Introduction of Thanakha (Limonia acidissima) and a Diversified Farming System into Yinmarbin Township, Sagaing Region, Myanmar

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Abstract In the Dry Zone of Myanmar, the traditional upland farming systems were able to secure people’s home consumption with adaptability to the environment, in addition to providing income. In the recent decades, local people there considered the introduction of new cash crops to increase the yield and income compared to those in the conventional cropping systems. Kyauk Pyote village, one of the typical upland crop-producing villages in Yinmarbin Township, Sagaing Region was studied for the introduction of thanakha (Limonia acidissima), a highly promising cash crop with adaptability to the agro-environment in the Dry Zone, based on farm household interviews and field observations. In this area, sesame, pigeon pea and tomato were traditionally cultivated for daily foods and basic household needs. The local people introduced thanakha and diversified their farming systems for food and income security, and crop diversification might generate a higher income and contribute to rural development. Although commercial cultivation has widely expanded in the surveyed area with villagers’ expectation, the introduction of thanakha is at a trial stage and has not produced profits yet.

Key words: Commercial cultivation, Dry Zone, Income security

Introduction

Arid and semi-arid regions occur in the central part of Myanmar, known as the Dry Zone, where temperatures are generally high, rainfall is scarce and the soils are undergoing deterioration (The Dry Zone Greening Department, 2010). In the Dry Zone, average annual rainfall is lower than in other parts of the country, ranging from 500 to 1000 mm (Oo and Nakao, 2002; Poe, 2011). In addition, over the past 4-5 decades, Myanmar has experienced an upward trend in air temperatures, and decrease in the rainy season duration (Baroang, 2013).

In the Dry Zone, irrigation facilities are limited and agriculture, therefore, is generally conducted under rainfed conditions and local people meet unstable livelihoods with little prospect of increasing agricultural production (Matsuda, 2013; Yee and Nawata, 2014). Since soil types and rainfall patterns are not suitable for rice cultivation, the major farming systems were characterized by upland crop cultivation, including multiple field crops such as peas, beans, maize, sesame and groundnut (Yee et al., 2009). Pigeon pea, generally cultivated for export and to some extent for home consumption, and sesame, mainly for home consumption, were the major upland crops in this region. Since the region was under rainfed conditions, crop production was determined by rainfall in this area (DAP, 2007). In Ghana, Peprah (2014) also found that inadequacy and uncertainty of rainfall often caused partial or complete failure of the crops, which led to unstable and/or low production. Therefore, the local people could not produce crops as expected and, accordingly, faced problems, such as insufficient income for foods and financial security.

To increase agricultural productivity and reduce the risks associated with the production under rainfed conditions, Lasco et al. (2011) recommended the introduction of new crops and crop diversification. Diversification of agriculture with the introduction of new crops and changes in cropping systems had been adopted in many tropical countries, for example, the introduction of sugarcane in Northeast Thailand (Ekasingh et al., 2007) and that of vegetables in Red River Delta, Vietnam (Yanagisawa et al., 1999) at village levels.

As stated previously, small holders in the Sagaing Region have been facing uncertainty in crop productivity in terms of yield and market price fluctuations for several decades (Hoseop and Gilhaeng, 2003; Yee and Nawata, 2014). In this sense, local people have introduced thanakha (Limonia acidissima), a promising semi-domesticated tree plant in this area, and adopted diversified cropping systems to provide higher economic viability than in the case of traditional cropping systems. The objective of the present study was to analyze the process of introduction of thanakha into their existing...
upland cropping systems and the adoption by the farmers of diversified agriculture in the selected village.

Methodology

The surveyed village in the present study, Kyauk Pyoke (KP), Yinnmarbin District, Sagaing Region, was located in the undulating plains, about 15 km North of Yinnmarbin Town (Fig. 1), at the average elevation of about 130 m above sea level. The capital of Sagaing Region, Monywa was located at 34 km Southeast of this village, and for trading agricultural products and social needs, the villagers frequently went to Monywa City. Monywa-Yagyi-Kalaywa Road, which connected Monywa to the Indian border, passed through the eastern regions of Yinnmarbin Township administrative area, about 5 km away from the surveyed village.

This village was selected for our study after preliminary surveys in 2011 in whole Yinnmarbin Township administrative area, because of the scarcity of water, compared to the neighboring regions, lack of irrigation systems and dependence on upland crop production. The surveyed village consisted of 185 households with a population of 1037, at the time of the survey in 2014. Among the 185 households in the village, 110 households were the farmers owning the land, while the other 75 households did not own their land for practicing agricultural activities. Thirty-four farm households among the 110 agricultural households were randomly selected for the interviews and for observing their fields in 2012, 2013 and 2014. The interviews covered land use, crops and cropping calendar, cultivation, and farming and cropping systems adopted at present and in the past. For further investigations such as village history, changes in crop productivity, and weather conditions in the past, we conducted group interviews and held informal discussions with knowledgeable elder persons and villagers. Observations and field visits were conducted to confirm the topography, physical conditions of the soils, household land ownership and agricultural practices. Information and statistical data were also obtained from various institutions such as District Offices, including the Department of Agriculture, the Meteorological Department in Monywa and Yinnmarbin Districts, and the Village General Administrative Office.

Results and Discussion

Agricultural land holding of the surveyed village

According to the farm household interviews and statistical data, the total land holding of the village was 1059 ha, in which 98% of the total land area, 1034 ha, consisted of an upland area, with upland crop cultivation fields, and only 2%, 25 ha consisted of a lowland area for rice cultivation. All the farm households (110) owned upland fields, and among them 35 households had paddy fields, too. Forty households owned over 5 ha of agricultural fields, and a little more than 50% of farm households owned an average farm size (approximately 4 ha). As for the paddy fields, only few households owned 2 ha, and an average farm size was 0.5 to 1 ha (Table 1).

Topography and soil

The village territorial area consisted of flat to undulating planes, and the elevation ranged from about 100 m to 153 m. Based on the physical properties and

Fig. 1. Map of the study area in the Dry Zone region of Myanmar.
appearances, local people classified the soils into 3 categories, i.e. gravel strewn red soil (mye-ni-kyauk-so-yit), caliche (phyt-chay-myey) and compact soil (kyit-myey). Soil properties in this area were characterized by a relatively low organic matter content (0.53%), and strong alkalinity (pH 8.01), with sandy clay and/or clayey texture, based on the analysis by the Soil Science Division, Department of Agricultural Research, the Ministry of Agriculture and Irrigation, in 2014.

**Precipitation**

The area showed a bimodal rainfall distribution pattern and the precipitation occurred from May to October with high variability, strongly affected by the monsoon, as reported in our previous study (Yee and Nawata, 2014). The heavy rains were received in August or September, and dry spells usually occurred in July. Fig. 2 shows the average monthly rainfall in the two periods, 4 decades ago (1971-1982) and in the recent 12 years (2001-2012) in Yinmarbin Township. The average annual rainfall during the previous period (1971-1982), which was 903 mm, had decreased to 835 mm in the recent period (2001-2012). In the previous period, the rainfall amount of June, July, August and November was higher than that in the recent period, and that of May and October was low. September was the month with the heaviest rains and did not show a considerable difference between these two periods.

**Cultivated crops, cropping patterns and markets**

According to field observations and statistical data, sesame, pigeon pea, tomato and naturally grown or intentionally planted jujube were widely observed in the upland fields, while rice production was only observed in a limited lowland area. All the interviewed farm households (34 hhs) cultivated pigeon pea and tomato, 88% (30 hhs) sesame, 29% (10 hhs) jujube and 18% (6 hhs) rice (Source: farm household interviews in 2012, 2013 and

<table>
<thead>
<tr>
<th>Upland field</th>
<th>Lowland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (ha)</td>
<td>Number of households</td>
</tr>
<tr>
<td>&gt;5</td>
<td>40</td>
</tr>
<tr>
<td>3.5</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>110</td>
<td>35</td>
</tr>
</tbody>
</table>

Source: The Village General Administrative Office in Kyauk Pyote.

Fig. 2. Monthly average rainfall in the previous period (1971-1982) and recent period (2001-2012), Yinmarbin Township, Sagaing Region, Myanmar. Source: The Department of Agriculture, Yinmarbin District (2014).

According to the farmers, the most common cropping pattern with adaptability to the local environment was a sesame-pigeon pea intercropping system, like in other areas in the Dry Zone (Yee and Nawata, 2014). The crop productivity had been generally stable with satisfactory yields and sustained over a long period of time to secure home consumption and to provide income to buy staple foods, in addition to covering household expenditures throughout the year. During the past three decades, the local people had experienced irregular and sporadic rainfall at the sowing time of sesame and pigeon pea, and scarce rains during the plant growing periods or heavy rains at harvest time. As a consequence, the villagers had not always obtained enough yields of sesame and pigeon pea for their livelihood. Early rainy season sesame (Fig. 3) did not yield well in several years and it was remarkable that no yield was obtained in 1999 and 2000, according to the interviews with villagers and group discussions with elder persons.

Due to the instability of rainfall in the early rainy season, the sesame-pigeon pea intercropping system has no longer been carried out recently in this village, and therefore, sole cropping of sesame and pigeon pea in different times of the rainy season, i.e. pigeon pea during the period from May/June to February/March, and sesame during the period from August/September to November/December in different land parcels, had been adopted in the recent years, because these 2 crops are very important for the surveyed village. The villagers paid great attention to pigeon pea, as shown by their practices, such as the adoption of line sowing instead of broadcasting, and application of fertilizers if they could. Pigeon pea and jujube were cash crops, mainly exported
to India and China. In Myanmar, the demand for tomato was high in local markets. The prices of these crops fluctuated by influences of domestic and foreign markets, as reported previously (Yee and Nawata, 2014).

**Introduction of a new cash crop**

As stated previously, sesame and pigeon pea production had been carried out over a long period of time, but the annual income from these crops had often been unable to cover household needs during the past three decades. One of the villagers in the surveyed village, who owned large upland fields (15 ha in 1996) started to cultivate thanakha, one of the Dry Zone tree crops, in his farm using traditional cultivation technology developed in neighbouring area in 1996, according to the records from the village headman and group discussions with the villagers. He intended to demonstrate that thanakha was adaptable to their agro-environment even under poor soil and scarce rainfall conditions because thanakha had been commercially produced over a long period of time in Wartan, Kanpyhu, Kanpaw and Wayaung villages in Ayardaw Township and Kyaukka village in Monywa Township, which showed similar agro-ecological conditions to those of the surveyed village. After confirming the high income and the existence of reliable markets for thanakha plantation in the field, the local people gradually introduced thanakha cultivation into their cropping systems. Table 2 lists the thanakha-growing households in 2014. All the interviewed households had already planted thanakha in their upland fields, with a change from sesame or pigeon pea sole cropping to thanakha cropping mixed with seasonal upland crops. All of them owned at least 2 ha of farmland and some farmers owned the largest fields of 6 ha. The percentage of thanakha farms in their agricultural land ranged from 50% (3 ha in 6 ha of total agricultural field, largest) to 10% (0.2 ha in 2 ha, smallest) in the surveyed households. Among them, 4 households owned a 6 years old thanakha farm and they had just started to harvest the product in their fields. Households who owned the smallest thanakha farm had just started thanakha cultivation 1 year ago (Table 3), because they considered that the scale of their landholding was relatively small for thanaka cultivation and they monitored the reliability of the market fluctuations and profits.

**Thanakha in Myanmar**

Thanakha, *Limonia acidissima* (syn. *Hesperethusa crenulata*), is a common tropical plant species in the Indian Subcontinent and Southeast Asia (Wangthong et al., 2010; Amornoppaparatpankul et al., 2012). Thanakha trees were grown in the area between the central part of Myanmar, Shwebo District, Sagaing Region and the southern part of Pyay District, Bago Region. The plant

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**Table 2.** Cultivated crops in selected households in Kyauk Pyote village, Yimmarbin District, Sagaing Region, Myanmar in 2014.

<table>
<thead>
<tr>
<th>Pigeon pea</th>
<th>Tomato</th>
<th>Thanakha</th>
<th>Sesame</th>
<th>Jujube</th>
</tr>
</thead>
<tbody>
<tr>
<td>34</td>
<td>34</td>
<td>34</td>
<td>30</td>
<td>10</td>
</tr>
</tbody>
</table>

Source: Farm household interviews in 2015 and 2014.

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**Table 3.** Crop calendar of the Kyauk Pyote village, Yimmarbin District, Sagaing Region, Myanmar.

Table 3. Thanakha plantation in the upland fields in Kyauk Pyote village, Yinnarbin District, Sagaing Region, Myanmar in 2014.

<table>
<thead>
<tr>
<th>Planted year</th>
<th>Number of thanakha cultivation households categorized by the total land ownership</th>
<th>Number of total households</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6 ha</td>
<td>5 ha</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>


can easily adapt to the Dry Zone agro-environments, i.e. gravel-strewn red soil, or sandy soil mixed with small stones, or compact soils with scarce rainfall (Davis, 1960; Burma Translation Association, 1972; Hla, 1974; Tun, 2014).

Thanakha is a wild or cultivated tree plant, whose bark is used for the production of a natural and traditional cosmetic, made by grinding the bark with a small amount of water on a circular stone slab. The stem bark of thanakha has been commonly used by Myanmar women and children as a skin care cosmetic for more than a thousand years (Davis, 1960; Burma Translation Association, 1972; Lwin, 1995). According to the Forest Department in Myanmar, thanakha is included into non-timber forest products generally harvested from the wild for trade purposes (Lwin, 1995), but thanakha trees have been cultivated in the Dry Zone for a long time. For trading, a document to authorize the transportation, issued by local Forest Department is necessary (Burma Translation Association, 1972).

According to Davis (1960), Burma Translation Association (1972) and Tun (2014), thanakha was naturally grown over a long time in some specific areas of the Dry Zone, including Yinnarbin Township. In some areas, thanakha had been cultivated in home gardens and horticultural gardens during several decades. In Ayawdaw Township, thanakha home gardening was initiated by two farmers in Kanphyu and Kanpaw villages in 1928 (Hla, 1974). According to the local people, home gardening in those areas expanded in 1960, and commercial production which started in 1980 increased rapidly.

The trees grown in upland areas of the Dry Zone were found to be more fragrant than those produced in other areas. It was also found that if produced in fertile soils, the tree showed a large trunk but with poor quality caused by the presence of thin bark, according to the interviews with the local people and growers. The demand for the products in this area was very high because thanakha with good quality can be produced only in some specific areas of the Dry Zone, where several thanakha markets are managed. Although thanakha is planted widely in the Dry Zone, the two most popular marketable thanakha plants are produced in Shwebo Township, Sagaing Region (Shwebothanaka) and in Pakokku and Yaesakyo Townships, Magway Region (known as Shinmadaungthanaka).

Commercial thanakha cultivation

The local people knew that thanakha was highly tolerant to drought and water deficit. As previously stated, thanakha in gravel strewn red soil (mye-ny-kyauk-sa-yil) in upland fields displayed a good quality. The villagers selected the seeds from the farm, which was well known for the high germination and quality of the seeds. The seedlings were grown in the rainy season. When the seedlings were 3 months old, they were transplanted at the spacing of 1.4 m between plants and 3 m between rows. The moisture requirement was minimal, and ample moisture was necessary only at sowing time. The growth continued with seasonal rains.

Careful management, including cutting branches at appropriate times, was important for growing thanakha with quality and raising income because hard, compact, straight and thick-bark thanakha trees were highly evaluated for the quality and offered a satisfactory price. It was also important to avoid narrow spacing and dense plant populations for quality control. Generally, the plant could be harvested within 6-7 years after transplanting, but the older plants showed higher quality and provided a higher price. After the first harvest, although the base of the plant was cut, and several new sprouts appeared from the basal part of the trunk, which resulted in the
second generation, the farmers used only 1-2 sprouts for good quality. Thus, they did not need new plantings. The possibility to use the third or fourth generations depended on the management and the quality of the plant, according to the local growers.

Present cropping system

Fig. 3 shows the recent crop calendar in the surveyed village. For sesame, 4 households were concerned about the unstable rainfall distribution and interrupted the cultivation at the time of the survey in 2014. Since thanakha was a tree crop with wide spacing, other seasonal field crops such as sesame, green gram, cow pea and maize, could be cultivated between the rows for the first 3 to 4 years (Fig. 4. a, b), before thanakha trees were fully grown. Thus many villagers in the surveyed village adopted these cropping systems. The cultivated area for the interviewed farm households covered 52.8 ha for pigeon pea, 44.4 ha for thanakha, 28.4 ha for tomato and 22.4 ha for sesame, respectively, in 2014.

Due to the climatic risks and crop price fluctuations, without productivity improvement and better adaptation to the local environment, the agricultural sectors experience significant losses (ADB, 2009). According to the field observations and farmers interviews, thanakha cultivation seemed to be successfully practiced in this village. Keeping the traditional upland crops and jujube was important for fulfilling the home consumption and raising income to buy rice, farm inputs, etc. The villagers considered the income from thanakha as long-term savings and mainly for additional purpose and security for their livelihood. According to the interviews, the villagers intended to use the profits from thanakha in special occasions, such as sending the children to universities, donations for religious or other purposes, purchase of land or a new house, cow, motorbike, etc., and urgent necessities, which were not covered by income from the other crops. In some years, if the traditional upland crop production failed and income did not cover the daily food and household needs, income from thanakha also could be used. On the other hand, as the area used for field crop production decreased, the necessary income for daily food and basic household needs decreased to some extent. Therefore, the villagers were attempting to support the household economy in different ways, such as by intercropping seasonal upland crops with thanakha for the first 3 years, getting temporary jobs at nearby villages in the cropping seasons and trading the recycled waste products like tin and plastic in the Monywa City.

Farming should be taken up with the objective of profit-making rather than just providing a subsistence living (Ramakrishna and Rao, 2008). The investment costs, average yield and crop price, and income from upland field crops in the surveyed village are listed in Tables 4 and 5. The yields and crop prices were calculated based on the data obtained from the interviews with farmers and officers at the Planning and Crop Market Sections of the Department of Agriculture in Monywa. The results showed that the income from thanakha was much higher than that from other crops, although the calculation of profit from thanakha production were difficult because it takes 6 years for getting the first income and thereafter the profit is gained every several years. When compared to the average profit for 6 years, the profit from thanakha

Fig. 4. a. Maize cultivation between thanakha rows in Kyauk Pyote village, Yinmarbin District, Sagaing Region, Myanmar. b. After harvest of sesame grown between thanakha rows in the above village.
production was higher than that from other crops. The profit from sesame mainly depended on the yearly market and productivity.

Crop diversification is an important mechanism to increase the resilience of subsistence farming to rainfall instability (Gilbert and Holbrook, 2011). In addition, it is one of the mechanisms to address food security, production instability and market risks (Rehima et al., 2013). As Abro (2012) reported in Pakistan, the basic objectives of agricultural diversification seemed to be the stable supply of household food and income security, considering crop production under high risk rainfed conditions with frequent price fluctuations of the products. The introduction of a more stable new cash crop and diversification of farming systems with the existing cropping systems, may contribute to the agricultural development of the Dry Zone.

In recent years, thanakha farms have appeared and the production has rapidly increased in this area, as shown in Table 3. In addition, the domestic demand for thanakha has not decreased and the thanakha became adapted to the upland farming conditions in the Dry Zone and was successfully produced, although there were some limiting factors for cultivation. To produce good quality thanakha commercially, specific conditions such as appropriate soils (gravel strewed red soils) are needed, even in the Dry Zone. Thanakha is a perennial plant with wide spacing, and the farmers should wait for at least 6 years after planting the trees to gain profits. Small holders have less opportunity for that kind of long-time investment without regular seasonal income, although some of them planted thanakha to some extent.

As stated previously, the construction of the Monywa-Yargyi-Kalaywa Road was completed in 2003. Before that, transportation of the agricultural products was very limited and difficult. Local people only produced

Table 4. Investment cost for crop cultivation in upland area of Kyauk Pyote village, Yinnmarbin District, Sagaing Region, Myanmar in 2014.

<table>
<thead>
<tr>
<th>Practice</th>
<th>Pigeon pea (kyat ha⁻¹)</th>
<th>Thanakha (kyat ha⁻¹)</th>
<th>Tomato (kyat ha⁻¹)</th>
<th>Sesame (kyat ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land preparation</td>
<td>39,680</td>
<td>34,720</td>
<td>49,600</td>
<td>45,880</td>
</tr>
<tr>
<td>Planting</td>
<td>16,120</td>
<td>37,200</td>
<td>93,000</td>
<td>14,880</td>
</tr>
<tr>
<td>Plant protection</td>
<td>42,160</td>
<td>270,000</td>
<td>352,160</td>
<td>60,760</td>
</tr>
<tr>
<td>Harvesting</td>
<td>53,320</td>
<td>30,000</td>
<td>260,400</td>
<td>52,080</td>
</tr>
<tr>
<td>Others</td>
<td>72,416</td>
<td>300,000</td>
<td>286,440</td>
<td>75,268</td>
</tr>
<tr>
<td></td>
<td>223,696</td>
<td>671,920*</td>
<td>1,041,600</td>
<td>248,868</td>
</tr>
</tbody>
</table>

* The investment cost for thanakha cultivation was calculated for a 6 years marketable thanakha farm.
Note: Inputs used and labor wages were calculated based on common agricultural practices in this region.
Nine hundred Kyats are equivalent to ca. 1 USD (in 2014).

Table 5. Average yield and price of crops in upland area of Kyauk Pyote village, Yinnmarbin District, Sagaing Region, Myanmar in 2014.

<table>
<thead>
<tr>
<th>Crops</th>
<th>Price (kyat basket⁻¹, kyat plant⁻¹, kyat viss⁻¹)*</th>
<th>Productivity (basket ha⁻¹, plant ha⁻¹, viss ha⁻¹)**</th>
<th>Income per year (kyat basket⁻¹, kyat plant⁻¹, kyat viss⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pigeon pea</td>
<td>24,000</td>
<td>24.7</td>
<td>592,800</td>
</tr>
<tr>
<td>Thanakha</td>
<td>15,000</td>
<td>1717</td>
<td>25,755,000***</td>
</tr>
<tr>
<td>Tomato</td>
<td>250</td>
<td>14,826***</td>
<td>3,706,500</td>
</tr>
<tr>
<td>Sesame</td>
<td>20,000</td>
<td>12.4</td>
<td>248,000</td>
</tr>
</tbody>
</table>

*Kyat basket⁻¹ for pigeon pea and sesame, kyat plant⁻¹ for thanakha and kyat viss⁻¹ for tomato
**Basket ha⁻¹ for pigeon pea and sesame, plant ha⁻¹ for thanakha and viss ha⁻¹ for tomato
***Viss is a Myanmar measurement for weight (One vissis ca. 1.65 kg.)
****The income was derived from a 6 years marketable thanakha farm.
Note: Productivity and income of thanakha were calculated based on the average and common price in this region.
For jujube productivity, very little information and few records by the people were available. It was not recorded officially by the Department of Agriculture.
Nine hundred Kyats are equivalent ca. 1 USD (in 2014).
thanakha as a home garden crop for their own consumption or as a commercial crop cultivated in their agricultural fields to some extent for local markets. After 2003, agricultural products were directly brought to Monywa City by the farmers or by the dealers from Monywa and Mandalay Cities, who visited the production sites. When the dealers found good quality thanakha in this area, they directly visited the production fields. Depending on the demand and quality, sometimes the growers earned more profits than expected, according to the interviews with the villagers and field surveys in several villages in Yinmarbin and Kani Townships. For example, when the tree was more than 10 years old, the stem was straight, the bark was thick and compact, and higher demand was generated in other regions, a broker once offered the high price of 100,000 kyats plant⁻¹, a much higher value than the average price (15,000 kyats plant⁻¹).

According to the Myanmar Agriculture Policy of the Ministry of Agriculture and Irrigation (MOAI), the local people are permitted to produce only the principal crops which are recommended by the Ministry of Agriculture and Irrigation, for example, rice in irrigated areas, and cotton and pulses in upland rainfed areas. In the surveyed village, jujube was originally grown and scattered in the upland fields, and tomato is a seasonal crop, produced to some extent. Therefore, the production of jujube and tomato are authorized by MOAI and the local authorities. Thanakha is categorized as a non-food crop by the Department of Agriculture, and is not allowed to be cultivate commercially in agricultural land, except in home gardens. However, to facilitate the development of the agricultural sector, the government improved the system after 1988 to control farmers, and the MOAI changed the policies to some extent (DAP, 2003; Fujita and Okamoto, 2006). Due to the release of policy constraints, the local people introduced thanakha to their upland fields.

Although some nearby areas display the same agricultural settings as those of the surveyed village, thanakha can be introduced only into few areas. Good transportation and communication with the city are one of the factors necessary for the establishment of commercial thanakha plantations. In addition, local people are concerned about the above agricultural regulation by MOAI. Thanakha is a non-food crop, and commercial thanakha plantation may be a risk, according to the local authorities in the regions, where the regulations are still too strict to permit the cultivation of thanakha. Therefore, although the incentive of thanakha cultivation is high, the commercial cultivation of thanakha in agricultural lands is still limited in the Dry Zone.

**Conclusion**

Considering agricultural production in terms of high-risk rainfed conditions and price fluctuations, thanakha could be a candidate for cultivation. The local people in the surveyed village introduced thanakha as a new cash crop, to gain higher economic profits than those in the traditional cropping systems. Sesame, pigeon pea and tomato were still cultivated for their daily foods and basic household needs. The income from thanakha was used mainly to lead a more comfortable life and security. Therefore, the local people have adopted the diversified farming system by introducing thanakha into the existing cropping systems for food and income security. Crop diversification with the introduction of new cash crops into the Dry Zone might have generated additional income and resulted in rural development. At present, however, the introduction of thanakha is still a kind of trial in this village, since most of farmers had not benefited from profits.

Thanakha which had long been used as a traditional cosmetic by Myanmar people has recently reached the foreign markets. Therefore, thanakha was highly promising as a cash crop with adaptability to the agro-environment in the Dry Zone. However, although our study found that thanakha farms and plantations had expanded in the surveyed area, the local people should carefully consider the supply and demand of thanakha in future. Although the incentive to cultivate thanakha is strong, commercial cultivation of thanakha in agricultural land in other areas under similar natural conditions may be restricted by the land holding, transportation system and government policy.

**Acknowledgement**

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