from the field maintenance for the crops, such as weeding and applications of fertilizers. After a few years the tree canopy becomes too dense for crops to grow well, and the food cropping stage is ended. Land becomes devoted only to its function as a tree plantation and farmers will move food production elsewhere.

Taungya has been increasingly adapted to the shifting cultivation of upland systems. As timber demand increases, farmers practicing shifting cultivation have been known to plant desirable trees alongside the new crops.

Unlike other intercropping systems that incorporate trees, the final outcome of taungya is tree production rather than food production. This approach not only helps re-establish deforested areas and maximise land use, but also enables farmers to get the most out of their labour by effectively cropping two completely different systems at once. [18]

Key Message: Agroforestry incorporates trees into cropping systems, and if well-established can create highly resilient cropping systems in uplands.

[16] Nair, “An Introduction to Agroforestry,” 123.
[17] Nair, “An Introduction to Agroforestry,” 68.
[18] Nair, P. K. R. An Introduction to Agroforestry. Dordrecht: Kluwer Academic Publishers, 1993: 78.

1.2d. Livestock and poultry

Livestock can generally be thought of as those farm assets that are live animals. As a category, livestock always includes ruminant animals such as bovines (cattle, gayal, buffalo, yaks, oxen), sheep, and goats. Non-ruminant animals, such as chickens, pigs, and horses are also usually considered livestock in the context of smallholder farms.

Livestock play a range of roles on smallholder farms. Their potential as a food source is only one important use. They may also be used for transportation, tillage, as a source of fertilizer, as a source of income through raising and selling, and in important cultural roles. Livestock have often acted as a kind of bank, that is, as a store for value in the long term which can be readily bought, sold and exchanged and to be relied on during hardship years. As tractors and motorcycles have gradually penetrated upland systems in Southeast Asia, large animals are being used less often for transportation and tillage.

Throughout Southeast Asia, water buffalo have traditionally been used for tilling rice fields, including upland rice paddy. Their large frame and hooves have made them ideal for ploughing in deep water and mud. Today tractors are increasingly being used for tillage, even in upland systems. Sheep, goats, buffalo, and cows can provide milk for dairy production, which is an important part of many upland systems worldwide, but is not widely found in Southeast Asia.[19] Leather, skins, and wool are other important products in many upland systems, especially those with temperate climates.

Pigs' ability to forage and digest many foods allows them to play a unique role in smallholder systems. In addition to corn and rice, they are often fed household food waste and crop residues, such as banana stems, eggshells, soured milk, peels and rinds. In this way, pigs are able to convert inedible waste into protein rich food.

Poultry production can be practiced with limited feed inputs. Most Southeast Asian upland smallholder farms practice scavenging or free-range chicken farming.[20] Scavenging birds receive almost no attention from farmers and scavenge for most or all of their food. Free-range chickens also forage for much of their food but are often provided with housing at night and some supplementary feed.

Like cropping systems, upland livestock systems will likely have fewer purchased inputs available. While for lowland farmers purchased feed may be central to their livestock systems, upland farmers will likely face inhibitive costs and transportation challenges that put purchased feed inputs out of reach. In such circumstances, upland farmers will adopt a conservative, integrated approach that takes advantage of local sources of feed. These may include integrating livestock systems with home gardens, harvesting local insects for chicken feed, or mixing key purchased ingredients with locally available resources.

Key message: In the heterogeneous contexts of upland farmers, livestock play a diverse number of roles within larger agricultural system of the farmstead.

[19]International Livestock Research Institute. Smallholder Dairying in the Tropics. Edited by J. Lindsay Falvey and Čharan Čhanthalakkhanā. Nairobi, Kenya: International Livestock Research Institute, 1999, pg 39.
[20]Dixon, John A., David P. Gibbon, and Aidan Gulliver. 2001. Farming systems and poverty: improving farmers' livelihoods in a changing world. Rome: FAO.

Feed Challenges for semi-intensive chicken production in Chin State

Protein is critical for physical and cognitive development in young children yet is deficient in many diets in Chin State. Improving poultry production offers a protein scarcity solution, and Myanmar Institute for Integrated Development (MIID) sought to build on and enhance local knowledge of poultry production as part of its 2016-19 programme in Hakha Township.

Traditionally, chickens in Chin State are kept as free-range birds, scavenging for food and getting most of their protein from insects. This approach is low-input but also low-productivity. Not only does local conditions limit bird size and flock size, but chickens are easy prey for predators and are vulnerable to disease.

MIID helped local farmers transition to a semi-intensive poultry production system. In this approach, a flock is kept in a chicken house with a scavenging area attached. This allows the chickens to grow more quickly, lay eggs more frequently and be better protected from predators and disease outbreaks. Proper procedures should be followed to maintain good hygiene and quarantine sick birds. However, while this method is high-productivity, it is also high-input. It requires farmers provide sufficient feed for the chickens in a daily ration, as they can no longer scavenge for themselves.[21]

It was then necessary for the project to find sustainable feed sources to help farmers provide the optimum feed ration. The primary limiting nutrient was protein which, as for humans, is key to healthy growth in chickens. Energy sources (rice or corn), vitamins (green vegetables) and minerals (shells) proved more easy to obtain through plants and other resources in the project villages.

Farmers experimented with different local protein sources. One good source was termites which some older farmers remembered previous generations harvesting for animal feed. A simple technique of encouraging termites to expand their nests into a container was (re)introduced; making use of (and revitalizing) existing local knowledge.

[21] moveable chicken run is sometimes a good ‘halfway’ option between free range and semi-intensive systems. It allows the chickens to scavenge in a limited area whilst protecting from predators. It does not necessarily optimize the chicken’s diet, but is a lower-input option.

1.2f. Aquaculture[22]

Upland aquaculture provides a high protein food source for households and a valuable product to sell on local markets. Yet aquaculture is not well-suited to many upland settings. The scarcity of flat land limits locations suitable for pond construction - and often ponds must be built far from farmers' houses and roads. Not only must the land be sufficiently flat, but the porosity of the soil (the volume of pore space in soil filled by air, water, or gas) must be low so that the soil retains water well. Soil composition will also affect water quality, which must be hospitable to fish. Even if all these conditions are favourable, upland farmers may be reluctant to invest time and resources in pond building and maintenance, especially if the area is prone to landslides—as is true of much of upland Chin State. Therefore, the feasibility of aquaculture in upland systems depends on good pre-existing conditions in specific areas.

Upland aquaculture is often practiced simply by catching fingerlings from local sources, depositing them in fishponds, and allowing them to grow with little interference. By contrast, high production fishponds require considerable labour, feed, and expertise. Productivity will depend on good pond maintenance, pond width and depth, quality fish feed, access to quality fingerlings, and controlled fertilization. Given the labour and capital investment that highly productive fishponds require, the low-input, low-productivity approach often

[22]FAO. Fish Pond Construction and Management: a Field Guide and Extension Manual. 2005.
FAO. Funge-Smith, Simon. Small-scale rural aquaculture in Lao PDR.

represents the optimal use of time and resources in uplands.

Because of its specialized nature, efforts to develop upland aquaculture will often focus on increasing productivity in areas already practicing aquaculture, rather than attempting to establish it where it does not yet exist.

When possible, fishponds make for an excellent component of integrated farming models. Chicken houses or pig pens constructed near or over fishponds will enrich the natural food in the pond through their droppings. Kitchen wastes and other farm by-products, such as cassava, rice bran, and broken corn can be thrown into the pond. Nearby termite nests can be collected (or even cultivated) and tossed into the ponds as a high protein food source. Likewise weeds and other vegetative material can be used to raise grass carp (*Ctenopharyngodon idella*).

Although more common in lowland areas, fish farming in uplands has sometimes been integrated into upland rice fields. As upland rice often depends on diverted water from streams as the primary water source, fish will often naturally spawn in rice fields. Farmers practicing upland rice-fish culture can take advantage of this situation by raising the rice pond walls to increase water depth and transferring fish among ponds during different growth stages.

Key message: The diverse terrain of uplands presents many challenges to aquaculture. Whether fish ponds are effective will depend greatly on the local conditions of a given area.

Aquaculture

In 2017, Myanmar Institute for Integrated Development conducted an assessment of aquaculture in Hakha Township to assess aquaculture's potential to improve nutrition deficiencies in Chin State. The results of this assessment helpfully illustrate the unique challenges faced by upland aquaculture systems.

Unsurprisingly, fish farming was found to be highly constrained by unavailable flat land and unreliable supplies of water. The most common fish farmed in Chin State by far is Common Carp, Cyprinus carpio, called in Burmese"Shwe War Nga Kyin."

Past efforts by the Department of Fisheries found that Tilapia was unsuitable for the colder climate in Chin State and Grass Carp unable to breed without induced spawning. Cultured far less often is Grass carp, Ctenopharyngodon idellus, called "Mietsa Nga Kyin" in Burmese. This is because it cannot be bred locally and require fingerlings important from lowland distributors, such as those in Kalay or Mandalay.

In Chin State, a few well-respected fish farmers have been successful and possess sufficient technical knowledge to separate male and female breeders into different ponds. Done properly, fingerling production requires careful attention to weights and breeding dates and number of days with a nursery pond ready for eggs.

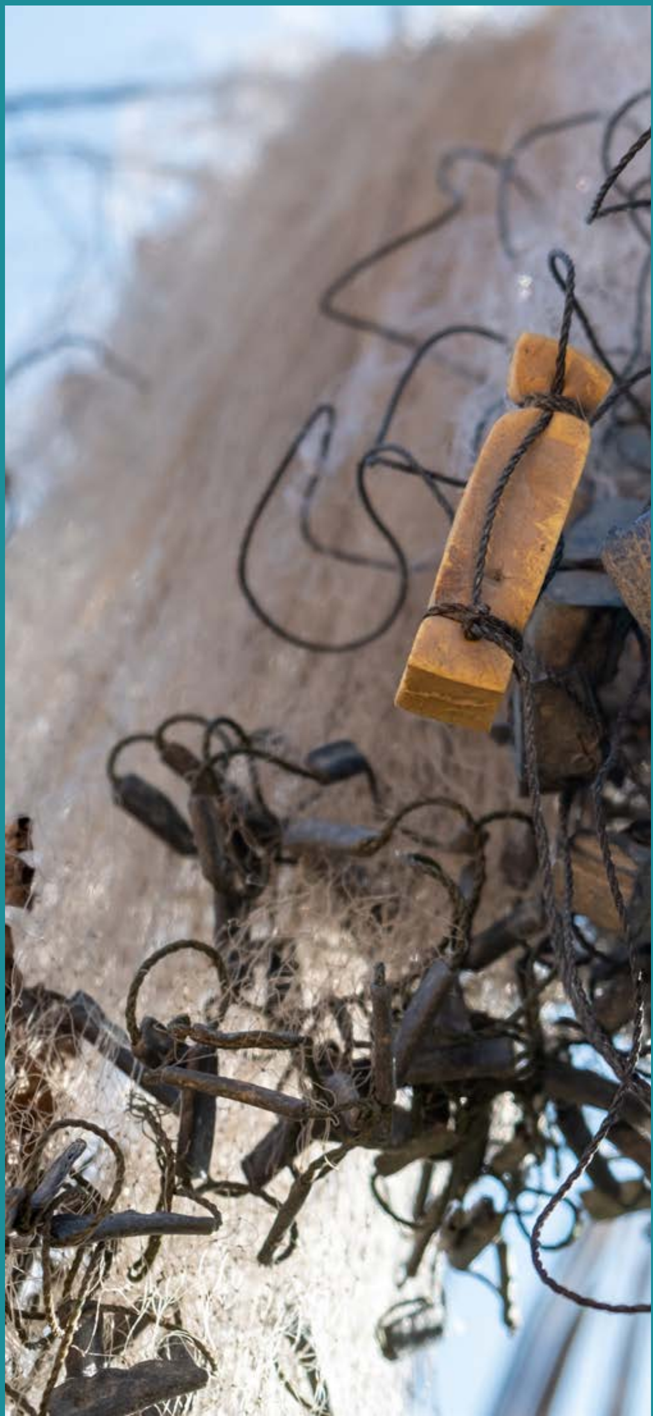
Yet in Chin State, only a few farmers paid attention to egg quality, and none paid attention to other brood-stock selection criteria such as favourable body shape, body colour, responsiveness to feed, growth and mortality rates, resistance to diseases, or adaptability. Improving this knowledge gap is an important point of intervention for future extension work.

Although better suited to aquaculture, many villages with less hilly landscape at lower elevations did not make fish ponds. This was largely because villagers had access to fish in rivers and streams already, and also preferred using the land for upland rice.

Most farmers with fishponds were found to not generally restock their ponds with new fish and do not know how many fish they have. Both fingerlings and fish feed often proved difficult to obtain in sufficient quantities to maintain high production. Most fishponds were rudimentary and operated by farmers with a low level of technical aquaculture knowledge.

Aquaculture could be promoted to great effect in Chin State. Such a project should carefully consider in which villages to promote aquaculture, selecting those with landscapes suitable to pond building and good water supply. As good land is in short supply in Chin State, farmers may have strong preferences for how to use their land. Interest in aquaculture should therefore be high before aquaculture is encouraged. Much effort should be invested in improving the technical knowledge of fish brood-stock selection and breeding techniques where aquaculture is already being practiced.

Incorporating aquaculture into integrated farming models should be considered where possible. While livestock are kept near the homestead, in Chin State land constraints often make fishpond building feasible only quite far from the homestead making them impractical for integration into other production systems.



Section 1 Study Questions

- What agricultural challenges typical of uplands might intercropping help solve?
- Name the usage cycle of a plot of land in “slash-and-burn” agriculture. What is happening in the land plot in each stage? What are the farmers’ activities at each stage?
- When might “slash-and-burn” agricultural practices be considered unsustainable?
- “Soil fertility is the driving factor in shifting cultivation.” Explain this claim. Do you agree or disagree?
- In regards to agroforestry, what are some characteristics an upland farmer might look for in a tree or bush to use in an upland cropping system?
- Name five roles livestock may play on a farm. Which of these may become less important in the future and why?
- Imagine you are an extension worker wishing to promote aquaculture in a region of twenty villages. You must choose three villages to pilot your aquaculture extension project. What are some features you might take into consideration when choosing your target villages and why?

2. Factors affecting outcomes in upland agriculture

Crops are the descendants of naturally occurring plants that have been subjected to thousands of years of human-guided selection pressures which have transformed them into the foods we know.

Rather than needing to compete with plants and animals for resources, humans perform much of this work for crops. We eliminate biological competition for crops by clearing fields. We provide water and nutrients with irrigation and fertilizers to enable continuous high growth. We fight off predatory organisms like insects and fungi with pesticides and fungicides. We treat other plants growing in our fields as invaders. The better farmers are able to understand all these needs and risks, the better they will be able to create the ideal growing conditions for high production.

While this is true of both upland and lowland agriculture, upland farmers will have less access to new seeds, fertilizers, agrochemicals, and extension services than the lowland farmers for whom markets have developed. They must contend with erosion year after year. They may wish to sell their products, but the nearest market might be small and perhaps a full day's travel away.

As upland agricultural systems are characterized by unique agricultural conditions, part of the challenge for farmers and extension workers is to identify the right cultivars and set of approaches that will work best for their local system.

This section explores upland issues relevant to Chin State, but are generally relevant to all upland agricultural areas. A range of technical approaches to these issues in Chin State are outlined in the technical package for home gardening, attached as annex 1.

2.1 Soil management

SALT

Sloping Agricultural Land Technology (SALT) is a package technology of soil conservation and food production for sloping land. The SALT approach updates traditional methods of terracing by integrating intercropping and knowledge about soil stability and fertility.

This approach a good example of how agricultural extension can build on and improve existing local knowledge and farmers' expertise. Successful implementation has been well-documented in upland areas of the Philippines.[23]

The advantage of the SALT method is that it allows for intensive agriculture on steep land. This is achieved through carefully formed terraces and intercroppping patterns designed to resist topsoil loss and maintain soil fertility, while producing a variety of agricultural products.

The SALT approach incorporates many different plants to create what can be thought of as an agricultural ecosystem. Permanent shrubs, such as coffee bushes or fruit trees are planted in hedgerows at 3 to 5 meters apart on a slope. This effectively creates stable, flat terraces for planting field crops such as cereals, legumes, root crops, etc. At the borders of the system, a boundary forest is planted which provides lumber and firewood but more importantly protects and stabilizes the terraces and hedgerows.

The final outcome is a very distinctive transformation of the upland landscape.

Like many technology packages that draw on agroforestry, SALT has been widely experimented in different geographic contexts. This has led to a variety of ideas about the details of how to do SALT. However there are some basic principles that many of these approaches have in common.[24]

The step-by-step guide in annex 1 highlights those basic principles. It is reproduced directly from the guides used by the ECHO project in the Philippines.

2.1a Tillage

The main physical condition relevant to agriculture is the soil's compactness. To prepare soil for cultivation farmers often loosen and mix the soil beforehand, a process known as **tillage.** The primary purposes of tillage are the eradication of weeds before sowing and the loosening of soil to facilitate seedling emergence. In this newly loosened soil, planted seeds are able to grow more easily with little competition from other plants and plenty of air and water.[25] Traditionally, tillage has involved dragging blades through fields with tractors or animals or by hand.

Recently, mechanization has reached smallholder farmers throughout the world by way of relatively

[23]See for example Watson, H. "The Development of Sloping Agricultural Land Technology (SALT) in the Philippines." Mindanao Baptist Rural Life Centre. Davao: 2011.
[24]Available at www.ECHOcommunity.org
[25]Juo, A. S. R, and Kathrin Franzluebbers. Tropical Soils: Properties and Management for Sustainable Agriculture. New York: Oxford University Press, 2003: 39

inexpensive, versatile machines able to perform many tasks, including tillage. While machinery has become more affordable, the cost of small hand tractors and the fuel they consume represents a financial barrier for those practicing subsistence agriculture as is often the case in upland systems.[26]

The large, flat fields that characterise lowlands are much more easily tilled than those in uplands. Tillage in lowland fields often involves little more than following straight lines back and forth until the entire field is ready to be cultivated. Uplands fields by contrast are often sloped, making access more difficult and tilling more complicated. For example, farmers must consider about how water might run down the hillside and which parts of the hill will be most susceptible to erosion.

The formation of beds, strips, and ridges is another activity associated with tillage. In effect, these are elevated parts of the ground on which crops can be planted year-after-year while empty spaces are left in between the rows of crops. This approach offers a number of advantages. Human traffic is confined to the empty spaces in between the elevated crops, leaving plants undisturbed. The improved navigability of the field not only makes weeding easier but allows for a more focused application of fertilizer and inputs. On the sloped plots of land in upland systems, these rows take the form of terraces, a series of flat areas like steps down a hillside.

Agricultural approaches which a special focus on conservation and sustainability recommend minimal soil disturbance, which includes shallow and localized tillage and direct seeding. Seeds may even be planted directly into small holes (direct drilling) without any tillage, maintaining a completely natural organic soil cover. These methods that avoid heavy tillage are known as **low-till farming** and **no-till farming.**

Key Message: Sustainable tillage practices require an integrated approach adapted to the dynamic, vulnerable conditions of upland landscapes.

2.1b Maintaining Soil Structure

In permanent cropping systems, applications of fertilizers and **soil amendments** will usually be necessary to provide the nutrients needed to maintain high growth. Yet good soil is more than simply having nutrients available for plants in sufficient quantities. Without good soil structure, roots will not be able to access the water and nutrients needed for growth.

A decline in crop yield over time will be due to a variety of soil-related factors including, (a) physical conditions, (b) nutrient depletion, (c) moisture-related stresses such as insufficient water (known as drought) or water saturation (known as waterlogging), and (d) a decline in organic matter and biological activity. Proper soil management pays careful attention to these factors.

Locally sourced soil amendments such as compost and manure act as fertilizers adding much needed nutrients to fields, while also improving soil structure by introducing organic material. This improved soil structure is important for aeration, water infiltration and water holding capacity, which in turn greatly facilitates

[26]Sims, Brian & Kienzle, Josef. Sustainable Agricultural Mechanization for Smallholders: What Is It and How Can We Implement It? 2007: 4

nutrient access for crops.

It is important to remember that **synthetic fertilizers** (see section 2.2b) target only limiting nutrients in soil, such as nitrogen and phosphorus. Farmers using synthetic fertilizers will find these inputs do little to improve soil structure and composition. For example, heavy use of synthetic fertilizer has increased soil acidity and decreased soil fertility in some upland areas of SE Asia. Compared to soil fertilised with organic soil amendments such as animal manures (see section 2.2b), soils fertilized with synthetic fertilizers may also end up being much harder. While not directly causing this hardening, the continued application of synthetic fertilizers will likely lead to poorer soil structure if additional steps are not taken.

Better results may be obtained if the synthetic fertilizer is mixed with organic soil amendments such as green manure, especially in sandy soils or in soils low in soil organic matter. This has the added benefit of helping soils retain nutrients for longer and reducing leaching of nutrients into the environment.

In short, the great appeal of synthetic fertilizers as quick solutions to relieve **soil exhaustion** can obscure long term risks of synthetic inputs. Simply applying synthetic fertilizers without paying attention to other critical aspects of healthy soil will result in poorer soil structure. If synthetic fertilizers are used, it is important they not be over-applied and be integrated into a program of good soil management.

Key message: Maintaining good soil structure requires a management approach that carefully considers the long term effects of soil amendments.

Elephant Foot Yam

Chin State's Department of Agriculture has prioritized a number of cash crops to encourage and extend across the region in the coming years. These include avocado, coffee, mulberry (for sericulture) and elephant foot yam (Amorphophallus paeoniifolius). Elephant foot yam is a well-established cash crop in southern Chin State, especially in the vicinity of the Mindat and Kanpetlet townships.

The next extension challenge will be test if it may be adapted for higher altitude areas in northern Chin State, for example Cinkhua village in Hakha township. If successful, it could represent a niche opportunity for upland farmers. A niche opportunity is one that is well-suited to upland geographies and therefore comparatively more profitable to grow in uplands and sell elsewhere. Niche opportunities can be further expanded if farmers are able to earn organic or good agricultural practice (GAP) certification.

In Cinkhua, The Choklei Organisation for Rural Agricultural Development (CORAD) has been introducing farmers to value-adding practices for elephant foot yam, such as slicing and drying the harvested tubers. This helps farmers respond to a growing market for elephant foot yam in China, Japan and across Southeast Asia.

Although introduced relatively recently as a cash crop for Chin State, elephant foot yam is already demonstrating great potential. This is because it is less labour-intensive, easier to cultivate, more resilient and often more valuable than other cash crops. In Chin State's Mindat Township many farmers are beginning to replace and supplement well-established coffee livelihoods with the production of elephant foot yam.

In the coming years, as the department of agriculture's priority cash crops are extended across Chin State, it will be an important challenge for extensionists to promote cash crops in a way that is not harmful to nutrition-sensitive home gardening.

Some projects in upland Southeast Asia have had success combining cash crop production and nutrition-sensitive home gardening. Nutrition education has been shown to be key to success in these cases.[27] This is likely because participant farmers—quite fairly—prefer to use available land to generate income through cash crops. Robust nutrition education programmes can complement the extension of cash crops by encouraging farmers to use their enhanced cash incomes to supplement their household nutrition.

[27]Berti, Peter R, Julia Krasevec, and Sian FitzGerald. "A Review of the Effectiveness of Agriculture Interventions in Improving Nutrition Outcomes." Public Health Nutrition 7, no. 5 (2004): 599–609.
Nayak, Uma. (1997). "Home gardening for combating vitamin A deficiency in rural India." Food and nutrition bulletin. 18. 337.

2.2 Factors affecting yields

Crop systems can be thought of as biological systems with a set of ideal conditions which will see maximum agricultural production. This set of conditions includes things like days of sunshine (known as growing days), nutrient availability of soil, the right amount of rain, good spacing, and access to light.

The better a farmer can approximate this ideal set of conditions for a crop in a given growing season, the greater the agricultural output. A farming system can be tweaked and adjusted in countless number of ways to maximize productivity, yet before a smallholder farmer starts worrying about small details, they should focus on the most easily achieved conditions that will result in the greatest marginal increases for the crop being grown. These conditions will be key sowing times and nitrogen availability in the soil.

2.2a Sowing time

Every crop is characterized by an ideal sowing/planting time for its specific agricultural context. In low-input upland agricultural systems, the best time to sow is generally after the first significant rains in the early wet season. This key planting period takes advantage of the time of year in which natural soil fertility is at its highest while competition from weeds is at its lowest.

This soil fertility results from the continued decomposition of soil organic matter during the dry season when crops and weeds are not growing. Important nutrients, especially nitrogen and phosphorus, will be found in higher quantities at this key period directly after the dry season and very early in the wet season. If a farmer plants too early, the soil will not yet have enough water to support growth. A great deal of work will then be needed to provide the plants with sufficient water. If a farmer plants too late however, weeds will have propagated and nutrients will have been leached out of the range of crops.

Thus, natural soil fertility increases during the dry season and decreases as the wet season advances. This burst of plant-ready nutrients that occurs when seasonally dry soil is wetted for the first time is often referred to in the literature as the **Birch Effect.**[28]

Key message: The best time to sow for optimal nutrition and weed competition is often after the first significant rains, early in the rainy season.

[28]Kieft, J.A.M. "Farmers' Use of Sesbania grandiflora to Intensify Swidden Agriculture in North Central Timor, Indonesia." Carins, Malcolm, Voice in the Forest. Washington, DC: Resources for the Future, 2007: 323.

2.2b Soil Amendments

Simply put, a **soil amendment** is anything added to improve a soil's growing-related physical and chemical properties. A fertilizer is a kind of soil amendment adds food for plants to the soil. Organic matter may be added to soil as a soil amendment to improve soil's permeability and water retention. When cost-effective and done well, the application of key soil amendments will increase crop yields and improve the economic well-being of farmers in both traditional and intensified upland agricultural systems.

Fertilizers fall generally into two categories: synthetic and organic. **Synthetic fertilizers** (also known as industrial or inorganic fertilizers) are those fertilizers made by humans with an industrial process. These often take the form of a small beads or powder that can be mixed with soil. Fertilizers that have not been created by an industrial process are popularly called **organic fertilizers**. Although commonly referred to as fertilizers, these are technically better described as soil amendments as they not only act as a fertilizer adding nutrients but also improve soil structure by adding decaying organic matter.

Organic fertilizers are sourced and managed locally—composts, green manures and animal manures. Composting often involves piling organic waste matter and waiting for the materials to break down, while green manures are excess plant material from harvest. Green manure refers to **mulch** from uprooted crops left on the agricultural land.

When composting, it is important to remember that the quality of compost is related to its source material. Compost made from old, coarse, low nitrogen vegetative material is of poorer quality than compost made from leguminous plants. In extreme cases, organic material consisting only of old grass or straw can potentially decrease crop yields due to their low nitrogen to carbon ratio. When organic mulches low in nitrogen are applied to a crop field, it is usually necessary to apply additional nitrogen fertilizer to maintain satisfactory yields.

Farm animals are a primary source of organic fertilizer. The stomachs of bovines, such as cows, sheep, buffalo, and mython (gayal), are full of microbes which specialize in breaking down tough plant materials into a usable nutrition source. While decomposition of the active layer of plant litter on a field will take several months, a ruminant's digestive system is able to break down plant material in a day or two. In this way, ruminants provide a steady source of highly fertile soil in the form of manure which can be spread on fields to increase crop growth to great effect.

Although crops produced with organic fertilizers can often be sold at a premium at markets, the quantities needed to cover significant areas of cropland remain unobtainable for many upland farmers. To purchase, organic fertilizers are bulky and impractical for transportation to uplands. The nutrients in synthetic fertilizers by contrast are much more concentrated and are characterized by much higher nutrient content per kilogram.

While synthetic fertilizers have greatly increased farmland productivity worldwide, in the remote contexts of upland farms the availability of both organic and synthetic fertilizers for purchasing is limited. Higher prices associated with transportation costs can be prohibitive. This is a reason to both improve market pathways to lowland distributors and encourage agricultural practices that take advantage of local sources for organic fertilizers.

If advising upland farmers on fertilization practices, an extension worker should consider the benefits and costs of both organic and synthetic fertilizers for a particular farmer before making recommendations. There is no one general 'fix' applicable to all farmers, especially in the uplands.

Key Message: Both synthetic and organic fertilizers will likely play important roles in maintaining soil fertility in upland systems. The advantages, constraints, and risks of any strategy should be considered when designing a soil management regime.

2.3 Labour shortages[29]

Smallholder farms are family farms. The primary labour force on smallholder farms will be family members, though many will hire additional labour at labour-intensive periods. At the subsistence level, the products of the farm will generally go directly to meet basic needs of the household. Some of the produce may be traded for other basic goods and money earned at markets will also be spent on basic goods. Savings will be small to non-existent.

Upland agriculture is labour intensive. This is in part because often upland systems are not mechanized and do not rely to the same degree as lowlands on synthetic inputs. Labour shortages in uplands are often exacerbated by increased out-migration of young workers, increased school attendance, and new local opportunities for non-agricultural work. These are commonly reported situations in Chin State.

[29]FAO. The Economic Lives of Smallholder Farmers. 2015.

When compared to shifting cultivation, agricultural intensification on a fixed allotment of land often requires a much greater labour investment to maintain consistent yields. These permanent fields will likely require maintenance and weeding and therefore additional labour, especially when technology and agrochemicals are unavailable.

Today the most effective labour-saving agricultural technologies, such as mechanization, modern irrigation techniques, and improved seed varieties require capital or credit to purchase, yet the small size of plots and lower agricultural productivity of upland systems limit the accessibility of these agricultural interventions. Not only are upland farms less profitable, but the low production rates of uplands make capital accumulation and repayment of loans difficult.

Improved seed varieties/cultivars also can be labour-efficient interventions and often popular with upland farmers. These seeds not only help maintain high production but are often resistant to pests and diseases . Improved yields and resistance translate directly into greater production per unit of work. However many improved crop cultivars can be grown only from purchased seeds, effectively putting them out of reach for subsistence farmers. Importantly, extension workers must recognise that improved food security depends not only on knowledge about improved varieties or showing farmers boosted yields with new seeds, but rather helping farmers establish sustainable production that will meet their market and consumption needs.

Like plant diseases, poor animal health also makes farming less productive effectively reducing the production value of labour. Disease control in farm animals by vaccines and veterinary care can also increase the return of farm animal production per labour input. However upland farmers may often find it difficult to obtain the correct vaccine, properly store it and administer it at the appropriate time and before the expiration date. These are all challenges associated with the relative isolation of upland regions.

Conceptually, labour is better understood in terms of efficiency rather than simply a number of hours worked. If the production of such farms were to be converted into money-value per hours worked, wages would be extremely low. Because labour is one of the only readily available inputs smallholder farmers possess, small farms are characterized by high labour intensity. In turn, the low monetary value of labour in upland systems makes investing in relatively expensive updates like machines far less cost effective. Enabling farmers to expand production into commercial agriculture and increase income is often advocated as a key step towards improving economic outcomes in uplands.

Key message: upland agriculture are labour intensive systems while key agricultural updates are often out of reach for farmers. Improvements in productivity will be helped by overcoming cost barriers to labour saving technologies.

Opportunity Cost and Cost/Benefit Analysis

Every year, farmers must decide how to best use their limited resources. The crops they can grow are always limited by how much land, labour and other resources they have available. When planning their system, they must decide which crop is the best use of the resources they have available.

Opportunity costs are the costs of having to choose one activity rather than another. To grow a particular cash crop, farmers must choose to not grow other crops. When choosing to grow a cash crop, a farmer will have likely weigh the advantages and disadvantages of growing the crop and made the best decision with the available information.

Equipping farmers with the knowledge they need to carry out simple **cost-benefit analysis** is one way extensionists can help farmers to make informed decisions and to assess opportunity costs.

A cost-benefit analysis is an attempt to compare the costs of a choice with its benefits. It can be as simple as giving a financial value to each cost and to each benefit in an intervention, and then subtracting costs from benefits to give the profit or 'net benefit' of the choice.

A more detailed example of a cost-benefit analysis worksheet used by a project in Chin State

Costs	**Value (MMK)**
House construction	70000
Feed	30000
3 Dead Chickens	45000
20 Infertile eggs	4000
TOTAL	149000

Benefits	**Value (MMK)**
100 eggs sold	20000
15 chickens sold	225000
TOTAL	245000

NET PROFIT

Benefits (245000)
- Cost (149000)

Profit = 96000

2.4 Environment concerns in Uplands

Over the past 50 years, many upland farming systems have shown serious signs of environmental damage and deterioration.[30] These include erosion, loss of soil fertility, loss of timber resources, and loss of biodiversity.

While poor soil management practices are partly to blame, many of these adverse effects are the results of policy decisions rather than deficiencies in traditional upland agricultural practices themselves.[31] For example, traditional shifting cultivation (long the dominant form of upland cropping) has sometimes been officially discouraged yet may actually conserve soil resources and biodiversity better than modern methods when population pressures remain low. This is because in these traditional systems, long fallows were employed and crops were grown for only one or a couple of consecutive seasons. After a few years, cultivated land was repopulated by natural species. Unlike permanent farming, soil was not subject to continuous tillage and the soil surface was largely undisturbed.

The slash-and-burn strategies common to shifting upland cultivation have often been viewed as backwards, destructive, and pollutive by outsiders. This is often true but not universally true. Yet even when land use has remained unrestricted, the tendency of governments and organizations has been to push permanent systems and modern methods.

When systems of shifting agriculture transition into permanent cultivation, this process is often characterized by reduced intervals between planting seasons and an increase in arable cultivation (physical disturbance of the surface for planting such as by ploughing) of the soil.[32] Regrowth during fallow periods will be limited and biodiversity will be reduced. Topsoil may be lost with increased with increased tillage, raising erosion rates. Additional labour, fertilizers and agrochemicals must compensate for these losses.

The extension worker needs to understand these factors before making any recommendations to upland farmers. Without a proper understanding of the unique constraints that characterize upland agricultural systems, even the best ideas will not be implemented properly. At worst, these decisions may make farming and selling more difficult for smallholders and small businesses and even result in higher rates of outmigration and increased environmental damage to upland areas.

Key Message: As upland agriculture transforms, alternatives to traditional practices should be promoted carefully with a focus on the wellbeing of local people.

[30]Mansfield, Lois T., Upland Agriculture and the Environment. Badger Press: Bowness on Windermere. 2011.
[31]Mansfield, Lois. (2011). Upland Agriculture and the Environment.
[32]Schmidt-Vogt, Dietrich. "Relict Emergents in Swidden Fallows of the Lawa in Northern Thailand," Cairns, Malcolm. Voices from the Forest. Washington, DC: Resources for the Future, 2007: 37.

Climate Change and Uplands

Human-induced climate change is the biggest challenge facing the world in the 21st century. Most people understand that their actions and behaviour have a direct impact on the rate and extent of climate change.

This is because human industry releases greenhouse gases, including carbon dioxide (CO_2) into the earth's atmosphere through burning **fossil fuels** such as natural gas, oil and coal. Each car or motorcycle journey for example is a direct contribution to the amount of carbon dioxide in the atmosphere, which in turn is warming of the atmosphere and destabilizing climates worldwide.

Agriculture is also a cause of air pollution. Livestock and mineral fertiliser both contribute significantly to greenhouse gas emissions globally . Some other activities which release CO_2 into the atmosphere are the deforestation, burning and cultivation associated with 'slash and burn' shifting cultivation, which releases the CO_2 stored within plants and soil organic matter into the atmosphere. Partly because of this, many governments and NGOs try to discourage shifting cultivation and to seek alternatives that preserve soil organic matter.

The **REDD+** programme, which is a set of policies and procedures for creating the circumstances to make reductions in deforestation economically viable, is one example of a longer-term programme to help farmers ensure their livelihoods are as ecologically sound as possible. It has been explored across Myanmar, including in Chin State.[33]

Deforestation in the world contributes around 10% of global greenhouse gas emissions[34] and restoring the world's forests is critical to the reduction in greenhouse gas emissions required to limit the worst impacts of climate change.

However it is important to remember that climate change is a global issue. The majority of the CO_2 released into the atmosphere has its origin in fossil fuel use in highly industrialized places including China, the USA, Canada and Europe. Farmers in upland Southeast Asia can influence the course of the global climate crisis only marginally compared to powerful policy makers and institutions in industrialized places—because their actions are constrained by their livelihood options and because their contribution is very small compared to industrialised nations . Therefore one good challenge for upland agricultural extension agents is to make sure that any alternatives to shifting cultivation promoted are as beneficial for upland livelihoods (or better) than the practices they replace.

Upland farmers are also disproportionately affected by climate change in terms of **adaptation** and **resilience,** as the present climatic changes are more severe and dynamic in mountainous areas[35], these changes will likely worsen the challenges of upland livelihoods in the coming century.

[33]See http://www.myanmar-redd.org/
[34]IPCC (Intergovernmental Panel on Climate Change). 2014. Climate Change 2014: IPCC 5th Assessment Synthesis Report – Approved Summary for Policy Makers. No. 978-92-9169-143-2. Geneva, Switzerland: IPCC
[35]Wester, P. Mishra, A. Mukherji, A. Shrestha, A B. (eds.) The Hindu Kush Himalaya Assessment: Mountains, Climate Change, Sustainability and People. ICIMOD, Kathmandu (2019)

2.5 Using participatory approaches

Identifying effective policies and strategies to benefit upland smallholders is challenging, precisely because one of the defining characteristics of smallholder systems is that they differ so much from one another. In a process sometimes described as 'top-down planning,' decision makers sometimes produce policies that do not take the diversity of uplands into account. Examples include:

- Bans on shifting cultivation, without viable, practical alternatives for villagers
- Land classification schemes that restrict which land can be used for shifting cultivation
- No permanent ownership of land by those cultivating it, leading to reluctance of cultivators to make improvements which would encourage efforts to conserve soil resources
- Restrictive control of villagers' rights to use community forests
- Authorities persuading villagers to adopt certain agricultural practices (such as the restriction of burning, planting hedgerows, banning synthetic fertilisers, use of organic pesticides) or crops which may not be appropriate for the villagers' situation

Policymakers, researchers, and extension workers all must approach smallholder systems with an open mind, ready to learn about these unique contexts from farmers themselves. Without a proper understanding of the unique constraints that characterize an upland agricultural system, even the best ideas will not be implemented properly.

Effective communication can be one of the biggest challenges to effective extension work. Sometimes simply the fact that the information comes from an unfamiliar perspective or different setting can be a barrier to adoption of new methods or making improvements to old approaches. Effective extension work requires long-term investment of time that involves learning local concepts and becoming familiar with unique social structures and agricultural systems.

Participatory approaches can be key to overcoming these barriers. These are approaches that directly involve local people in the identification of problems and solutions. There is a huge range of tried-and -tested methods for participatory approaches to different rural development problems. A selection of relevant examples is included in the bibliography of this chapter.

Key message: Agricultural updates that no not take into account local needs and constraints can produce unhelpful decisions or policies. Participatory approaches reduce the risk of making ill-informed recommendations.

Using farmer input to validate new technologies or interventions

One critical aspect of Myanmar Institute for Integrated Development's (MIID) efforts to introduce new practices and technologies in home gardening, aquaculture and poultry production in Chin State,[36] was gathering and recording participant farmers' experiences.

The project worked with farmers to design record books to track the impact of new technologies on the farmers' livelihoods and conduct cost-benefit analyses. It was hoped that if farmers took part in the design of the record books, they would find them as directly useful as possible and continue to utilise them.

For home gardening farmers used the record books to keep track of the expenditure and income generated by different crops, as well as record yields and plant pests and diseases.

However the record books were only useful for a limited range of the participant farmers. Some found them very useful and adapted them for other purposes. Others, especially illiterate and innumerate farmers, stopped using the record books.

Whilst the record books were good at helping the farmers to generate new knowledge, the project needed a simpler, more inclusive and participatory approach to validating the technologies that would involve innumerate and illiterate farmers equally.

The project held focus groups, in which a preference matrix exercise was used to gather and document farmers' experiences with the new crops introduced. The project adapted and experimented with a preference matrix method in 80 Tools for Participatory Development[37] by Frans Geilfus, reproduced as adapted by the project here:

Step 1: Gather a group of participant farmers
Ensure women's participation is equal and even throughout the exercise. If this is difficult to achieve, the group could be separated by gender and two exercises conducted. Depending on the social norms, separating groups by gender may also promote more open and independent thinking.

Step 2: Identify relevant criteria for assessing the crops or technologies
Ask the farmers what criteria are important for them with questions like "What do we look for in a new crop?" or "What do we like in a particular variety?" If it is difficult for the group to start to generate criteria, ask what are the characteristics of their favourite crop that was introduced. Perhaps criteria such as nutritional value, resistance to pests and taste will emerge.

Step 3: Draw a matrix on a board or flipchart

	Tomato	Eggplant	Bitter Gourd
Good yield			
Low water needs			
Pest resistant			
Tastes good			

The criteria identified in Step 2 will become the rows of the matrix – and the crops being evaluated are the columns. There are two options for doing the evaluation, either:

Agree an evaluation scale (perhaps 0-5 where 0 = bad and 5 = excellent) and assess each crop against each criteria, or;

Distribute a total number of points (perhaps 8) amongst the crops for each criteria – perhaps the best crop for that criteria will be awarded 3 points, two good crops 2 each and the worst only 1. This forces an 'honest' appraisal and resists the tendency to score each crop or technology highly. It is also good for illiterate participants – who can distribute a pile of counters or dried pulses amongst the crops rather than written numbers.

The scores should be reached by consensus – the role of the facilitator is to make sure the group participates equally and evenly.

Step 4: Discuss and recap the results

It is good to make sure the results accurately reflect the experience of the group. Be sure to share the finished matrix with participants. Remember also that whilst such participatory approaches are an efficient way to validate an intervention, they do not directly benefit an individual participant farmer. Where possible and relevant, record keeping and cost-benefit analyses can help farmers better manage their home gardens and validate (or invalidate!) new technologies.

[36] http://www.mmiid.org/projects-research/positive-nutritional-outcomes-through-agriculture-extension-in-chin-state/
[37] Geilfus, Frans - 80 tools for participatory development: appraisal, planning, follow-up and evaluation / Frans Geilfus. -- San Jose, C.R.: IICA, 2008: 113

Section 2 Study Questions

- What are some tillage-related challenges upland farmers must uniquely face compared to tillage in lowlands? How might an upland farmer address these challenges?
- Compare the benefits and challenges of both synthetic and organic fertilizers for upland farmers. As an extension worker, what factors would influence which fertilizer you would recommend?
- What are some good soil management actions you would recommend to a farmer who simply applies large quantities of synthetic fertilizers directly to soil?
- Upland smallholder farms are characterized by high labour intensity. What are four reasons why this is so?

3. Opportunities for improving upland food and nutrition security through good agricultural extension

Agricultural production worldwide increased dramatically in the latter half of the 20th century, starting in the 1960s. New technologies and practices such as the introduction of hybrid cereal varieties, better irrigation, and the application of synthetic fertilizers, pesticides, weedicides and fungicides greatly improved the production capacity of farmland worldwide. This in turn improved food security for people throughout the world.

Food security is defined in terms of food availability, accessibility, and utilization.[38] In other words food security describes people's ability to get food, with close attention not only to local quantity but also affordability. An individual is said to be **food secure** if able to obtain sufficient food year around to meet their dietary needs.

As the number of food insecure people in the world declined significantly,[39] other critical food problems became more apparent. In part this was because these initial efforts focused on boosting cereal crop yields, yet cereals alone however do not provide the nutritional needs of a healthy person. Although the food supply increased, malnutrition persisted.

Thus since the 1996 *Rome Declaration* the concept of food security has included **nutrition security**.[40] Nutrition security is achieved when diets are characterized by sufficient quantity, safety, and diversity of nutritious food.

Local norms and preferences surrounding foods must also be taken into account when promoting nutrition-sensitive interventions. Efforts to produce nutritious foods will be ineffective if the food produced is not one that local people are likely to eat. Establishing nutrition security requires access to food that meets both nutritional needs and food preferences of people.

[38]World Food Programme. What is Food Security? 2019. https://www.wfp.org/node/359289
[49]FAO. "World Hunger Falls to Under 800 Million." Rome. 2015.
[40]FAO. "Rome Declaration on World Food Security." World Food Summit. Rome. 1996.

3.1 Nutrition-sensitive home gardening

Not only do most households already keep home gardens, but successful home gardening can empower people to take control of their own diets. Farmers often experiment in their home garden plots and will likely be interested in working with an extension worker to learn new techniques and try out new plants.

Most home gardens will meet the following five characteristics identified by Michelle and Hanstad[41]: 1) located near the main residence; 2) include a high diversity of plants; 3) production is supplemental, and not the main source of calorie intake or income; 4) occupy a small area; and 5) are an agricultural system virtually everyone in rural contexts can practice.

While home gardens are not a primary source of food for a household living near the subsistence level, they are often critical as a source of micronutrients in nutrition insecure households. They can therefore occupy a central place in extension efforts seeking to improve nutrition outcomes.[42]

Key message: Homegardens can play a critical role in household nutrition outcomes.

[41]Mitchell R., Hanstad T. "Small Homegarden Plots and Sustainable Livelihoods for the Poor." Rome. 2004.
[42]Hashini Galhena, Dilrukshi & Freed, Russell & M Maredia, Karim. "Home Gardens: a Promising Approach to Enhance Household Food Security and Wellbeing." Agriculture & Food Security. 2013.

Nutrition-sensitive home gardening

Home gardens represent an increasingly important land use type in upland Myanmar and elsewhere in Southeast Asia. In Chin State the increasing relevance of the cash economy (and therefore cash crops) has coincided with an ageing population less able to practice shifting cultivation, making home gardens a common feature of the landscape.

Home gardens are, of course, a potential source of dietary diversity. Chin households can get access to the supplementary nutrition they need if they can grow a diverse range of nutritious fruits and vegetables in their home gardens.

In 2016, Myanmar Institute for Integrated Development (MIID) began a project to promote nutrition-sensitive agriculture through home gardens in Hakha township. The project tested a range of different nutritious vegetables to see which were most viable for extension in the local context. Some were unpopular with farmers as they didn't taste good or were difficult to grow.[43] But others, such as broccoli, also proved successful.

Some of the seeds used in the project were available only in Hakha town. This meant the project had to often strengthen market linkages between the town and the village. To do this, the project established seed savings groups amongst participant farmers, helping them to save for and purchase seeds from Hakha town if they were confident of success. In the process, the project learned how to base interventions on existing market linkages first, rather than trying to artificially construct a market for farm inputs and produce.

Another important lesson learned was that market forces were an important context for nutritional impacts of the new crops. As the project's final evaluation noted:

"The balance and trade-offs between [home consumption] and marketing must also be acknowledged; sometimes, garden diversity is reduced by the commercial importance of one or two crops."[44]

[43] A less popular crop was Sacha Inchi (Plukenetia volubilis) which is sometimes considered a 'superfood' and a high potential cash crop for uplands.
[44] Geilfus, F. Final Evaluation of "Securing Positive Nutritional Outcomes through Agriculture Extension, Nutritional Education and Institution Building in Rural Chin State." UNOPS. Yangon. 2018.

3.2 Incorporating nutrition outcomes

Nutrition is distinct from food security but they are closely related. Nutrition deals with the prevalence of the essential nutrients for life and health in a person's diet. Undernutrition is a significant issue in upland Myanmar (see box 1). Dietary diversity—often indicated by the range of colours on the plate, or the variety of foods produced in the home garden—is a good measure of nutrition.

The first 1000 days of an individual's life (from conception to 2 years) is a critical time for nutrition and has an impact on lifelong development, health and wellbeing. Intervening in and improving nutrition in young children is therefore often a priority for government institutions and development organizations.

It would seem that adapting and improving home gardens would be a very direct way to improve nutrition (see box 2). Research shows that "a positive relationship between farm production diversity and dietary diversity is plausible, because much of what smallholder farms produce is consumed at home."[45] But the reality is more complex and the link between home gardening and nutrition is not guaranteed. The buying and selling of foods and the decisions made about household food consumption also have an impact on child nutrition. Broadly speaking, unless a family were to produce all the food they eat in their home and to have a full understanding of their children's dietary needs, improving home garden diversity is not a guaranteed solution to good nutrition.

Here are 6 possible pathways through which agriculture could affect nutritional outcomes, adapted from *Agriculture and Nutrition in India: Mapping Evidence to Pathway* published by the New York Academy of Sciences.[46] This framework shows the complexity of the relationship between agriculture and nutrition:

- **Agriculture as a source of food:** Farmers produce nutritious food for their own consumption. This is where home gardens are most relevant. More diverse home gardens can lead to more diverse diets at the household level.
- **Agriculture as a source of income for food and non-food expenditures:** As a major direct and indirect source of rural income, agriculture influences diets and other nutrition-relevant expenditures. Many studies have shown a positive relationship between household income and household dietary diversity.
- **Agricultural policy and food prices:** Agricultural conditions can change the relative prices and affordability of specific nutritious foods and the prices of foods in general.
- **Time constraints:** The high labour requirements of small farms often take time away from the attention available for making important household decisions about food allocation, healthcare, and childcare.
- **Maternal employment in agriculture and childcare and feeding:** A mother's ability to manage child care may be influenced by her engagement in agriculture. This has an impact on the first 1000 days of life.
- **Women in agriculture and maternal nutrition and health status:** Maternal nutrition may be compromised by the often difficult conditions of agricultural labor, which may therefore influence child nutrition outcomes.

Currently, pathways 1, 2 and 3 have been the most widely researched, and evidence shows that improvements in agriculture does have a positive impact on household nutrition. Home gardening is therefore one of a range of agricultural pathways to nutrition, and is often one of the easiest for agricultural extension programmes to influence. However, an individual child's nutrition is also influenced by a broader range of factors including the dynamics of the household. This is why pathways 4, 5 and 6 are important.

Agricultural extension programmes often incorporate key nutrition awareness or education activities for this reason. By helping families better understand the nutritional needs required for adult health and normal physical and cognitive development in children, households are better able to participate in nutrition projects and understand the underlying nutritional information behind an agricultural intervention.

Table 1 lists several key nutrients and the sources from which they can be derived, as well as the signs associated with their severe deficiency. This table has been adapted to reflect the deficiencies and foods in Chin State, but the information will overlap significantly with other nutrition insecure upland areas in South East Asia.

[45] Sibhatu et al (2015)
[46] S. Kadiyala, J. Harris, D. Headey, S. Yosef, S. Gillespie Agriculture and nutrition in India: mapping evidence to pathways, Ann. N. Y. Acad. Sci., 1331 (2014), pp. 43-56

Table 1

Nutrient	**Home garden/ on farm/ Market sources**	**Deficiency symptoms**
Protein	Chickpeas, meat, poultry, fish, eggs, milk, lentils	Liver failure, flaky or splitting skin, redness and patches of depigmented skin and hair loss, Loss of muscle mass, increase severity of infections
Vitamin A	Sweet potato, carrot, spinach, broccoli, sweet red pepper, pumpkin, mango, tomato	Night blindness, dry skin, dry eyes, infertility and trouble conceiving, delayed growth, throat and chest infections, acne breakouts
Vitamin B	Brown rice, meat, eggs and dairy products, legumes, sunflower seeds, broccoli, spinach	Tingling hands or feet, trouble walking, pale skin, fatigue, fast heart rate, shortness of breath, mouth pain, irritability, vomiting and diarrhea
Iron	Spinach, broccoli, lentils and beans, sunflower seeds, brown rice, water convolvulus	Anemia, weakness, pale skin, extreme fatigue, chest pain, headache, cold hands and feet, poor appetite
Zinc	Meat, chickpeas, beans, nuts, eggs, whole grains.	Diarrhea, appetite loss, mouth ulcers, dry skin, stunted growth
Iodine	Iodized salt, eggs	Swelling neck (goiter), reduced cognitive development

3.3 Emerging cash crop opportunities in the uplands

As discussed above, the unique and heterogeneous environments of uplands generally make agriculture more challenging. Yet in some cases, the unique environment of uplands can work to farmers' advantage. For the extension worker, selecting specific crops to promote as cash crops should require a highly inductive, long-term approach.

Cash crops are those crops which are grown specifically to sell for profit as opposed to those grown for household consumption. While crops grown for sale on local upland markets might technically be considered cash crops, discussions of cash crops usually focus on those crops for which considerable external market demands exist. Often they are specialty crops, such as elephant foot yam, mulberry or coffee for which local demand will be quite low but are easy to sell to third party businesses for processing and commodity production.

In agriculture, a **competitive advantage** describes the capacity of an agricultural system to deliver agricultural goods to a market at lower prices than other systems. Often, this capacity is related directly to naturally occurring conditions favourable to a particular crop. Economic factors, such as the relative costs of labour and transportation will play into whether a farmer can gain a competitive advantage.

For staple food products, uplands will rarely be able to provide a competitive alternative to lowlands. This is not only because of more challenging growing conditions and lower rates of production, but also due to higher costs associated with transportation. Yet in tropical climates, upland systems will be an important source of off-season food (especially vegetables) when agriculture production falls in the lowlands during the wet and hot seasons. Cooler upland regions may also be better suited to grow temperate-zone crops such as varieties of carrots, apples, avocados, pears, beets, barley, potatoes, cabbage, cherries, grapes, corn, strawberries, tomatoes, and even cut flowers, among others.

Finally, while many agricultural products in uplands will have no obvious competitive advantage at the national level, they are still important foods for household consumption. Extension efforts promoting cash crops in upland systems must keep in mind that balance must be found between crops grown for selling elsewhere and those for household consumption. Local growing conditions and lowland market demand must also be carefully considered.

Key message: As uplands are better integrated with markets, opportunities will become increasingly available to take advantage of niche markets by growing cash crops.

Section 3 Study Questions

- Although hunger rates have seen remarkable decreases, malnutrition has persisted in many areas in Southeast Asia. Why is this so? What are some examples of nutrition-sensitive approaches that should characterize extension efforts in the future?
- Imagine a situation in which upland households in a region have recently seen an increase in locally available nutritious food thanks to intervention work by extension organizations. Once availability has been achieved, is the organization’s work done? What additional efforts should be taken?
- Might choosing to grow cash crops rather than crops for household consumption put a household’s nutrition outcomes at risk? Why or why not?

4. Conclusion

While Southeast Asian lowlands tend to be more similar to each other in terms of farming systems, upland landscapes are more varied and heterogeneous. This heterogeneity leads to a challenging environment for doing agricultural extension and suggests that the best approach requires a targeted solutions appropriate to each context, rather than blanket approaches. What works well in lowlands may not work in uplands, and what works in one upland area may not work in another.

Yet within this highly varied geography, many shared circumstances relevant to the environment, access to markets, economic outcomes, and nutrition and food security may nevertheless be identified.

The resources in this chapter's bibliography and annexes are included to help plan and deliver effective agricultural extension in these challenging circumstances in the Myanmar, Hakha (Chin) and English languages.

Glossary

Agricultural extension: The spreading (or extending) of new agricultural technologies, knowledge or best practices through farmer's education.

Agrochemicals: Chemical products used in agriculture, such as insecticides, herbicides, fungicides, and synthetic fertilizers.

Agroforestry: An integrated agricultural approach to land use in which trees are grown among or around crops in a way that is complementary to crop growth.

Alley-cropping: A form of agroforestry in which crops are grown in the wide spaces (alleys) in between rows of trees.

Aquaculture: Farming fish or other animals that live in water, under controlled conditions. In uplands, aquaculture is devoted to cultivating freshwater fish.

Cash crops: A crop grown primarily to sell for profit, rather than for family or livestock consumption (compre with subsistence crops).

Chin State: An administrative region of Myanmar dominated by upland systems. Chin State remains one of Myanmar's least populated and regions. Chin State borders India and Bangladesh, as well as Myanmar's Sagaing, Rakhine and Magway regions.

Competitive advantage: When a production system is able to perform better than its competitors because of the advantages of its unique circumstances. For example, coffee grown at high altitudes is considered of higher quality, so high altitude communities often have a comparative advantage in coffee production.

Continuous cultivation: Land use in which agricultural production is not interrupted by fallow periods but sees crops replanted every year.

Cost-benefit analysis: A way for making informed decisions by adding up and comparing benefits and costs.

Crop rotation: Alternating the crops grown in a plot of land to increase production or to help improve soil quality.

Cultivars: Varieties of plants that have been bred for specific qualities—often hybrids of two plant species.

Fallow: Land left uncultivated for a period, usually to allow for the recovery of soil fertility.

Food security: A description of how much food a given individual or community can access, involving both food availability and affordability. See also nutrition security.

Heterogeneous environment:. A heterogeneous environment is one made up of many dissimilar parts and features with much variation that may change from year to year. In the context of upland agriculture, farmers must adapt their cropping systems to a unique set of environmental features such as steep slopes, hours of sunlight, and water access challenges.

Home gardening (uplands): A home garden is a relatively small food production unit typically attached to or nearby the home and is often characterized by many different fruits and vegetables.

Industrial fertilizers: See synthetic fertiliser.

Inorganic fertilizers: See synthetic fertiliser.

Intercropping: An agricultural practice in which two or more crops are grown in close proximity. Intercropping increases production of land and often provides important ecoservices such as shading or stabilizing land.

Livestock: Farm assets that are live animals.

Lowlands: A landscape that is generally large, low, and flat, especially when compared to upland areas characterized by higher, more varied landscapes.

Malnutrition: A lack of proper nutrition that results in poor health conditions. This includes a lack of food leading to undernutrition, as well as unbalanced nutrition in which key nutrients are not being consumed. In children, malnutrition can lead to increased susceptibility to diseases, stunted growth, and impaired cognitive development.

Mechanization: In agriculture, the process by which agricultural production is improved by agricultural machinery that greatly increases farm worker productivity.

Mulch: Discarded plant material used to cover the surface of the soil used in agricultural production. Mulch can have positive effects on water retention, aeration, and soil fertility while helping reduce weed growth.

No-till farming: (also called zero tillage farming) while conventional tillage involves turning over and mixing the first several inches of topsoil, no-till farming leaves soil undisturbed. Often, holes are made directly into the soil for seeds or seedlings to be placed. This method aims to improve soil health by preserving natural biological processes and native microorganisms.

Nutrition security: A description of the quantity and availability of food able to meet the nutritional needs. A community is said to be nutrition insecure if a proportion of members do not have access to food able to sufficiently meet their dietary needs. Nutrition security is often considered a critical step after achieving food security (access to sufficient calories), yet these goals should be targeted together.

Opportunity costs: The loss of benefits or profits from the choice not selected are the opportunity costs. For example, if a farmer decides to grow elephant foot yam instead of tomatoes for a cash crop, the opportunity cost is the profit lost by not growing tomatoes. Ideally, the opportunity costs should be less than the final profits earned growing elephant foot yam (if not, than a better choice would ave been to grow tomatoes.)

Organic fertilizers: Soil amendments to improve soil fertility that have not been created with industrial processes. Composts, green manures, and animal manures are commonly referred to as organic fertilizers.

Participatory approaches: Participatory approaches to agricultural extension emphasize a process of shared-decision making among stakeholders during project design and implementation. In practice, this approach may involve community members or farmers defining their own goals and implementation strategies, but with input and support from extension workers.

Permanent farming: Farming in which land is continuously cultivated from season to season and year to year and depend on inputs such as agrochemicals and soil amendments to maintain high yields. Often contrasted with shifting cultivation in which plots are left fallow for several years and farmers change the site of cultivation.

Seed varieties (improved): Improved seed varieties (also called hybrid seeds) are seeds for crops produced by cross-pollinating plants. The first generation of plants grown from these seeds will have a certain desired features by design, although in subsequent generations these features will be lost or less pronounced and farmers will likely need to buy the improved seeds every year.

Shifting cultivation: An agricultural system in which farmers move their cultivated plots after only a couple of years. This is understood to primarily be a way to maintain high yields by regularly shifting production systems to more fertile land.

Slash-and-burn: A kind of shifting cultivation which depends on cutting down (slashing) and burning of the trees or woody plants in the new field. This process is understood to not only be a way to clear land for crop production, but also to reduce weeds, pest infestations, and further improve soil fertility.

Slash-and-mulch: A recently promoted alternative to slash-and-burn which seeks to reduce the stresses placed on soil and land often associated with slash-and-burn. In this system, rather than burn regrowth and crop residues, plant material is collected and spread out on the soil as mulch before the rainy season.

Smallholding: A small farm and household, generally run by a family, usually characterized by a mixture of cash crops and subsistence farming.

Soil amendments: Anything added to soil to improve its agricultural capacity, such as fertilizers and organic matter to improve fertility or structure.

Soil exhaustion: A state of low agricultural capacity of land after continuous cultivation, usually associated with low nutrients and collapsing soil structure.

Soil Fertility: The capacity of a soil to support plant growth. High fertility soil is associated not only with high

nutrient content but also nutrient access by plants which depends on good soil structure.
Swidden agriculture: See slash-and-burn agriculture.

Synthetic fertilizers: Fertilizers made by humans with an industrial process. Commonly, synthetic fertilizers are often thought of as purchased bags of high nitrogen or phosphorus soil amendments that take the form of beads or powders which are then mixed with soils.

Subsistence farming: Farming in which crops are grown primarily for household consumption. If sold, money earned will also be spent on basic goods.

Subsistence crops: Standard crops grown primarily for household consumption. Compare with cash crops.

Taungya: This is a unique kind of intercropping system in which crops and saplings are grown together. The samplings greatly benefit from the crop maintenance and after several years of growth the plot will have transformed into an orchard.

Terraces: Terraces in upland agriculture, terracing describes sloped land that has been landscaped into several flat ascending platforms resembling steps. Terracing hills for agriculture helps reduce both erosion and water runoff and can greatly improve irrigation.

Tillage: During the land preparation stage of farming, soil must be softened and mixed to reduce weeds, aerate the soil, and incorporate organic material. This activity, which can be performed with tractors, animal-pulled ploughs, or hand tools such as hoes, is known as tilling the soil

Uplands: A landscape that is relatively higher than adjacent landscapes and is often characterized by topographic diversity, varied landscapes, and an absence of floodplains.

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