TRADITIONAL AGRICULTURE
Practice and Sustainable Livelihood
A Thematic Report

NAGALAND

Strengthening of State Plans for Human Development
A GOI-UNDP PROJECT

Government of Nagaland
Department of Planning and Coordination
Nagaland - Kohima 797 001

A GOI-UNDP PROJECT
TRADITIONAL AGRICULTURAL PRACTICES AND SUSTAINABLE LIVELIHOOD

A THEMATIC REPORT

2009
TRADITIONAL AGRICULTURAL PRACTICES AND SUSTAINABLE LIVELIHOOD
A Thematic Report

Authored by:

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Agriculture has traditionally been and continues to be the mainstay of Naga way of life. Seventy-three percent of the people in Nagaland are engaged in agriculture. And like most of the world’s tribal population, the agriculture system has been prototype, enabling close links between nature and people. These linkages and traditional practices have been formalized through experience yet have not been formally documented.

Introduction of non-traditional crops has gained popularity in recent years, converting traditional agriculture from subsistence farming to commercial activity. However, the relationship between traditional agricultural practices and traditional farming communities in the preservation of eco-biodiversity, organic production, regeneration, replication and multiplication of indigenous species of plants cannot be undermined. Transfer of knowledge of time tested nature friendly agricultural practices have survived only through oral tradition. Unless these practices are documented, knowledge of nature friendly practices will die with the passage of time. The support of UNDP and Planning Commission, Government of India for preparation of this thematic report ‘Traditional Agricultural Practice and Sustainable Livelihood’ has therefore come at such a crucial juncture.

The Thematic Report on ‘Traditional Agricultural Practice and Sustainable Livelihood’, aims to draw attention to indigenous practices of farming and development strategies and sustainability of livelihood options of the people in the rural villages. Food security being one of the daunting challenges, the report also outlines the vision for ensuring human development harnessing the rich agro-biodiversity.

The report is the outcome of the efforts of Professor Manoj Pant, Jawaharlal Nehru University, New Delhi who co-ordinated the reported and efforts of lead author Shri. Vengota Nakro, Joint Director, Department of Soil and Water Conservation, Government of Nagaland and member of the Project Operations Unit, NEPED and his team.

I hope this report provide insight into the benefits of time tested traditional agricultural practices for preservation of the rich eco-biodiversity, into the possibility of co-existence of such practices with modern farming methods and interventions required for using traditional agricultural practices to produce and realize food security.

Alemtemshi Jamir, IAS
Additional Chief Secretary & Development Commissioner
Government of Nagaland
Acknowledgement

The thematic report ‘Traditional Agricultural Practices and Sustainable Livelihood’ is an outcome of the inputs, efforts and support of many people and organizations. The project team acknowledges and express gratitude to them.

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Kevileno Angami, IES
Officer on Special Duty & Nodal Officer for SSPHD
Planning and Coordination,
Government of Nagaland
### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>CABI</td>
<td>Commonwealth Agriculture Bureaux International</td>
</tr>
<tr>
<td>CSWCRTI</td>
<td>Central Soil and Water Conservation Research and Training Institute</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agriculture Organisation</td>
</tr>
<tr>
<td>IRRI</td>
<td>International Rice Research Institute</td>
</tr>
<tr>
<td>NEPED</td>
<td>Nagaland Empowerment of People through Economic Development</td>
</tr>
<tr>
<td>NTFPs</td>
<td>Non Timber Forest Products</td>
</tr>
<tr>
<td>POU</td>
<td>Project Operations Unit</td>
</tr>
<tr>
<td>SARS</td>
<td>State Agriculture Research Station</td>
</tr>
<tr>
<td>TRC</td>
<td>Terrace Rice Cultivation</td>
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Preface

One of the issues that now periodically come up in discussions of the environment is the role of traditional agricultural systems and the threat they pose to sustainability, especially of forests. In the light of recent fears of climate change and the role of forest as ‘carbon sinks’, these discussions are becoming extremely relevant. A traditional agricultural system that is often under attack in this context is that of jhum or shifting cultivation.

This study, based on an indepth empirical investigation of traditional agricultural systems in Nagaland identifies four traditional systems: jhum cultivation, terrace cultivation, firewood forest reserves and home gardens. Using well known techniques, the authors argue that the jhum cultivation currently undertaken is not environmentally unfriendly given the forest regeneration during the fallow period. This fixes more carbon than is lost during the burn period. The authors also argue that the agro diversity of traditional practices represents an optimal choice of farmers given uncertainty of reliance on any one form. These diverse practices are also environmentally sustainable and may even aid in the transformation from subsistence to commercial farming. This is shown through the increasing importance of home gardens as income sources for farmers.

Hence, this study indicates that it is possible to integrate traditional agricultural practices into sustainable commercial agriculture with a suitable policy attention on the various parameters associated with each agricultural system.

Prof. Manoj Pant
Jawaharlal Nehru University
Lead Author and Coordinator, Thematic Studies
Executive Summary

One prominent feature of traditional agriculture practices in Nagaland is its high degree of agro-biodiversity. This high agro-biodiversity evolved through exploitation of local site factors, consideration of food security for the family, judicious selection of crops and varieties for cultivation, diversified forms of traditional agricultural systems and in recent years, the cash income generating possibilities.

There are four diversified forms of traditional agriculture practiced by the rural villagers of Nagaland: the Jhum (Shifting Cultivation) System, Terrace Rice Cultivation (TRC), Firewood Reserve Forests and Home Gardens. This paper describes how the practitioners strategize their adaptation processes to meet the challenges of population growth and aspiration for better livelihood options for the family and to take advantage of market demand for its products and bring about a transition from subsistence agriculture to market economy.

The sustainability of the traditional agricultural practices in addressing the livelihood options for the people of rural villages needs to be the focus of attention in development strategies. Shifting cultivation system is by far the most prominent form of traditional agriculture, both spatially and in terms of population involved. The system is sustainable and environmentally sound, for example, the carbon emission during burn is negated by the natural regeneration of trees during fallow period. The production of rice is far from meeting the needs of the people cultivating them. In the past when the population was less and land was plenty, the area cultivated per person was sufficient to meet the needs of the family. In the present context, with the increase in population the areas are fragmented and have become too small to produce sufficient rice for the family. In many villages, rice produced under shifting cultivation areas is sufficient for only four months of the year. Through up-scaling of ‘good’ practice models that are available among some communities of Nagaland, the shortfall of rice production could be addressed but to make for eight month’s deficit may not be possible.

The area and production per hectare under terrace rice cultivation (TRC) is increasing across the State. Perhaps because of the increase in TRC, the shortfall of rice from jhum is somewhat mitigated. Innovative uses of TRC, such as cultivating winter crops of cabbage, tomato and potato cultivation and incorporating fishes and snails as supplementary activities are generating income for the farming families.
The main source of energy for both lighting and cooking in the households of rural areas is firewood. Knowing this, the villagers maintain firewood reserves in the immediate surrounding of the village boundary. The products from these reserves ease the pressure on the primary forests and at the same time, meet the household energy needs. With increasing demand for firewood, both in the village and towns, the reserves are diminishing in some villages while in others the farmers are taking advantage of the demand and increasing its areas.

Home-garden is an extension of the traditional house. The family is able to obtain a perennial supply of fresh vegetables for the household consumption by harvesting the crops. There are indications that the areas under home-garden is increasing due to demand. In the past, home gardens were the domains of the women but with the income generated from the home-gardens, men have started to get involved, resulting in an increase in area as well as production. Now home-gardens are no more only a traditional agriculture system for subsistence but also a source of income generation for the household.
Introduction

TRADITIONAL AGRICULTURE IN NAGALAND
1.1. INDIGENOUS AGRICULTURAL PRACTICES

Traditional agriculture, an indigenous form of farming is the result of the co-evolution of local, social and environmental systems. It exhibits a high level of ecological rationale expressed through the intensive use of local knowledge and natural resources, including the management of agro-biodiversity in the form of diversified agricultural systems.

The traditional agriculture in Nagaland is an extremely complex system. Farming families, in order to sustain their livelihood, adopt and maintain diverse forms of agricultural practices, mainly terraced rice cultivation (TRC), shifting cultivation, home-garden, and firewood reserve forests, simultaneously. The locations of these varied sites compel the farmers to adopt and adapt practices that suit the site factors. The prominent site factors, particularly the altitude, temperature, precipitation, soil and biotic and abiotic factors play important roles in management of traditional cultural practices and also in conserving agro-biodiversity. As a result of these adoptions and adaptations, traditional farming systems have a high degree of agro-biodiversity which is one of its prominent features. These traditional farming systems have emerged over centuries of cultural and biological evolution and represent accumulated experiences of indigenous farmers interacting with the environment without access to external inputs, capital, or modern scientific knowledge (Chang, 1977; Grigg, 1974).

Intimate knowledge of the microclimate prevailing in the village enables traditional farmers to select crops and its varieties for cultivation. This is particularly important because the food security for the year required by the family depends on cultivating the suitable crop and its varieties suiting the location. The landholding of a farming family is spread throughout the village traditional land boundaries that may be located anywhere from foothill plains to top of the ridge. The family also has to take into consideration the physical features such as the aspect, slope and soil fertility status of the field to be cultivated. They also keep in mind the distance between the field and the place of habitation. Using inventive self-reliant experiential knowledge, and locally available resources, traditional farmers have often developed farming systems with sustained yields (Harwood, 1979). Areas put to other forms of traditional agriculture such as firewood forests, rice nursery sites and home/kitchen gardens are integral parts of the agricultural practices.
But these forms are yet to draw the attention of researchers and decision making development workers as important livelihood activities in the rural lives of Nagaland. Many of these traditional agriculture systems constitute major in-situ repositories of both crop and wild plant germplasm.

Perhaps the greatest challenge to understanding how traditional farmers maintain, preserve and manage biodiversity is to recognize the complexity of their production systems. Today, it is widely accepted that indigenous knowledge is a powerful resource in its own right and complementary to knowledge available from western scientific sources. Therefore, in studying such systems, it is not possible to separate the study of agricultural biodiversity from the study of the culture that nurtures it.
Areas

UNDER TRADITIONAL AGRICULTURE
2.1. CROP ACREAGE

Out of the total geographical area of 16,57,900 hectares, the gross area under agriculture was 3,68,130 and area under traditional agriculture was 2,29,640 hectares annually. The traditional agriculture areas include area put under Jhum paddy, terraced rice cultivation (TRC) paddy, and maize. Areas covered under commercial crops like oilseeds and pulses to the tune of 1,38,490 hectares are largely monoculture and were not included in the traditional agriculture areas.

Table No. 2.1.
Area Under Agriculture In Nagaland (In Hectare)

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Area</th>
<th>Area Under Traditional Agriculture</th>
<th>Non Traditional Crops</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Jhum Paddy</td>
<td>TRC Paddy</td>
</tr>
<tr>
<td>2003</td>
<td>339070</td>
<td>88500</td>
<td>67500</td>
</tr>
<tr>
<td>2004</td>
<td>342990</td>
<td>87100</td>
<td>66900</td>
</tr>
<tr>
<td>2005</td>
<td>355137</td>
<td>88150</td>
<td>68250</td>
</tr>
<tr>
<td>2006</td>
<td>442190</td>
<td>99980</td>
<td>64700</td>
</tr>
<tr>
<td>2007</td>
<td>368130</td>
<td>97420</td>
<td>68580</td>
</tr>
<tr>
<td>2008</td>
<td>380950</td>
<td>95780</td>
<td>73200</td>
</tr>
<tr>
<td>2009</td>
<td>387860</td>
<td>90940</td>
<td>83330</td>
</tr>
</tbody>
</table>


From Table No.2.1, one can observe that there was a steady increase in the total area under agriculture and then a significant jump from 3,55,137 hectares in 2005 to 4,42,190 hectares in 2006. This quantum rise was the result of efforts put by the Government of Nagaland under the programme “Year of the Farmers”. Incidentally the increase was in the areas put in the production of jhum paddy that rose from 88,150 hectares in 2005 to 99,800 and other cash crop production systems.

In the subsequent years there was gradual decrease in the areas. Rice is the staple food for most of the people of Nagaland. Maize is cultivated largely for pig feed and also for consumption in some part of the State where rice cultivation is not conducive.

In recent years there has been a significant increase in the area under maize cultivation from 45,140 in 2003 to 64,400 hectares in 2007, an increase to the tune of 19,260 ha. The increase may be attributed to the fact that rural farmers in many villages are producing maize on a commercial scale because of its high demand in the market. Similarly, there was also significant increase in the area under TRC and jhum paddy by 5,700 and 7,280 hectares respectively from 2003 - 2008. This increase could be largely to meet the need to feed the growing population. The population increase was from 18,06,844 to 24,34,897 (Projected Population of Nagaland From 2002-2010, Directorate of Economics and Statistics - 2004).

**Figure 2.1.**

![Graph showing Area Under Traditional Agriculture Production of Paddy and Maize with Reference to Population Cultivating Them](image)

- **Area under traditional agriculture in '000' Ha.**
- **Production of paddy and maize in '000MT**
- **Rural population practicing traditional agriculture**
There are three ways to address this gap: the urgent need to increase production per hectare through improvements of traditional agriculture, arresting the population growth rate and providing opportunities for off-farm income generating avenues. Although addressing the issue of arresting population growth in the rural villages is not a subject to be dealt with in this section, it is a matter of concern in ensuring food security. In order to improve traditional agriculture, it is imperative to understand the diversified forms of practices in order to identify the potential areas for improvements.
Diversified Forms
OF TRADITIONAL AGRICULTURAL PRACTICES
3.1. AGRO-BIODIVERSITY OF TRADITIONAL AGRICULTURE

A salient feature of traditional agriculture in Nagaland is its form of diversity. Apart from keeping domestic animals, a single farming family maintains three to four systems of agriculture, namely Jhum, home garden, firewood reserve, and among the Angamis and Chakhesang tribes of Kohima and Phek districts, terraced rice cultivation fields. Within these four systems there is a high degree of crop diversity in each of them. In order to understand the forms of traditional agriculture being practiced by the farmers of Nagaland, household survey was conducted by NEPED project staff at random on 25 households across Nagaland.

The methodology of conducting the study was that respondents were selected at random. Preferred method was to interview the farmer while the family was working in the field so that the researcher could make a direct observation of the number of crops being cultivated by the family. Most of the respondents were women farmers, they being the custodians of seeds. Summary of the survey is indicated in Table No. 3.1 below.

Table No. 3.1.
Average Number of Crops and Varieties Cultivated by One Farming Family in Traditional Agriculture (Household interview in 70 Sample Villages)

<table>
<thead>
<tr>
<th>Forms of Traditional Agricultural Practices</th>
<th>Average Number to be Found</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Number of Crops Cultivated in Jhum</td>
<td>41</td>
</tr>
<tr>
<td>Number of Rice Varieties in Jhum</td>
<td>8</td>
</tr>
<tr>
<td>Crops in Home Gardens</td>
<td>20</td>
</tr>
<tr>
<td>Terraced Rice Cultivation:</td>
<td></td>
</tr>
<tr>
<td>1. Rice Varieties</td>
<td>4</td>
</tr>
<tr>
<td>2. Insects, Larvae, Fishes Collected from TRC</td>
<td>11</td>
</tr>
<tr>
<td>3. Uncultivated Vegetables Preserved</td>
<td>11</td>
</tr>
</tbody>
</table>

Source: Primary Data Collected by NEPED Staff during March and April, 2009

It was observed that there were several crops such as green leafy vegetables, maize, chili, spices and condiments cultivated in both jhum and home-gardens. There were perennial tree crops such as bananas, oranges and solanum. Other fruit trees were found only in home-gardens. In the terraced rice fields, an average 6 rice varieties were cultivated. Taking into consideration the different forms of traditional farming system,
it was observed that a single family was cultivating not less than 60 different crops. It was reported that in some cases, a single farming family was cultivating 69 crops in one jhum plot (Supong - 1997).

Most of the seeds and planting materials are preserved and stored by the family, especially women. The traditional knowledge of selection and storage of seeds possessed by the farmers are impressive. Many of the crops are sown taking into consideration the site factors where it will thrive. There are several reasons as to why traditional farmers maintain high agro-biodiversity. The strategy of minimizing risk by planting several species and varieties of crops stabilizes yield over the long term, promotes diet diversity, and maximizes returns even with low levels of technology and limited resources (Harwood, 1979). Such biodiverse farms are endowed with crops that perform ecological functions such as nutrient enriching plants, insect repellents, weed suppressing, nitrogen fixing and decomposing bacteria, and a variety of other organisms performing various beneficial functions.

We will look at each in detail.

(I) ADAPTATION TO ALTITUDE AND SITE FACTORS

A transect walk in traditional farming fields revealed the following crop diversity based loosely on altitude, as classified by the farmers:

- **Very High Altitude:** The fields are adjacent to forests, or a new area of primary forest is brought under cultivation. The soils are rich in humus and so, cold variety crops like green leafy vegetables, beans, bulbs and maize are cultivated.

- **High Altitude:** The area is warmer allowing more number of crops to be cultivated in addition to the crops grown in the ‘very high’ areas. In this region, in addition to the crops grown above, spices, paddy and more pulses are introduced along with crops from regular jhum.
• **Mid Altitude**: Crops of regular jhum and some varieties of warm region crops are integrated in this region and so crop diversity is the highest here.

• **Warmer Region**: Only those crops and varieties suited to the altitude are grown. The crops that have been added in the previous region are carried on to this region. The farmers have more choice of crops for cultivation as there are several crops that could be cultivated in this region.

(II) **MANIPULATION (EXPLOITATION) OF CROPS’ PHYSICAL CHARACTERISTICS**

• **Contour Bund Crops**: Contour bunds are constructed by placing poles across the slope and weed debris and soil clods are collected along the contour. The soil depth is more and therefore, more fertile in these locations. Taking advantage of the quality of the soil, farmers cultivate tuber crops, leafy vegetables, beans and lablab in these locations.

• **Special Crops**: Types of crops that are required by the family but could not be cultivated along with the others because of their high light demanding nature are cultivated separately in specialized locations. Crops such as garlic, chili, brinjal, tomato, tulsi, onion, spices, cabbage and green vegetables are cultivated in small patches as monocropping.

• **Boundary Line Crops**: Creeping crops such as cucumber, pumpkin and beans that are likely to interfere with the cultivation of the main crops like rice and maize are cultivated on the boundary lines.

• **Main Crops**: Depending on the staple food of the community the major crops are cultivated. These could be a mixture of rice and maize, maize and perrila, rice and colocassia and so on.

• **Crops Near Hut**: The highest agro-biodiversity is found near the field hut. In this location, farmers cultivate almost all vegetables, condiments, spices, fruits, perennial crops and even experiment with new crops by introducing them. Seeds of new crops that are able to grow well in this location are collected and propagated in the following year.
(III) CROP DURATION

• Short duration crops, especially vegetables, are required to be cultivated so as to meet the immediate needs of the household.

• Millet is a major cereal crop that is harvested earlier than paddy and is used as the main food till paddy is harvested.

• Major crops are normally of good keeping quality that is harvested as a matter of course for the family’s sustenance for the year. They are normally the staple food like paddy, maize, millets, khollar, pulses and oilseeds.

• Long duration and late sown crops. These are crops that continue to stand in the field even after the main crops are harvested. They are either long duration crops, e.g., job’s tears, or late sown like soybean.

• Biennials and perennials hibiscus sp., chili, brinjal, ginger, and yam are some examples. These crops are grown for sale and also for food security during the lean period.

(IV) DOMESTICATION OF UNCULTIVATED VEGETABLES

• Domestication of erstwhile wild vegetables has become common. Farmers have begun to preserve wild edible plants that are found growing in the jhum fields, which in the past, would have been weeded out. Zanthoxylum sp., Clerodendron sp. and Rhus semialata are some example of such domestication.

• Awareness of medicinal values of some wild plants is another reason for crop diversity in the farmer’s field and home garden; Mentha arvensis, Swertia sp., Litsea citrata etc. are some examples.
ADVANTAGES IN WIDE RANGE OF AGRO-BIODIVERSITY

i. A wide range of food products is obtained from the different crops grown. This contributes to food security, nutritionally balanced food and good health.

ii. Promotes maintenance of traditional and site-specific varieties.

iii. The family continues to harvest its food needs almost all year round making the household self-reliant in food needs.

iv. The special crops serve as supplementary income or as the sole source of cash income.

3.1. (A) JHUM SYSTEM

A comprehensive literature search at the Commonwealth Agriculture Bureaux International (CABI) on shifting cultivation and related subjects 20 years ago had resulted in about 5500 publications. Many of these publications arrived at the same conclusion as that of Nye and Greenland in 1960, in which the authors documented the results of measurements of the nutrient cycle during the cropping period as well as dynamics of the fallow period (Robinson & McKean, 1991). Despite these repositories of knowledge, researchers continue to conduct experiments and farmers continue to practice traditional systems of jhum cultivation.

Shifting cultivation is the most complex and multifaceted form of agriculture or agro-forestry practices in the world (Darlong, V.T., 2004). Perhaps, because of its complexities, it is also the least understood form of agriculture. As a result, shifting cultivation is condemned in many forums as being destructive to the environment because forest areas are being converted to agriculture through its practices, thus diminishing the area under primary forests. On the other hand, some forums considered shifting cultivation and farmers’ innovations in particular, contributing to forest cover and biodiversity conservation, while at the same time maintaining agriculture and forest productivity (Kerkhoff, E & Sharma E 2006).
The intention of this section is to highlight several aspects of lesser known features of shifting cultivation that are important to the practice of shifting cultivation. The benefits accrued in the process of natural regeneration of trees during the fallow period are often overlooked by researchers, planners and decision makers. Aspects like traditional institutions exerting indigenous knowledge for the benefit of environmental good governance and evolving innovative practices to the pressure of population growth on land are highlighted in this section.

### 3.1. (B) SHIFTING CULTIVATION AND PRIMARY FORESTS

Often, shifting cultivation is blamed for deforestation and forest degradation. It was presumed that under this practice, a virgin forest land in the hills is cleared by burning and the land is put to cultivation. When production declines, the land is abandoned and another virgin forest site is selected for cultivation. Meanwhile, the abandoned land is regenerated with vegetative growth and people come back to cultivate the same land again. In Nagaland, our study (NEPED-2008) in 153 villages showed that (Figure 3.1) land conversion had taken place more than 40 years ago in 87 percent of the villages and in only 14 percent of villages during the last 20 to 30 years. In many cases these recent land conversion of primary forests to agricultural uses followed logging operations. A prominent common feature about setting aside primary forests for community reserves was to conserve the water source. This feature confirms that there exists a vast traditional knowledge on the natural resource management among the village communities and they are aware that primary forests serve as water reservoirs. In depth interview with the villagers substantiates that there is a strong resolution passed by the Village Council to conserve and preserve the water sources of the village.

*Figure 3.1. Number of Years Past when Last Conversion of Primary Forest to Agricultural Uses Took Place (153 Sample Villages)*

[Graph showing number of villages for different years]
In districts like Mokokchung, Zunheboto and Phek, there are signs of jhum fallow land turning to secondary forests and plant succession processes tending to climax forests has been observed. Large tracts of land areas that were previously subjected to jhum cultivation are now left undisturbed. In fact, villages like Sungratsu and Mishilimi in the districts of Mokokchung and Zunheboto respectively have resolved to set aside large areas of jhumland for the Village’s Community Reserve. In Longsa and Wokha villages in the district of Wokha, the farmers have taken up cultivation of passion fruit on commercial scale and as such it was reported that the farmers have no time for jhum cultivation. This has resulted in reduction of area cultivated per head. Similar examples are occurring all over the State where alternative livelihood options are available.

3.1. (C) INVENTORY OF TREE NATURAL REGENERATION DURING THE FALLOW PERIOD

Trees are important for recovery of soil fertility to enable the farmer to cultivate the same patch of land in the next jhum cycle. The trees pump up nutrients from the deeper soil layers improving the physical and chemical soil conditions by their nutrient-rich litter; their leaf biomass production allows humus formation; the soil is protected by their crowns and litter during the fallow period from the beginning which reduces erosion and restores fertility faster than a slow natural succession on an abandoned jhum field.

In order to assess the volume of trees that regenerated per hectare during the fallow period, a study was carried out by the NEPED team in 2007 in 21 villages. In these 21 sites:

i. Eight villages had jhum cycle of less than 10 years

ii. In 10 villages, the jhum cycle was 10 years and in 2 villages 12 year jhum cycle.

iii. One village had 25 years jhum cycle, in this village the farmers cultivate for four consecutive years and leave the land fallow for 21 years.

iv. Farmers practicing one year cropping period had more number of standing trees as compared to those that have two or more years.

v. Farmers opined that tree density per ha of 1200 to 1500 is optimal.
METHODOLOGY

Field procedure on Minimum Representative Area (MRA) was followed. In this procedure, a stand analysis comprises of all strata from seedlings to pole sized trees to forest giants, all of which require a plot size of their own. The following steps were followed to assess the natural regeneration of tree species during the fallow period of shifting cultivation.

Systematic selection method was employed in the data collection. Sampling lines were placed at regular distance along a baseline.

Compartment A

20 x 20 m for all trees of 10 cm dbh and above. 25 such plots were established making it to 1 ha. Distance between one Compartment A to the next Compartment A was determined by:

\[ D = \sqrt{c \times N \times 10000/n} \]

where:
- \( D \) = the distance from one sample plot to the next
- \( N \) = the total population who are going to cultivate that location
- \( n \) = the sample size; 25 in this survey
- \( c \) = approximate area cultivated per head; 0.15 ha
**Compartment B**

One subplot of 10 x 10 m was carved out from within the Compartment A to assess saplings and poles of ≥1.3 m high to less than 10 cm dbh.

**Findings**

<table>
<thead>
<tr>
<th>Number of Sites (Villages)</th>
<th>21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Districts</td>
<td>9</td>
</tr>
<tr>
<td>Average Jhum Cycle (Years)</td>
<td>9</td>
</tr>
<tr>
<td>Average Number of Trees Per Ha</td>
<td>872</td>
</tr>
<tr>
<td>Average Number of Sp. Per Ha</td>
<td>52</td>
</tr>
<tr>
<td>Average Basal Area (m²/ha)</td>
<td>14.77</td>
</tr>
<tr>
<td>Average Volume (m³/ha)</td>
<td>188.37</td>
</tr>
</tbody>
</table>

**Biomass Accretion in jhums of Nagaland**

- Employing thumb rule wood density at 0.58 gm/cm³ the above ground biomass is about 110 tones per hectare for 188.37 m³ stand volume.
- 50 percent of the standing biomass is carbon itself, therefore above ground carbon stock is 55 tones per ha.

Below ground biomass had not been accounted for in the inventory.

**CONCLUSION AND RECOMMENDATION OF THE STUDY**

i. In jhums of Nagaland, the regeneration of trees during the fallow period negates the carbon emission during burning.

ii. All biomass slashed are not subjected to burning and therefore, there is sequestration of carbon.

iii. Farmers’ practice in preserving of poles during cropping need to be replicated.

iv. Increasing the number of trees per ha from 852 to 1500 is possible.
3.1.(D) MANAGEMENT OF MAIN JHUM PARAMETER TO INCREASE CARRYING CAPACITY

The sustainability of jhum system depends on how the population practicing jhum make use of the main parameters: the cropping period, the fallow period, area cultivated per head and average percentage of land not subjected to jhum. Under pressure of population on the jhum land, the farmers have the following options:

i. Increase the cropping period and keep the fallow period constant.

ii. Reduce the fallow period without disturbing the cropping period.

iii. Reduce the cultivated area per person without disturbing both cropping and fallow period.

iv. Bring more areas that were previously uncultivated because the land is too steep or considered infertile for cultivation.

FALLOW PERIOD AND CROPPING PERIOD

Several authors postulated the required minimum length of a fallow period to sustain jhum systems. For a cropping period of one to two years under monsoon climatic condition as found in Nagaland the required minimum fallow period is 12-15 years (Weidelt, 2000). The length of a fallow period required can also be calculated by a formula (Young, 1991):

\[
R = \frac{\text{Years Under Cultivation}}{\text{Years Under Cultivation Plus Fallow}} \times 100
\]

Where \( R \) is the ratio of the length of the cropping period and the fallow period in percent.

By this estimation, for Acrisols such as in Nagaland, the required R-factor is 15 percent, under the present condition the R-factor is 15 percent, (that is \( 1.5/(1.5+8.5) \times 100 = 15 \) percent). Ramakrishnan (1992) postulated that in Northeast India, where the cropping period is normally 2 years, it should be followed by a minimum of 8 years fallow period making a total of 10-year jhum cycle.
In Nagaland, according to the authors mentioned above, on an average of the 249 sample villages, the existing jhum system is sustainable because the fallow period is long enough to restore the soil condition to the same state as in previous cycles. It should be noted here that the 10-year jhum cycle is an average of 249 villages out of which 45 villages are below 9-year jhum cycle and therefore not sustainable.

**Figure 3.2**

In most villages of Nagaland the gregarious cropping period is only one year and left to fallow in the second year. It was also common that farmers would take due care to conserve soil during the first year cropping to take the second year cropping.

However, a survey of 75 farming families on their average rice consumption came to 0.66 kg/day/per person for three meals, that is; morning meal, lunch and dinner. The total rice requirement was about 240kg/head/year. According to International Rice Research Institute (IRRI)-Science-Rice Statistics 1999, millet rice consumption per year for people of Myanmar is 210 kg, Chinese - 90.7 kg, Indian - 74.2 kg, Philipinos - 99.7 kg and Vietnamese - 170.3 kg. Nagas are nearer to the people of Myanmar in rice consumption than the fellow Indians.
Table No. 3.2.  
Analysis of Yearly Shortfall Rice Production of Jhum in Nagaland

<table>
<thead>
<tr>
<th>Year</th>
<th>Area Under Jhum Paddy In Ha.</th>
<th>Production In Mt</th>
<th>Population Of Jhumia*</th>
<th>Production/Ha</th>
<th>Area/Person Ha.</th>
<th>Production/Person Of Milled Rice Kg</th>
<th>Yearly Consumption/Person</th>
<th>Yearly Shortfall/Person Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>88500</td>
<td>128000</td>
<td>1102175</td>
<td>1.45</td>
<td>0.08</td>
<td>58.07</td>
<td>240.00</td>
<td>181.93</td>
</tr>
<tr>
<td>2004</td>
<td>87100</td>
<td>133500</td>
<td>1158361</td>
<td>1.53</td>
<td>0.08</td>
<td>57.62</td>
<td>240.00</td>
<td>182.38</td>
</tr>
<tr>
<td>2005</td>
<td>88150</td>
<td>134100</td>
<td>1217411</td>
<td>1.52</td>
<td>0.07</td>
<td>55.08</td>
<td>240.00</td>
<td>184.92</td>
</tr>
<tr>
<td>2006</td>
<td>99980</td>
<td>160000</td>
<td>1279471</td>
<td>1.60</td>
<td>0.08</td>
<td>62.53</td>
<td>240.00</td>
<td>177.47</td>
</tr>
<tr>
<td>2007</td>
<td>97420</td>
<td>166460</td>
<td>1344695</td>
<td>1.71</td>
<td>0.07</td>
<td>61.90</td>
<td>240.00</td>
<td>178.10</td>
</tr>
<tr>
<td>2008</td>
<td>95780</td>
<td>171080</td>
<td>1413244</td>
<td>1.79</td>
<td>0.07</td>
<td>60.53</td>
<td>240.00</td>
<td>179.47</td>
</tr>
<tr>
<td>2009</td>
<td>90940</td>
<td>175510</td>
<td>1485287</td>
<td>1.93</td>
<td>0.06</td>
<td>59.08</td>
<td>240.00</td>
<td>180.92</td>
</tr>
</tbody>
</table>


As can be seen from the table above, the rice production from jhum is meeting only 4 months of rice requirement. In villages where farmers are practicing terraced rice cultivation along with jhum, the rice production may be sufficient for the year. But in those villages where they are totally dependent on jhum rice, there is a shortfall of rice requirement for about 8 months. This fact was confirmed by farmers in villages that are mainly dependent on jhum. In order to meet the milled rice requirement the following solutions are recommended:

- increase the production by four times from 1.7MT/ha to 6.8MT, or
- increase the area cultivated per person from 0.07ha to 0.28ha reducing the fallow period or increasing the total area under jhum cultivation but that might amount to encroaching into primary forest, or
- reduce the population mainly dependent on jhum by providing alternative livelihood options.

As can be seen in the Table No. 3.2, the area put under jhum annually ranged from 885km² in 2003 to 999 km² in 2006 and declined in the subsequent years. This showed that the practice must confine to an average area of about 970 km². In order to maintain the carrying capacity of land under jhum, the maximum population density must be maintained taking advantage of the elasticity of the main jhum parameters.
It is generally understood that the carrying capacity is the number of individuals that can be supported in a given land area without irreversibly reducing its capacity to support people in the future. The carrying capacity of shifting cultivation can be sustained only when the cropping period is not too long and the fallow period is long enough. Weidelt (1968) postulated a model to estimate the maximum population density per km². Weidelt’s formula takes into account the main parameters of shifting cultivation and therefore, is the most suitable one for computing maximum population density of land under jhum in Nagaland:

\[
D = \frac{100-e}{b/a + 1} c
\]

Where,
- \(D\) = population density per km²
- \(a\) = average cropping period in years
- \(b\) = average fallow period in years
- \(c\) = average cultivated area per head in hectare
- \(e\) = percentage of land not suitable for agriculture (Infrastructure, rocky, steep or swampy ground, etc)

**ASSUMPTION**

The maximum population density ‘D’ refers to only those who are depending on jhum cultivation for livelihood. The table below is to quantify each of the parameters in the formula under different jhum systems and also to assess the flexibility under population pressure.

**Table No. 3.3.
Increasing the Carrying Capacity by Improving the Main Parameters of the Jhum System**

<table>
<thead>
<tr>
<th>System Number</th>
<th>Jhum Systems</th>
<th>Cropping Period</th>
<th>Fallow Period</th>
<th>Area Cultivated Per Person</th>
<th>Area Not Available For Jhum</th>
<th>Carrying Capacity</th>
<th>Population The System Can Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sustainable System Without Improvement</td>
<td>2</td>
<td>15</td>
<td>0.30</td>
<td>30</td>
<td>27.5</td>
<td>26353</td>
</tr>
<tr>
<td>2</td>
<td>Recommended Sustainable System</td>
<td>1</td>
<td>8</td>
<td>0.27</td>
<td>30</td>
<td>28.8</td>
<td>27654</td>
</tr>
<tr>
<td>3</td>
<td>Model Recommended by Ramakrishnan</td>
<td>2</td>
<td>8</td>
<td>0.27</td>
<td>30</td>
<td>51.9</td>
<td>49778</td>
</tr>
<tr>
<td>4</td>
<td>Current Practice in Nagaland</td>
<td>1.5</td>
<td>9</td>
<td>0.07</td>
<td>30</td>
<td>142.9</td>
<td>137143</td>
</tr>
<tr>
<td>5</td>
<td>Alder Based Jhum System (Khonoma Model)</td>
<td>2</td>
<td>2</td>
<td>0.27</td>
<td>30</td>
<td>129.6</td>
<td>124444</td>
</tr>
<tr>
<td>6</td>
<td>Jhum Intensification Sars Model</td>
<td>4</td>
<td>8</td>
<td>0.27</td>
<td>30</td>
<td>86.4</td>
<td>82963</td>
</tr>
<tr>
<td>7</td>
<td>Leakonger Model Of Incorporating French Beans and Alder Trees</td>
<td>6</td>
<td>10</td>
<td>0.20</td>
<td>30</td>
<td>131.3</td>
<td>126000</td>
</tr>
<tr>
<td>8</td>
<td>Tuophema Model</td>
<td>4</td>
<td>21</td>
<td>0.20</td>
<td>20</td>
<td>64.0</td>
<td>61440</td>
</tr>
</tbody>
</table>
SAFETY FACTOR

While employing the formula in planning any project, it must be kept in mind that the data used in arriving at a conclusion are approximations from sample estimates. Therefore, as a safety factor 20 percent may be deducted from the maximum population density of the systems 3, 5, 6 & 7.

(I) SUSTAINABLE SYSTEM WITHOUT IMPROVEMENT

In the evergreen tropical forest, the shifting cultivation system is sustainable if the cropping period is not more than 2 years and the fallow period is not less than 15 years. The cultivated area per person is generally estimated for subsistence farmers at 0.30 ha. Assuming that 70 percent of the land is suitable for cultivation, the maximum population density works out at 27 persons/km². In Nagaland, this ideal situation is gone long ago. The system was sustainable when the population was only 26,353 cultivating in 970 km².

(II) RECOMMENDED SUSTAINABLE SYSTEM

One year cropping period followed by 8-10 years fallow period has several advantages. Farmers spend less time in preparing soil conservation measures and spend more time and efforts in cultivation of the crops in the field. According to jhum farmers, eight years fallow period is ideal because if the fallow period is more than eight years, they spend more energy in felling the trees. But when the fallow period is less than eight years, the soil fertility would not have regained the optimum level for cultivation. The area cultivated per person at 0.27 ha was considered sufficient to yield paddy enough for one year’s consumption. Setting aside 30 percent of the land for other uses including spatial requirements for tree poles to stand in the field, preserving remnant forests, keeping the original forests areas in the ravines and streams, and giving provisions for footpaths and field huts was considered ideal. However, in this system an area of 970 km² enables only 27,650 persons to cultivate, which is far too small to accommodate the over 1,44,000 jhumias.

(III) MODEL RECOMMENDED BY RAMAKRISHNAN

As stated in the preceding section, according to P.S. Ramakrishnan (1993), 2 years cropping period should be followed by 8 years fallow period. This system would enable about 49780 persons to cultivate in 970 km².
(IV) CURRENT PRACTICE IN NAGALAND

The current general jhum practice in the study area is a 1.5 years cropping period followed by a period of 9 years fallow with cultivated area per person at 0.07 ha, and land not available for jhum at 30 percent. The carrying capacity works out to be 142.9 persons per km² and accommodated about 1,40,000 persons. On the other hand, it should be noted that the required cultivated area per person is about 0.27 ha for an individual’s subsistence needs. This system seems to reflect the present condition in Nagaland quite well.

(V) ALDER BASED JHUM SYSTEM (KHONOMA MODEL)

Taking advantage of the nature of Alder trees’ ability to fix atmospheric nitrogen, the Khonoma farmers and also farmers in several other villages across Nagaland have incorporated this tree species into their jhum system. While other villages planted Alder as a matter of routine in their jhum fields, Khonoma had perfected the system. In this, Khonoma farmers had evolved a system where they could cultivate for two years followed by a fallow period for only two years and the same field was subjected to cultivation again. They were able to do this by pollarding the Alder tree branches during the cropping period and carefully dressing the stump and nursing the sprouts so that each old stump was supporting only 3 to 5 coppices at the end of the cropping period. In this system, the area subjected to burning is minimal. By adopting this model in 970 km² it shall be able to support a population of 1, 24, 444 persons and produce sufficient rice to meet the yearly requirements.

(VI) JHUM INTENSIFICATION SARS MODEL 82963

The State Agriculture Research Station (SARS), Yisemyong had developed a model where rice was cultivated for a consecutive 2 years. In the third year, legume cover crop was cultivated and harvested. This was followed by cultivating rice in the fourth year. Reports of on-farm trials of this crop rotation have indicated encouraging results. In that case, the carrying capacity can be 86 persons/km² accommodating 82,960 persons. The carrying capacity could be increased to 163 persons/km² and accommodate 1,56,734 persons.
(VII) LEAKONGER MODEL OF INCORPORATING FRENCH BEANS AND ALDER TREES

In this model, the major crop is French beans. The French beans is cultivated consecutively for 4 years followed by 10 years fallow period. The farmers sell off the beans and buy rice with the sale proceeds. The farmers had planted Alder in their fields, which had augmented the process of regaining soil fertility. The system could bring the carrying capacity of jhum to 131 persons/km² and enable 1,26,000 persons to cultivate in 970 km².

(VIII) TUOPHEMA MODEL

In this system, farmers of Tuophema village in the district of Kohima cultivated the same field for 4 consecutive years followed by 21 years of fallow period. Though the system required augmentation of tree plantation, as a model it could support 64 persons/km² and accommodate in 970 km², annually.

Cross Cutting Consideration to Sustain the Systems (vi) to (viii)

It is presumed that farmers take adequate soil conservation measures though traditional, and plant fast growing nitrogen fixing trees that can be pollarded and coppiced well e.g. Alnus nepalensis, Albizia stipulata. It is stipulated that the combination of nitrogen fixing trees and legume crops in the jhum practices would sustain the jhum systems. An added advantage in this system is that over and above the increased maximum population density, the trees that are planted in the first year of the cropping period would be already 9 years of age. These trees could be harvested to meet fuel-wood and round-wood needs of the farming family.
3.2. TERRACE RICE CULTIVATION

Terrace Rice Cultivation has been the pride of the people of the Angami and Chakhesang tribes of Nagaland. The technology distinguishes Angamis and Chakhesangs from other tribes. This system of growing paddy has been there since the establishment of the village. The first settlers had brought the technology with them. Most of the terraces that anyone comes across in these regions could be as old as the village and that would mean not less than 300 years old. Terrace Rice Cultivation is a system of irrigated agriculture for growing rice. The terraces vary in breadth and length depending on the slope of the land and the expertise of the people developing the terrace. The Chakhesang are able to develop broader and longer terraces for the same slope than the Angami tribe.

Scientists of Central Soil and Water Conservation Research and Training Institute (CSWCRTI), Dehradun, are of the opinion that terracing above 30 percent slope is not feasible and durable. But Naga farmers have proved them wrong. The limit to terrace construction is not the slope but availability of irrigation water. ‘Give water and you have terrace’. As for the slope the sky is the limit, almost.

“Where the steep rise in the slope commences, the spurs are at once more level, and are terraced for rice cultivation; not a square yard available land has been left, and the system of irrigation canals well aid out. I have never, even in the better-cultivated parts of the Himalayas, seen terrace cultivation carried out to such perfection. Today the peculiar terrace cultivation of these tribes is observed in perfection. The labour incurred in first making these terraces must be very great, and the skill manifested in irrigating them would do credit to an engineer”. (The Nagas in the Nineteenth Century. Verrier Elwin)
There are two types of terrace rice cultivation. Dry Terrace where irrigation is given only during the growing period of paddy from June to October and ponded water is drained out and allowed to remain dry from November till June because water sources are not perennial. Wet Terraces are where water is impounded throughout the year with irrigation. In this Wet Terraces several cultural operations that are given to Dry Terraces are averted. They also have a better yield than that of Dry Terraces.

**Figure 3.3**

![Year Wise Comparison Of Area And Production Under Terraced Rice Cultivation](chart)

In Nagaland there is an increase in area, production and yield as compared to the status in 2003. The area has increased from 67,500 ha in 2003 to 83,300 ha in 2009 and along with this increase, the yield had also increased from 1807 kg/ha in 2003 to 2377 kg/ha in 2008. The production increase was from 1,22,000 to 1,74,000 metric tonnes. The increase could be attributed to better management practices and selection of higher yielding variety from among the landraces available within the village by discarding low yielding ones. For example the sticky rice variety that has low yield but has special uses such as in brewing local wine, was not cultivated. Instead other rice varieties that have high yielding characteristics were cultivated. This was a common occurrence in many villages.

The demand for rice in India is projected at 128 million tonnes (mt) for the year 2012. It will require a production level of 3,000 kg/ha, significantly greater than the present average yield of 1,930 kg/ha. This low level of productivity can be increased substantially by growing high yielding varieties/hybrids and by increasing both the area under balanced fertilizer use and application rates (K.N. Tiwari - 2002, Better Crops International). The yield in TRC of Nagaland at 2330 kg/ha indicates that the
State is progressing towards the yield target set by Tiwari in 2002. In fact, according to reports by SARS, the yield of Mehouru was 3-3.5 MT, Ngobano 3-3.7 MT, Nagaland Special 2.5-3 MT. Thus by up-scaling the cultivation of these varieties and also through participatory plant breeding (PPB) of selected varieties that may have high yielding characteristics, it will not be farfetched to expect an average yield of 3000 Mt/ha. It is a possibility because Nagas cultivate about 360 different varieties of rice (Yanger, Y.P -1999, as cited in ‘Building upon Traditional Agriculture in Nagaland’).

In-depth interviews with farmers revealed that a farming family spends about 156 working days to harvest 700 kgs of milled rice in Dry Terrace. Whereas, in Wet Terrace, in order to harvest the same amount of milled rice the farming family spends 131 working days (NEPED Internal Survey – 2009). In the village, cost of milled rice was ₹ 18/kg, hence the total income from 700 kg was ₹ 12,600/-. In monetary terms, the wage per day works out to be about ₹ 80/day in case of Dry Terrace and ₹ 96 a day in case of Wet Terrace. Considering that hard cash is scanty in the villages, earning ₹ 80/- or ₹ 96 a day was found to be a reasonable income. However, when the family had to employ additional hand for the works, they had to pay not less than ₹ 100 a day and also provide mid day meal, which works out to be expensive for the family.
In another case study, the farmer had incurred an expenditure of ₹ 5300/- and generated an income of rice yield equivalent to ₹ 2400/-. According to this farmer, other than intangible benefits such as keeping traditional agriculture alive, there is no monetary benefit in TRC. The farming family in TRC does not confine to cultivating rice alone. Along with cultivating rice, several other income generating activities are taken up. Some of them are described below:

3.2. (A) SIDE BENEFITS FROM PADDY NURSERY

*Cultural operation of raising paddy nursery is common in both types of terraces.*

i. The location where the farmer is to have his paddy nursery is slashed in the month of August.

ii. Depending on the intensity of vegetation, controlled burning is done as soon as leaves are dried, sometimes burning may not be required.

iii. Tree poles are laid across the slope to prevent soil erosion just after burning.

iv. The field is ploughed and small soil mounds are made by burying twigs and leaves. These mounds are then burned and the soil clods are spread uniformly all over the nursery.

v. Legume crops, especially soybean (Glycine max) are sown. This crop is harvested in the month of November and another plough is given with crop residue.

vi. Sowing of paddy seed is done in the later part of March and early April.

vii. Paddy seedlings are transplanted by later part of May or first week of June.

viii. As soon as seedlings are transplanted, the same field is given a deep plough and suitable legume crops including soy bean is sown again. In this way of alternating paddy nursery with legume coupled with giving deep plough, a farmer is able to raise seedlings for over 5 years.

ix. Mix crop is taken from paddy nursery, ginger, yam, beans and cowpea in the contour bunds, Hibiscus sabdariffa and cucumber in the margins. Mustard leaves and crops belonging to the lily family are not planted in paddy nurseries.
3.2. (B) BENEFITS FROM ADAPTATION TO MODERN CONCEPT OF AGRICULTURE

In the past Dry Terrace was considered inferior to Wet Terrace. Now as road communication has reached almost every village, this type of terraces have been used in growing cash crops, mostly potatoes and tomatoes during winter using residual moisture from paddy cultivation. Therefore, the value of Dry Terraces has increased.

(I) POTATO CULTIVATION

As soon as paddy is harvested, deep plough is made in the terrace along with whatever residue weeds and straws are present in the field. As the field gets a little dry, soil clods are broken and preparations are made to sow seed potato.

Potato is harvested just before the time to puddle and the owner gets some cash income by selling the potatoes. Not only that, the first normal plough is averted and also cleaning of the risers and embankment operations are done while giving cultural operations to the potato crop. Residual moisture from paddy crop and a shower that comes in March is sufficient to have a bumper harvest of potato. Additional irrigation is not required.

Utilizing pig-droppings as bio-fertilizers and weeds as green manure, little or no chemical fertiliser is used, making the product attractive to the niche market. This type of cultivation is more common among the southern Angami sub-tribe of Kohima district. The farmers of this area have been able to make use of the advantage of the National Highway 39 in marketing their produce. It is a clear indication that land constraints can encourage a Naga farmer to be ingenious. The villages of the southern Angami are large and population is putting immense pressure on land, compelling farmers to innovate ways on and means of survival and also improve their livelihood options making use of the limited land resources.
(II) TOMATO CULTIVATION

Growing tomato with residual moisture from paddy crop is again a speciality of another large village Phesachodou, in Phek district. Here tomato seed is broadcasted in the month of September as water level in the terraces begins to recede. Paddy stalks are utilized as much, as well as support to tomato stems. As the farmer gives the first plough operation in the month of February, tomato is harvested and sold to Pfütsero and Kohima markets. Additional irrigation or intercultural operations are not given. In both cases above, the villages involved are large, and there is acute land scarcity. This would imply that as the population increases, farmers find ways to utilize their land holdings into productive use in supplementing their income.

3.2. (C) SIDE BENEFITS DERIVED FROM WET TERRACES

i. An Algae called Azola resides in these terraces which is the host plant of a bacteria that fixes atmospheric nitrogen into the soil in the course of their symbiotic relationship metabolism. Soil fertility is high and so is the harvest.

ii. A large number of edible aquatic animals live here, which provide food for the farming family. Chief among them are mud fish, frogs, snails, larvae of dragon fly and water bugs. Not only are these creatures a micro nutrient supplement, but they are also a delicacy.

iii. During the late 60s and early 70s, the Government of Nagaland introduced the common carp fish into these terraces and it thrived well. The farmers are now earning some cash from the sale of these fishes to fellow villagers and nearby townships.

iv. Nesting place for fishes’. Dugout farm ponds are constructed in the terrace. The size of land pond is about 7 to 9 feet diameter and 6 to 7 feet depth. Split giant bamboo is placed at the bottom and stones are put on top of it to keep them under water, several layers are made till they at almost the same level on the ground. Fishes produce fingerlings from these ponds. 2 or 3 such ponds can exist in one single terrace.
v. Main focus of attention is paddy but on the risers, margins and embankments other vegetables like cowpea, brinjal, passion fruit, ginger, mustard, gynura, beans and yam are grown. These vegetables are the mainstay for midday meal preparation. The family needs only to bring salt from home to have a good meal in the field. They also provide vegetables for the household throughout the year. In recent years the farmers have increased the area under such activities and are beginning to harvest them for sale in the market.

vi. Farmers report that legume crops planted on the risers and embankments lead to higher yield of paddy than those that are without them.

It is often considered by a section of people that TRC is not profitable, but when one reflects on the side benefits that are not measurable, it is beneficial.
3.2. (D) VARIETY SELECTION IN TERRACE RICE CULTIVATION

i. All aromatic varieties are transplanted in the first terrace where cooler water hit the crop first because they are resistant to cold.

ii. These aromatic varieties are normally hard to thrash but are also late in maturing. That is why they are not as widespread as others but farming families continue to maintain the pure line so as to grow them where irrigation water hits the terrace.

iii. In the same terrace, cold weather resistant variety and normal variety lie side by side and new strain develops. Hence, when harvesting seeds these areas are avoided.

iv. Gum rice a special utility rice, is grown here. These varieties are used for brewing rice beer. They are normally a hardy crop but yield is not as good as other varieties and so, farmers would grow them in less quantity.

v. Mutation in paddy takes place as observed by farmers. They have observed that even as they transplant white rice, occasionally red variety is harvested. Since the farmers like to have pureline in their seed, these mutants are not used as seed.

vi. A farming family may have terrace in several locations at different elevations, and the paddy variety would differ accordingly.

vii. In giving cultural operations, the top terrace is always the first to be operated. Water is then allowed to flow down the next terrace and so on till all terraces are uniformly irrigated. This water is recycled over and over again. The farmer would keep watch in all terraces to see that there is no leakage in any terrace to prevent them from drying.

viii. Terraces on the riverbanks that are prone to stream bank erosion Willow (Salix sp.) and a type of bamboo that has short internodes are planted. The rooting system of these two species is such that it binds the soil to itself making it resistant to erosion.
3.3. HOME GARDENS

Home garden to a Naga family can be defined as ‘land surrounding a house or easily accessible within minutes on which a mixture of annual and perennial plants are grown, together with or without animals, and largely managed by the (women) household members for their own use or commercial purposes’. Home gardens are as old as the village itself located either in the backyard, retaining walls of the house, outskirt of the village, vacant plot of abandoned house and sidewalk of footpaths and roads.

Home gardens are the main components in the agriculture system where most of the vegetables are produced for home consumption and also for sale. These home gardens are normally located near the homestead or at the outskirt of the village. They are the nearest of the agricultural components in the entire system, and therefore, are by far the most well taken care of. In these home gardens a mixture of trees, perennials, creepers, climbers and annual crops are cultivated. In fact, as many as 122 species being grown in Tanhai village in Mon district has been reported (Godbole, Archana 1998).

The cultivated vegetables that are being sold by the women vendors in cities and towns of Nagaland are harvested from:

a. Margins of terraced rice cultivation,
b. Jhum fields, and
c. Home gardens.

Each of these components contributes to the supply of vegetables for sale at a point of time. Thus, there is a constant supply of fresh vegetables in markets across cities and towns of Nagaland.

In order to understand the number of vegetables and fruits that are produced in the village and vended in Kohima and other towns, a ‘free-listing’ exercise was undertaken with a focused group of women vendors of Pholami village. As can be seen in the Table No. 3.4, in the months of January, February and March the number of crop species available is least and most of them were collected from home gardens.
Assessment of total cash income generated by the women vendors during December 2003 and January 2004 indicates that about ₹ 110,000/- was brought into the village from market by these women vendors. This amount generated is significant to the village because there are virtually no off-farm employment opportunities available in the village. The main regular source of cash income circulating in the village is through the monthly pay of Government employees who are mostly Primary School Teachers residing in the village. But then, much of the pay of these school teachers is spent outside the village. Survey conducted by NEPED in 185 villages across Nagaland showed that about 4 percent of village land is used as home garden.

**Table No. 3.4.**  
*Number Of Vegetable Species Vended In Each Month In Kohima*

<table>
<thead>
<tr>
<th>Month</th>
<th>Number of Wild Vegetable</th>
<th>Number of Cultivated Vegetable</th>
<th>Total Number Vegetable</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>8</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>February</td>
<td>8</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>March</td>
<td>8</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>April</td>
<td>11</td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td>May</td>
<td>11</td>
<td>14</td>
<td>24</td>
</tr>
<tr>
<td>June</td>
<td>11</td>
<td>19</td>
<td>30</td>
</tr>
<tr>
<td>July</td>
<td>11</td>
<td>22</td>
<td>33</td>
</tr>
<tr>
<td>August</td>
<td>11</td>
<td>22</td>
<td>33</td>
</tr>
<tr>
<td>September</td>
<td>11</td>
<td>28</td>
<td>39</td>
</tr>
<tr>
<td>October</td>
<td>11</td>
<td>30</td>
<td>41</td>
</tr>
<tr>
<td>November</td>
<td>11</td>
<td>27</td>
<td>38</td>
</tr>
<tr>
<td>December</td>
<td>11</td>
<td>19</td>
<td>30</td>
</tr>
</tbody>
</table>

*Source: NEPED - 2007 Focus Group Discussion with Women Vegetable Vendors and Growers of Pholami Village*
3.3. (A) CHARACTERISTIC OF HOME GARDEN

i. Many new crops are tried in home gardens before cultivating them in the field.

ii. Medicinal plants are cultivated in small plots for home use and also food supplement in the village life. The dividing line between medicinal plant and vegetable cannot be differentiated.

iii. Provides food during the lean period.

iv. Pig feed is often grown here.

v. It is the dumping yard of household waste and ashes from the family hearth.

vi. All kinds of vegetable and crops can be found in two or three storeys. Medicinal plants such as mint and basil in the under canopy, vegetables above these plants, perennial vegetables of shrubbery nature and on top, fruit trees.

vii. Often creeper crops such as passion fruit are introduced in the fencing.

viii. On the rock crevices and stone walls gynura, cabbages are grown.

ix. Domestication trials of wild vegetables begin from home garden before it is introduced in the field.

x. If any edible wild vegetable sprouts naturally, it is preserved and domesticated, this is how ciekhruga, a Clerodendron sp. became a cultivated crop in home gardens as well as a field crop.

xi. Home gardens are well terraced, permanent and managed.

xii. Weeds and leaves are not burned but allowed to decompose in situ.

xiii. The enemies of home gardens are chickens and pigs.

xiv. Pest and diseases control trials are done here before applying to field site.

xv. It serves as nursery bed for many fragile crops.

xvi. Crop diversity in home gardens is impressive. Recent studies of Konyak home gardens in northern Nagaland revealed that more than 120 plant species are found in large, spacious home gardens. A market survey of Kohima and Mon town markets showed that out of the total product recorded, 40 are harvested from home gardens (Archana Godbole).
Home garden is a woman’s affair. The men of the house would construct the terrace and leave all management chores to the women. She knows in which corners and crevices which kinds of crops have been put. Suppose there is a sickness in the house and a meal with a certain vegetable is likely to relieve the sickness, she is the one to look out for the vegetable. Home garden to the women is not only an economic activity but is also an institute where women exchange knowledge for crop production in their home gardens. In exchanging home garden produces, the women would compare the quality of their crops and learn from each other.

In some communities, men folk attending to home garden is considered an insult to his manhood. However, with the change in economic benefit that is derived from home gardens, more areas are being put to it. It is even changing the village fabrics. In the past, a house in the middle of the village is place of honour, but now the better-off in the village are looking forward to shifting their house to the outskirts of the village so as to have a larger home garden.

Planting season and time of harvest are crucial as the primary aim of home gardens is to provide food security at all times.
3.4. FIREWOOD RESERVE FOREST

In the daily village life in Nagaland where there are no alternative sources of energy, fuel wood is one of the most important needs of a family's existence. In fact, it is next only to rice in importance. Firewood is not only used in cooking but also for heating homes and a host of other utilities.

An Indian official has expressed the problem, “even if we somehow grow enough food for our people in the year 2000, how in the world will they cook it?” (National Academy of Science, 1980). This is not surprising, considering the fact that wood fuel production in India during 1999 with a population which had crossed over 1 billion was only 279 million m³ (FAO Database, 2001).

Next to food security, firewood is the most important resource in the life of a farming family in the village. Firewood reserve forest is an area just at the outer margin of the village boundary where a farming family had planted, preserved naturally sprouting useful species and maintained trees including bamboo for domestic use. This forest type is a replica of main forest except for the size of trees which is smaller in this area and that it normally surrounds the village.
3.4. (A) FUNCTIONS OF FIREWOOD RESERVES

i. It provides firewood requirements of the family.

ii. Poles and bamboo requirements for house construction. Since post and poles requirement for house construction is met from the reserve, the pressure on forest is reduced.

iii. Sources of uncultivated fruits and vegetables including pig feeds.

iv. Surrounding the village, it cools the village with its “cool breathe”.

v. It provides space for rice nursery and home gardens since it is near village areas after firewood is harvested.

vi. For many villages, firewood is a major source of cash income generation.

As stated in the preceding section, firewood is the main energy source in the rural villages and it is important to assess the consumption of firewood per person. A study in Rangoon showed that the consumption per person was about 1.5m$^3$ and elsewhere in Nepal it was estimated at 3m$^3$ annually.

3.4. (B) ASSESSMENT OF FIREWOOD CONSUMPTION

NEPED conducted household surveys to assess firewood consumption in 60 villages across Nagaland. In this survey it was seen that the consumption of firewood is more where piggery was thriving -an obvious conclusion, but also requiring attention to modify the mode of feeding pigs. The study generated a need to go for further comparison between the classes of firewood and their efficiency. The result displayed below is based on average consumption regardless of wood class.

**Findings**

<table>
<thead>
<tr>
<th>Number of Respondent Families</th>
<th>659</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Individuals Living in These Families</td>
<td>3879</td>
</tr>
<tr>
<td>Total Per Year (m$^3$)</td>
<td>389.30</td>
</tr>
<tr>
<td>Average Per Family(m$^3$)</td>
<td>22.17</td>
</tr>
<tr>
<td>Average Per Person(m$^3$)</td>
<td>3.74</td>
</tr>
</tbody>
</table>
The total projected rural population was 23,16,793 in 2007. Computing from the above, firewood consumption in Nagaland is about 8.7 million cubic meters assuming the tree stand volume to be approximately equivalent to that of jhum, which is 188 m³ trees from 46,090 ha of wood. Fortunately, firewood forests have much denser tree stand. While on one hand it has been reported that several villages such as Sungratsu of Mokokchung district and Lozaphehu of Phek district had imposed a ban on export of firewood by the Village Council in order to protect the village’s environment, on the other hand, many villages are taking advantage of its demand in the market and generating income from the sale of firewood.

**Box 3.1.**

*Thetsumi Village Generated ₹ 2.00 Lakhs Sale Proceed From Firewood*

Thetsumi village of Phek district subjected a jhum location that was planted with trees under NEPED programme in 1997. A study was done to estimate the standing growing stock of trees in this site using minimum representative sampling methodology. The result is as follows:

- **Average number of trees per hectare**: 627
- **Average basal area per hectare**: 14.45 (m²/ha)
- **Average volume**: 190.68 (m³/ha)

During 2007, this site was subjected to jhum. The trees felled were:

- used in soil conservation measure by laying them along the slope.
- retained in situ the support of creeping crops such as French beans.
- harvested for firewood where part of it were consumed in households and the rest sold.

The village had sold out about 600m³ to a nearby Pfütsero Administrative headquarter. The village authority estimated that an amount of not less than ₹ 2.00 lakh was brought to the village from sale proceeds of firewood alone. They also estimated that about 2000 to 2500 trees were harvested for this purpose. The good thing about this is that an estimated 70,000 number of mostly firewood trees were planted during the year 2007.

In order to meet the firewood requirement both for rural and urban population, it is imperative that energy plantation is taken on a large scale. Demand for firewood is on the rise in cities and towns of Nagaland. Providentially, it was observed that firewood plantation by the farmers was found to be simple and effective.
3.4. (C) BENEFITS FROM FIREWOOD PLANTATION

Oak trees (Quercus spp) are considered to be among the best quality firewood. In order to plant this tree, seed collection is done in the months of October and November; they are then packed in gunny bags or cement bags. The seed germination starts in the bags in the month of March looking like ‘Dog’s fangs’. It coincides with sowing time in jhum and the germinated seed is dibbled along with other jhum crops. In firewood forests, dibbling of the seeds could be done in the months of January or February. The survival rate is about 70 to 80 percent.

Farmers observed that yield of jhum rice in oak plantations was normal as opposed to the notion that nothing grows well underneath oak trees. However, they also observed that jhum maize in oak plantations is not suitable.

For a stand density of 1500/ha oak trees are maintained for 2 years in jhum fields along with 2 year cropping period and it is left to fallow for 7 years. Through direct observation, it was seen that 10 trees make a stake (Thak) which was sold at ₹ 1700/Thak (Kikruma-2008). 1500 trees yielded 150 Thaks. By selling them the farmers earned a gross income of ₹ 2,55,000/-.
INDIGENOUS KNOWLEDGE RELATED TO AGRICULTURE
TRADITIONAL AGRICULTURAL PRACTICES AND SUSTAINABLE LIVELIHOOD - A Thematic Report
4.1. SIGNS AND SEASONS

i. During the period between November 16 to December 15, soil is dry and dusty. If it drizzles and rain drops splash over the dust resembling ‘footprint of rat’ then that year the season is to be ‘soft’ where all seasons including wind, sunshine and rain are to be on time. So the ‘footprint of rat’ villagers are content to have normal cropping operations.

ii. When leech goes down and pine goes up mankind will vanish.

iii. All villages have a place where the setting of the sun tells the time for tillage operations.

   • Talks about time to slash jhum field because the sun had set behind a certain mountain range.
   • The sun had set in its seat, the 21st June. This is the best day for transplanting rice. The villagers say that they can literally see the crops growing.
   • The sun setting in the winter seat, the 21st December. All slashing for jhum cultivation must be done before this day.

iv. ‘Three star falling’ a phenomenon where 3 stars that are standing vertically falls and lie horizontal. In 1999 this phenomenon was on the 11th of May as observed by a progressive and elderly farmer.

   • It is safe to sow seeds of any crop before ‘three star falling’. But seeds sown after it will be infested with pests and diseases.
   • The phenomenon is normally observed by cowherds, on that day the fresh droppings of cow dung dropped in the morning will be infested with insects by the afternoon. They will then inform the fellow villagers that ‘three star falling’ had taken place.

v. When wild cherry (Prunus sp.) flowers and birds begin to gather on the branches, then it is time to sow major crops. They are rice nursery, maize and Job’s tears.

vi. “When you do not know the season to sow your seeds, look at the flowering of crab apple, raspberry and peach. If they are flowering then it is time to sow paddy nursery and dibble maize seeds”.

vii. “Look at the moon, on the 9th, 11th and 13th lunar day. If the moon is dark, sow seeds. If any crop is planted, there will be no pest and disease infestation on the crop”.

viii. When Bauhinia variegata begins to flower, which is a little later than wild cherry, then it is time to sow sticky rice.
ix. When oak (Quercus sp.) leaves start shooting than it is time to plant trees and bamboo. This time will be confirmed by the mating season of winged termite ‘Lula pa’ when village boys collect the winged termites to use as baits to trap birds.

x. When there is going to be a long spell of dry season new leaves of Zanthoxylum sp. would appear before frost.

xi. When winter rain is early, monsoon will also be early.

xii. When winter wind is early, monsoon will also be early.

xiii. When the first thunder is from the southeast direction, monsoon will be early and rain is always good. But if thunder comes first from northwest, monsoon is late and rain is not adequate.

xiv. When the Cuckoo begins to sing from jhum land, the monsoon is on time but if it begins to sing from the forest, monsoon is late.

xv. When Hibiscus sabdariffa flowers, it is safe to sleep out in the jungle because winter wind had begun to blow and so one will not get sick sleeping out.

xvi. When the sun sets in the same place twice, harvest is bad.
4.2. SIGNS OF SOIL FERTILITY

i. When first colonizers plants replaced by trees and broader leaf plants and creepers like Vitis oxalis, Meletia, Cylea would creep on the trees, and the undergrowth would be clear.

ii. When trees dominate the area.

iii. Soil clods are loosely packed and breaks on trampling.

iv. Plants are easily uprooted because soil is loamy.

v. Brownish and blackish soil colour also indicates the productivity of that area.

vi. Proportion of gravel and soil along with the temperature and altitude of the location would determine the crops to be grown.

vii. Earthworm droppings are strong indicators of soil fertility. When plenty of earthworm droppings are present, it is taken for granted that the plot is fertile and good harvest is anticipated. The bigger the size of dropping, more fertile is the land.

4.3 SIGNS OF SOIL INFERTILITY

i. First colonizer’s plants are like ferns, buck-weeds, biden, thatch, cyprus grass, etc are still dominant.

ii. ‘Dirty plants’ will be the first coloniser along with Cylea, Thunbergia, Milodinus and the like would emerge together and obnoxious weeds would become extinct giving way to trees with Vitis, Meletia, Melodeons etc. creeping on trees.

iii. Farmers would discontinue cropping the land when they see obnoxious weeds such as bur marigold, wormwood, palm-grass, strawberry, ferns, buck-weeds, neilia, cuckoo bread, raspberry, etc.

iv. Places with the presence of ferns and wild cardamom are signs of infertility. So even if the soil appears to be matured soil, harvest is not good.
Conclusion

RECOMMENDATION AND WAY FORWARD
5.1. RECOMMENDATION AND WAY FORWARD

There is a high degree of agro-biodiversity in traditional agriculture. This diversity is being threatened by the introduction of monoculture for commercialization of selected marketable items displacing the normal traditional crops that are cultivated for subsistence. Also selective cultivation of high yielding rice variety in favour of food security has resulted in erosion of varieties that have the characteristic of special uses occurring within the village.

Shifting cultivation in the present form is environmentally sound and sustainable. However, with the increase in population resulting in fragmentation of areas cultivated per person, it is too small to sustain the people cultivating them. This issue requires immediate attention so that by inducing improvement measures in the other three main parameters of jhum viz, cropping period, fallow period and land that were not put to cultivation, the shortfall of rice requirement per person annually could be addressed to a certain extent.

It may not be possible to produce sufficient rice to meet the needs of the rural population under shifting cultivation, but it is possible to improve the jhum system to generate income and sustain it. In order to achieve this, up scaling the existing good practices elsewhere in the communities with improvement interventions such as planting trees and strengthening soil and water conservation measures would go a long way.

Developing TRC, firewood reserves and home-gardens to its full potential would improve the economy of the rural population to a great extent. This also would ease dependency on primary forests for Non Timber Forest Products (NTFPs). External intervention in the form of providing resources and technical back stopping is a necessity to increase the production.

i. A strong and accredited data base centre on traditional agriculture with emphasis on shifting cultivation should be set up for the State. This would facilitate sound planning for the people and address issues that are needed. The data should include actual number of population and families practicing shifting cultivation and further categorization into wholly dependents and partially dependents.

ii. Traditional knowledge in the rural areas is fast eroding. Therefore, there is a pressing need to document the knowledge for further applications and replications.
iii. The fact that farmers are continuing to practice traditional agriculture and also adapting to modern agriculture indicates its hidden strengths and innovations. It is necessary to search and document these innovations for replications.

iv. With the pressure for commercialization of agriculture, land races that have been handed down from time immemorial are being lost. It is therefore, necessary that steps are taken to preserve the seeds.

v. While introducing high yielding varieties of crops and new crops are necessary in some locations to address food security, providing technical support to seed characterization and selections from within the locality would have more acceptability and therefore be sustainable.

vi. There are innovators and progressive farmers within the communities who are silently leading the communities in adapting to climate change that is taking place in the local environment. It is imperative that such persons are identified, given due recognition and encouraged to lead.