



## AGROECOLOGY CASE STUDY

### ADDRESSING THE CHALLENGES OF UPLAND FARMING IN SOUTHERN SHAN STATE FOR CLIMATE RESILIENCE

#### 1. SYNOPSIS

Smallholder farmers particularly in climate vulnerable developing countries such as Myanmar are facing increasing challenges related to food insecurity and climate change.<sup>1</sup> Research has increasingly pointed towards agro-ecology as a movement, with the science and approach suitable to building the resilience of smallholder farmers. Since 2014, the Myanmar Institute for Integrated Development (MIID) has been actively working with ethnic Taungyoe villages in southern Shan State, Myanmar, to build climate change resilience in part by promoting and implementing agro-ecology. The work of MIID covered in this study is largely funded by the European Union through the International Centre for Integrated Mountain Development (ICIMOD) and USAID through Winrock International, with additional funding from The Field Alliance and the Alliance for Agro-ecology in Southeast Asia (ALiSEA). The work has been implemented in six villages covering 394 households.

This case study will examine transitions in the upland project area to contribute to a growing knowledge base on agro-ecology in the ASEAN region to support the adoption and promotion of these practices. Initiatives include conservation agriculture, organic agriculture and integrated crop management. More specifically, the techniques which have been taught in the villages through a farmer field school approach will be highlighted, including ginger value chains, intercropping, contour land preparation methods, organic composting, seed banks, seed selection and natural management of pests and diseases.

<sup>1</sup> ILEIA 2016. *Farming Matters: Making the case for Agroecology*. The Netherlands: Wageningen.

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## 2. PROJECT AREA CONTEXT

**Location and topography:** The project consists of a six village cluster that straddles two hilly townships in southern Shan State in the Inlay Lake region. The villages are Zeyar from Bawnin Village Tract in Kalaw Township and Pantin, Thayet Pin, Kyaung Nar, Kyaung Taung and Enpak of Let Maung Gwe Village Tract in Nyaungshwe Township. The villages are situated close to the towns of Heho and Nyaungshwe both of which are approximately seven kilometers from Let Maung Gwe, a two-hour walk or 30 minutes by motorbike depending on the village. The village altitudes are between 1,200-1,450 meters above sea level. Hills dominate the topography with moderate to extreme sloping that consists of scattered permanent vegetation.<sup>2</sup> Forest trees are scarce with natural forest only remaining in small areas near the monasteries and other religious sites.

**Climate:** The climate in southern Shan State is subtropical to temperate. Precipitation in southern Shan State rarely occurs during the dry season from November to March limiting cultivation options. The wet season commences in April, peaking in August and ending by November. However, the project area can also face periods of drought and/or excessive periods of rainfall during the wet season. The mean number of rainy days is 119 annually, which is less than that of Yangon. Climate data from recent decades suggests that the monsoon season may be shortening in this region of Shan State. Rain-fed cultivation for upland farmers in the region starts from May. If soil maintains its moisture, short span varieties such as pigeon pea or bean can provide two harvests.<sup>3</sup>

**Soil conditions:** The predominate soil type in the project area is known as "red earth and yellow earth" according to local classification. This soil is generally low base, low activity clay of red, brown or yellow in color. The limiting factors of soils in these villages are limited depth, stone and rock presence, minimal water holding capacity, poor internal drainage, slow soil permeability, low fertility, low cation-exchange capacity, presence of toxic ions and an absence of some nutritional elements.

**Socio-economic status:** Records do not exist but village elders estimate that ethnic Taungyoe settled in the area approximately 100 years ago. The total population of the six project villages includes 1,623 adults of whom 843 are females and 780 males, equating to 394 households. The main livelihood is a mixture of subsistence and commercial farming predominately on sloping land. Customary land use practices remain common, namely shifting cultivation (also known as "slash and burn" or "swidden agriculture"). Farmers divide land and utilize plots for a year or two before rotating to another plot to allow the land to fallow and rejuvenate. However, the numbers of years have reduced from the ideal eight-year rotations to three to five years. Seventy percent of households have access to less than two hectares of marginal and sub-marginal land per year.<sup>4</sup>

**Crop production:** The main crops in the project area consist of cereals (upland rice, wheat and maize), oil seeds (groundnut and niger-seed), pulses (pigeon pea and rice bean), spices (ginger and turmeric) and vegetables (butterfly bean, cucumber, cauliflower, chilies, tomato and mustard). Crop production is predominantly for household food security, however some crops are produced for the market such as hybrid maize, wheat, and ginger.<sup>5</sup>

2 Lwin, U Ko, and Victoria Garcia. 2015. *Value Chain Analysis Of Agricultural Small Holders In Southern Shan State*. Yangon: Myanmar Institute for Integrated Development.

3 Based on rainfall data from 1983-2018. Myanmar Institute for Integrated Development 2014. *Land Resource Assessment Report: Himalica Pilot Project Myanmar*. Yangon: Myanmar Institute for Integrated Development.

4 Lwin, U Ko, and Victoria Garcia. 2015. *Value Chain Analysis Of Agricultural Small Holders In Southern Shan State*. Yangon: Myanmar Institute for Integrated Development.

5 Ibid.

**Challenges:** Villagers living in the project area face numerous challenges including a lack of formal recognition of land tenure, poor quality housing, limited access to markets and infrastructure as well as deforestation and soil erosion. In addition, villagers are facing increasing climatic extremes, which exacerbate the existing weather conditions most notably the water scarcity during the dry season, and reduced fallow periods.

The response by MIID has been informed by evidence based on participatory research, close consultation with community members and additional research by subject matter experts in the areas of water, agriculture, value chains and hydrogeology. Drawing upon existing practices, knowledge sharing and promoting agro-ecology methods, MIID has worked toward building climate resilient communities in the project area.

### 3. RESEARCH METHODOLOGY

The approach of agro-ecology provides the theoretical framework for this case study, broken down into three major themes: biodiversity, conservation agriculture and local knowledge. This case study focuses on an agro-ecology approach of farmer field schools including demonstration plots. The following three thematic questions were addressed:

1. **Biodiversity:** Can smallholder farmers manage pests and soil erosion naturally, enhancing both beneficial biological activity and overall soil fertility, and use synthetic chemicals safely and with knowledge of proper usage, avoiding excessive application?
2. **Conservation agriculture:** Are hillside plots becoming reclaimed through contour farming/planting, mulching, and green manure cover crops?
3. **Local knowledge:** Have isolated villages accessed high quality seeds reliably when they work in cooperation to grow and manage their own supply, perpetuating locally preferred varieties? What does agro-ecology mean to farmers? What are the strengths and weaknesses of the approach and stories of change?

The research method included primary and secondary data, using a mix of quantitative and qualitative methods. Primary data was collected through key informant interviews with project staff and beneficiaries from Let Maung Gwe Village Tract. Existing data was obtained from project annual reports and research commissioned by MIID including a Baseline Survey, Participatory Rural Appraisal, Land Resource Assessment Report and Value Chain and Gender Analysis of Agricultural Small Holders in Southern Shan State. The latter two studies included the following primary research:

- Land Resource Assessment Report: interviews with 78 individuals in total including seven with government officials and five focus group discussions
- Value Chain Analysis of Agricultural Small Holders in Southern Shan State: key informant interviews with 30 farmers who cultivate ginger, one Village Tract Administrator; five traders, five people who produce dried ginger, and four officials from the Department of Agriculture.

### 4. RESPONSE: PLANNING AND APPROACH

MIID engaged with the project villagers using best practice participatory and community engagement approaches, including baseline surveys, focus group discussions, meetings with farmers and village leaders and participatory rural appraisals. After gaining a deep understanding of the context it became evident that improved water harvesting and soil quality would be a priority. A holistic and integrated approach was developed to enhance and improve existing customary practices within the project areas such as shifting cultivation, mixed cropping, with



Clockwise from top left: Trainees study their soil to understand pest management; Harvesting ginger; Traditional vertical land preparation method which increases risk of soil erosion; Agroecology trainee learns about different insect types.

complementary agro-ecology techniques and value chain development. More specifically the project goals were to enhance sustainable agriculture, support viable agricultural value chains, conservation agriculture, and land management practices toward environmental sustainability and increased agricultural yields. Expected outcomes included reduced soil erosion and increased soil fertility, enhanced agricultural diversity and productivity, strengthening market linkages and increasing incomes.

#### 4.1 Advancing knowledge sharing through Farmer Field Schools

Agro-ecology is grounded in both science and local knowledge sharing and community organization platforms. Farmer Field Schools (FFSs) are integral to this process, as they provide space for farmers to engage in two-way learning, through sharing of practices amongst each other and with technical support facilitators. FFSs are practical in nature, with demonstration plots used as a key tool for illustrating various practices such as intercropping, organic methods for fertilizers and pesticides, and mulching. MIID's Land Assessment completed in 2014 captured the challenges facing upland farmers. The FFS approach built upon the recommendations from land assessments and value chain research. Value chain analysts found that FFSs (through the interactive and practical two-way learning demonstration approach) could support communities in the project area in the following ways, by:<sup>6</sup>

- Promoting environmental practices for sustainable and climate resilient communities
- Improving seed selection and preservation techniques

<sup>6</sup> Lwin, U Ko, and Victoria Garcia. 2015. *Value Chain Analysis Of Agricultural Small Holders In Southern Shan State*. Yangon: Myanmar Institute for Integrated Development

- Increasing capacity and awareness around appropriate fertilizers for identified value chain crops such as ginger
- Improving community mobilization and associations between farmers, and extension services.

Farmers were provided the opportunity to discuss solutions using their intimate local knowledge of the ecology, geography and land use practices in the region. The technician role facilitated group sessions by introducing new techniques, encouraging existing techniques that were helpful, particularly sustainable customary practices, and highlighting the drawbacks of some recently adopted methods for increasing yield including the dangerous use of chemical products that could sacrifice long-term productivity.

## 5. AGRO-ECOLOGY TRANSITIONS IN SOUTHERN SHAN STATE

This section will highlight the key agro-ecology transitions occurring in the project area to address upland farming challenges in southern Shan State for climate resilient communities. The following stories of change focus particularly on:

- Organic agriculture and healthy soils
- Green manure and rejuvenating fallow land
- Sustainable land preparation and ginger value chains.

### 5.1 Organic agriculture and healthy soils

*"Organic agriculture aims at sustaining the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and natural cycles adapted to local conditions, rather than the use of chemical inputs with potentially adverse effects."*<sup>7</sup>

Organic agriculture and healthy soil concepts and practices were promoted through FFS sessions. Demonstration and awareness raising to the negative impacts of synthetic hormones, chemical pesticides were introduced alongside the benefits of natural methods of pest control and identifying when and how to use them. Natural compost, bio-pesticides, foliar fertilizers, bio fertilizers (fish amino acid), soil conservation techniques, plant hormones, compost mulching, and natural fungicide were discussed and practiced. Fish amino acid was introduced to the group as an alternative to commercially available fertilizers, particularly those that often result in excessive use of nitrogen that pollutes the ground and surface water. Fish emulsions such as fish amino acid have been found to interact with the soil to promote seedling growth and fruiting, especially when used in combination with light folia mist inputs to increase the uptake and reduce runoff. Most interviewed respondents can now adequately identify characteristics of unhealthy plants, diseases and pests, and select methods that are affordable, conserving soil for improved yields and restoring healthy biological activity.

Compost making has been taught to the farmers by the project team and has been adopted throughout the project area. The composting method taught uses effective microorganisms (EM) to accelerate compost product. After compost application, villagers have noticed improvements in their soil as a result and will continue to use the EM method of producing fertilizer. Compost making has also supported the reduction of purchased chemical fertilizer; for example, some village respondents after attending the FFS now use one bag mixed with compost rather than two bags of chemical fertilizer for their upland farming. Almost every household has at least one compost pit in their house compound and some have two or three depending on their requirements and availability of raw materials.

<sup>7</sup> AliSEA 2016 'Organic Agriculture', Agro-ecology Learning Alliance In South East Asia, date accessed 3rd August 2017 at <http://ali-sea.org/cat/organic-agriculture/>

## GREEN MANURE AND FALLOW LAND

Green manure refers to integrating a fast-growing cover crop to provide soil cover and thereby improving soil quality and reducing the incidents of weeds. Most farmers in the project area have access to three plots of land per year, for one to two years they allow one plot to fallow and rejuvenate. In the past, the years left to fallow were much greater - up to eight years. Due to climatic changes and increased demand for land, the soil has eroded to a level that is impacting the fertility. Through the FFS sessions, MIID introduced the technique of green manure using nitrogen fixing legume species, as these increase organic content and nitrogen. Agro-ecology research demonstrates that the benefits also include increases in soil microorganisms, nutrient enhancement, increased root growth, weed suppression and overall soil and water conservation. The MIID agronomist reported that farmers have noticed improved soil fertility and increased yield. There are a variety of cover crops for green manure available depending on the season and appropriateness. According to several respondents the use of green manure particularly on fallow land has been an effective land preparation technique.

### 5.2 Conservation agriculture: Collective ginger value chains

*"Conservation agriculture is an agro-ecosystems management approach aimed at improving and sustaining agricultural productivity, increasing profits and food security while preserving and enhancing the resource base and the environment."<sup>8</sup>*

Ginger is a commercial crop suitable for the farmers in Shan State and can be produced at altitudes of 1,500 meters above sea level, in tropical and sub-tropical regions. It requires fertile, well-drained soil with mild acidic pH levels for healthy growth. It can grow well in warm and humid climates under rain-fed conditions, however the soil conditions must allow for moisture retention and adequate water drainage to avoid water-logging. The plant is harvested eight to ten months after planting. Ginger is commercialized as a spice and medicine, and can be marketed as fresh ginger and dry ginger, ginger powder, ginger oil, ginger oleoresin, ginger ale and other products. Ginger has been cultivated in the project area for approximately 20 years, with prices fluctuating until 2011 where an increase in demand from the international market emerged leading to a price spike that year. Cultivation is favorable therefore, both as the agro-climatic conditions are appropriate and because of income benefits. According to MIID research in the area approximately one in four farmers cultivate ginger, investing between 100 to 1,200 viss (1,623 to 1,950kg) of seed during the 2014 cropping season.

**Challenges:** Ginger cultivation and production is quite labor intensive due to basic mechanization, and the challenges faced by the topography of the area. Most activities are manual: land cleaning, burning, ploughing (with buffalo), furrowing, weeding and harvesting. Most households rely on family support and reciprocity based community practices for labor, although sometimes labor is hired. Farmers predominately prepare their ginger plots on steep hills, tilling the soil up and down the slope. These vertical rows on loose soil have become vulnerable to soil erosion. During the first rains of the season in May or June, the important soil cover, fertilizer, and in some instances cow dung and ginger rhizomes wash down the slope. This has resulted in reduced yield and soil degradation. Farmers tend to favor this approach as vertical rows as the labor required is less intensive. In addition, they have limited land tenure security, which reduces incentive to invest in their plots. Although prior to the project start some farmers practiced contour and terra-forming

8 AliSEA 2016 'Conservation Agriculture', Agro-ecology Learning alliance In South East Asia, date accessed 3rd August 2017 at <http://ali-sea.org/cat/organic-agriculture/>.



Clockwise from top left: Farmer field school classroom; Collecting water; Women bamboo craft makers prepare their wares; Ginger seedbank provides a boost to poor farmers; Farmers gather their ginger in the village to sell collectively

farming, which improves water retention and reduces erosion, it was limited to slight sloping land, government intervention and/or where farmers had notable customary recognition of land tenure.

**Land preparation:** To mitigate soil erosion on the sloping plots, land preparation and soil conservation techniques were demonstrated and trialed for farmers to improve ginger yield, quality and maintain soil fertility. The project agronomist provided inputs while the interested farmers agreed to participate in setting up the plots utilizing their land and labor. The demonstration plots were positioned to be visible to village members, often situated on a prominent hill, roadside or near the FFS site. In 2015 MIID and villagers created four demonstration plots, and six ginger plots were established in 2016, across six villages as a part of farmer FFS sessions. The ginger demonstration plots were constructed by using a land preparation method that is a compromise between up and down tilling and contouring which the project called the 'curve method.' This introduced a method aimed at replacing the vertical tilling method that is commonly used in this area, which negatively impacted the soil. By ploughing in diagonal rows, staggered rows, or both, soil erosion can be reduced. Intercropped with sugar snap pea, the demonstration plots also promoted the improvement of soil fertility, as ginger is a nutrient intensive crop. The curve method used is described as a land preparation pattern that is a compromise between the vertical method and horizontal terracing, but is not difficult to implement. By intercropping with pea crops, farmers can harvest two crops and their soil becomes more fertile. 89 percent of respondents reported knowing the purpose of intercropping, and 86 percent indicated using some form of intercropping with ginger. According to respondents and the MIID agronomist, this design is a good compromise suitable for farmers since it improves soil erosion, but is not as

labor intensive as full contour farming. MIID also introduced a more efficient method of drawing the sowing line by using buffalo on the flat and slightly hilly areas where farmers previously used a hoe.

### 5.3 Collective management: Access to quality seeds and markets

**Seed selection and identification:** During the FFSs an effective and affordable seed selection method for upland rice was introduced and has produced good results for the farmers according to respondents who have applied this method for two years. The MIID agronomist introduced to farmers a simple but highly effective seed selection technique for upland rice known as the "Salt Method" which aims to reduce seed borne diseases and pest attacks in rice seed through identifying quickly and easily the good quality seeds from the damaged ones. Rice seeds are put into a salt and water solution and the bad seeds float to the top while the good seeds sink. This allows for more accurate harvests and avoids time wasted on sowing unhealthy seeds.

#### CASE STUDY

Farmer Ko San Min from Kyaung Nar Village stated he increased his yield from seven to 12 baskets using the techniques taught in the FFS. Since upland rice is used predominately for household consumption he now has greater access to rice all year round, and can set aside two baskets for the next sowing period. The FFS also provided demonstrations on seed characteristics, varieties, genetic and physical purities, germination and vigor, planting values, seed health, and seed moisture.





## SALT METHOD: UPLAND RICE SEED SELECTION

### Materials (one basket of rice):

Salt – four viss, water – eight gallons, eggs – one, plastic cup – one, sieve – one, plastic mesh – one.

### Procedure:

- Make a plastic sifting tray using the sieve and plastic mesh
- Pour eight gallons of water into a plastic bucket
- Place four viss of salt into bucket
- Stir the solution using a clean stick or by hand
- Drop the egg into the solution which demonstrates how salt is an effective indicator
- Undesirable seeds (unfilled grain, weed seeds, damaged seeds) will float in the solution, whereas healthy seeds fall to the bottom of the bucket. The floating seed / unfilled grains can be removed with the plastic sifting tray
- Seeds that sink to the bottom of the container need to be washed with fresh water 2 to 3 times in order to eliminate the salt
- The seed is then spread over the tarpaulin sheet

Treatment can prevent fungus problems during the seedling stage, and allow more accurate estimates of harvest amounts.

**Seed banks:** The farmers in the stud area have low income and poor access to financing. Microfinance services exist in the region, but maintain a high interest rate and require a short rate of return. As a result, they are not conducive to seed purchases as, by the end of the harvest season when the loans can be returned, the loan with compounded interest is likely to be very high for these farmers and thus uneconomical. In 2015, seed banks were constructed in the six project villages to increase availability and all have reached operational capacity. Seed bank management committees were established and regulations were created. Ginger rhizomes were provided to the banks by MIID to start the first loans and these rhizomes were then loaned to individual farmers at manageable interest rates of approximately 25 percent per season. The seed loans are repaid with interest in the form of seeds during the harvest season. With each harvest the seed bank grows from the interest and can thus lend to more farmers. Once the seed bank is physically full, any excess seeds can be sold and the profits can be used for village public works.

Furthermore, the seed banks serve as a collection point for village collective selling. MIID has provided capacity building workshops to each seed bank committee. Reported benefits from the seed bank include increased access to affordable local varieties of seed. A farmer from Khaung Nar village stated that he borrowed 100 viss of seed from the bank which was multiplied after harvest into 500 viss. He paid back 125 viss and retained the remaining seeds for consumption, sale and sowing for the next year. A total of 134 participants have completed seed bank trainings and a total of 47 have attended bookkeeping trainings.

**Direct market linkage for ginger producers:** MIID supported the linkage of farmers to the private sector. The Managing Director of Phyo Kyaw Export and Import Company came and met with the villagers. During the discussion, the businessman made a commitment to villagers that the company will continue to buy ginger from them in the future. The ginger sold in this area is attractive for its high quality and low use of chemical inputs. The price offered in 2015 and 2016 was 10 MMK higher per viss than the price available in the Heho market. During the harvest

season, villagers that want to sell collectively harvest their ginger and bring it to the seed bank at a predetermined time where they meet the trader and collectively sell their ginger. A weight scale has been provided and is kept at the seed bank, which allows the farmers to measure amounts accurately. Previously, each farmer would spend one whole day of labor time for attending the market to sell ginger each week as well as incur costs for transport (tractor or buffalo) and food in the market. This time is therefore saved for other livelihood pursuits. One respondent mentioned that he spent at least 1,000 MMK for food when he would go to the market in Heho, thus he can save money on both transportation (approx. 1,000 MMK) and food when buyers come to him instead.

**Income:** Ginger is harvested from December to February each year. Ginger was first sold collectively in the 2015-2016 harvest season and continued the following year. The total ginger sold from December 2016 to June 2017 was 302,100 viss (1.1 million pounds or 492,423 kg). The product was sold at prices ranging from 300 MMK to 350 MMK per viss for total estimated sales of 72,727 USD. This is triple the amount of ginger sold collectively in the 2015-2016 season.

### SEED BANK COMMITTEE

#### Objectives

- To get good quality seeds for the village
- To be able to get enough seeds for every farmer's need in the villages over the coming years
- To raise funds for village development activities.

#### Rules and regulations

1. Borrowing farmers must return seeds to the seed bank by the date contracted with the seed bank committee
2. Borrowers must return quality seeds to the seed bank
3. In loaning seeds, the weight scale that was provided by project should always be used
4. An agreement will be made with suitable interest rate
5. In the event that one is unable to return seeds to seed bank because of unfavorable weather conditions, there will be opportunity for discussion
6. The farmer must pay extra (5,000 MMK) if the farmer is late in returning seeds
7. The management committee will explain the flow of the seed bank system clearly to each villager to be sustainable
8. The seed bank committee and villagers must arrange regular seed bank maintenance
9. Profits from the seed bank will be used for village development activities.

*Seed Bank Sustainability Committee:* The committee is formed by seven people in each village, except the committee in Pantin Village which has only five. Committee members are selected at village mass meetings by vote.

## 6. CONCLUSIONS

Though these Taungyoe villages in southern Shan State are close to local markets and tourist zones, they face several challenges related to sustainable livelihoods and environmental degradation. Issues include the extensive incidences of deforestation, soil erosion, pests and disease in the area due to chemical inputs, unsustainable cultivation and increasingly unpredictable weather patterns. Agro-ecology principles were effective in developing strategies for MIID's approach to improving local knowledge to restore previous practices and adapt to new challenges in the uplands. More specifically, by promoting sustainable agriculture with an integrated approach that enhanced profit and food security whilst aiming at strengthening resilience and protecting the environment. Organic agriculture contributed to healthy soils, ecosystems and livelihoods through strengthening ecological processes and biodiversity that were relevant to local circumstances. Raising awareness to the dangers of chemical inputs has been important, particularly when coupled with introducing tools that can reduce the associated risk. MIID has addressed the challenges of upland farming in Taungyoe villages in southern Shan State by prioritizing activities that are aligned with key agro-ecology principles to affect transitions for climate resilience. Through the FFS trainings and field demonstrations, MIID provided the basis for mobilizing and engaging farmers to learn and share about addressing the challenges faced in the area and planning for long-term sustainability.

**Biodiversity:** Overall, smallholders in the project area have commenced practices that manage pests naturally, increasing the return of healthy bioactivity and improved soil fertility and yield by adopting naturally available fertilizers. Smallholder farmers have improved overall soil fertility by reducing the use of synthetic chemicals and adopting natural pest and disease methods. Crop diversification has increased with the introduction and improvement of existing crop production that both support subsistence farming needs and additional income through intercropping ginger with bean, pigeon pea and sugar snap pea. The FFS sessions have provided a space where farmers have increased their knowledge and capabilities to both identify pests, diseases and soil erosion, whilst discussing and applying methods to counter these issues.

**Conservation agriculture:** Hillsides are increasingly being reclaimed with sustainable methods of land preparation, mulching and green manure that support soil moisture, fertility and increase yields. There is a transition occurring in the project villages from past methods of up and down tilling for land preparation and cultivation to horizontal, contour and other land preparation method. Farmers who have adopted the contouring method have reported reduced soil erosion. Land that otherwise is left to rejuvenate for a short time, is now increasingly being rejuvenated with farmers' application of green manure during the fallow period, improving soil quality and yields of future harvests.

**Local knowledge:** Farmers have obtained accessible techniques that allow them to identify and plant higher quality seeds which are locally preferred and suitable varieties. Farmers are working in cooperation to both manage their supply of ginger and upland rice seeds to increase yields and income. Ginger crops have increased in yields, improving livelihoods through enhanced control over seed input supply. Control over food systems are enhanced due to control over production and bargaining position for access to the local market, control over local seed varieties through improved seed selection methods, and seed banks for access and managed supply.



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