CONTRIBUTION OF POTATO-BASED CROPPING SYSTEM IN HOUSEHOLD INCOME OF SOUTHERN SHAN STATE, MYANMAR

by

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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in
Agricultural Systems and Engineering

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Thailand
May 2012

Acknowledgements

The author wishes to convey sincere recognition and thorough thankfulness to the followings:

Professor Ganesh P. Shivakoti, Chairperson of my thesis examination committee for his suggestions, guidance for data analysis during the study and preparation of thesis.

Dr. S.L. Ranamukhaarachchi, academic advisor and member of guidance committee for his guiding me through my course work and research, discussion and encouraging me to think about the ideas to advance the thesis.

Dr. Peeyush Soni**,** member of my thesis examination committee, for his valuable comments, patience and assisted me through the difficult times.

Joint Japan/World Bank Graduate Scholarship Program and AIT, for providing me a scholarship to attend a master degree program at Asian Institute of Technology.

Ms. Hla Hla Nyaunt, Township manager of Myanma Agriculture Service and Mr. Nyein Tun, manager of seed farm, Inkhaune in Kalaw , for helping me during the data collection, needed information and communicated to extension worker for field survey in the study area.

Ms. Myint Myint, assistance manager of seed division in Southern Shan State, for her guidance and invaluable advice during the data collection.

Mr. Zaw Lwin and Mr. Mya Htay, extension worker of the study area in Kalaw Township, their guidance needed for convenient and continuous help during the field survey and all respondents.

Mr. Aung Kyaw Oo, Ms. Khin Su Ye deputy supervisor, plant protection division, Ms. Myat Thida and Ms. Ei Shwe Sin, assistant supervisor, Myanma Agriculture Service for their supporting and helping me during data collection in the field and in office at Southern Shan State.

Ms. Thin Nwe Htwe and Ms. Cho Cho San, Doctorial students from Germany for their invaluable advice, help and moral support during my study at AIT.

Abstract

Southern Shan State is an important and the largest potato production area of Myanmar. Kalaw Township occupies about 25% of total cultivated area of the Southern Shan State. The research deals with the assessment of potato-based cropping system contribution in household income of the Southern Shan State. The major objectives of this research were to identify the current farming practices and socio-economic situation of the farmers, to identify the productivity and profitability of current potato-based cropping system in the study area and to study constraints of the crop production through assessing farmer's knowledge and practices in farming.

Data collected from a randomized sample of 74 households in two villages in the Kalaw Township area. The data were tabulated and analysed by using descriptive statistics. Economic analysis as cost and return analysis was used to expose farm income and profitability of selected crop and cropping pattern.

The study was carried out to identify socio-economic situation, farming practices, productivity, profitability and constraints in potato-based cropping system. About 97% of household income was from on farm income. Potatoes were the highest gross margin provides in comparison with 11 other crops. Summer potato gives the highest profit among the three growing seasons. Besides, potato (summer)- lowland rice was the highest profit provides in the six predominant cropping patterns. This research showed that the crop management practices of summer potato in lowland (le land) and monsoon potato in upland (Yar land). Low price of product, high input prices, inadequate funds, non-availability of good quality seed, disease and insect attack and limit of technology were the production and marketing constraints for potato cultivation in the study area.

The research concluded that potato is the second most important food and cash crop after rice in Kalaw Township. Growing potato is a costly farming practice with sufficient income if the reasonable price of the output is prevailing in the market. Summer potato-based cropping pattern was the highest profit maker and can be practiced in lowlands under irrigation. However, most of the potato in Kalaw is produced in mountains under rainfed condition and those farmers usually confront with mainly the low price of product due to seasonal production.

Keywords: socio-economic, cropping pattern, productivity, profitability and constraints.

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List of the Abbreviations

CAPSA	Centre for Alleviation of Poverty through Secondary Crops' Development in Asia and the Pacific
CGPRT	Coarse grain, Pulses, Roots and Tubers
FAO	Food and Agricultural Organization
GMS	Greater Mekong Sub region
IRRI	International Rice Research Institute
MADB	Myanmar Agricultural Development Bank
MAS	Myanma Agriculture Service
MOAI	Ministry Of Agriculture and Irrigation
SEE	State Economic Enterprises
FYM	Farm Yard Manure
SLRD	Settlement and land Record Department
SPSS	Statistical Package for Social Science
SLORC	State Law and Order Restoration Council

List of Conversion Factors

1 Basket of paddy	-	46 pounds
1 Basket of Groundnut (husk)	-	25 pounds
1 Basket of Maize	-	55 pounds
1 Basket of Pigeon pea	-	72 pounds
1 Basket of Wheat	-	72 pounds
1 Basket of Soybean	-	72 pounds
1 Basket of Sunflower-	-	32 pounds
1 Basket of chick pea	-	69 pounds
1 Basket of Sesame	-	54 pounds
1 Hectare	-	2.47 acres
1 ton	-	600 viss
1 Viss	-	3.6 pounds
1 metric ton	-	2204 pounds

Chapter 1
Introduction

1.1 Background

Potato is the most broadly cultivated tuber crop, and the fourth largest crop in title of fresh product (after rice, wheat, and maize) in the world. According to the Food and Agriculture Organization, the global production of potatoes in 2005 was 322 million metric tonnes which made it the fifth greatest yielding crop in the world. In 2007 more than 300 million tonnes of potatoes were harvested around the world. By 2020 it is predicted that more than two billion people worldwide will depend on the potato for food, animal feed or income.

Potato consuming is extending heavily in developing countries, at that now make for more than half of the overall yielding and where the potato's easiness of plantation and large energy composition have created it a profitable cash crop for millions of farmers. At the same time, the potatoes different in cereals are not an all over traded goods. Only a part of the whole production access aboard trade, and potato market prices are decided commonly by local production costs, not by the varies of global markets. Therefore, this is a tremendously advanced food security crops that can provide low-income farmers and vulnerable consumers ride out supreme events in global food supply and demand (FAO 2008).

The potato have made to improvement and food security in Africa, Asia and Latin America, at that place potatoes had become a major staple food and profitable crop. However, both improve in the productivity, profitability and sustainability of potato-based farming systems and a powerful engagement by the international community to agricultural and rural improvement is stand in need to progress (FAO 2008).

Myanmar is the third highest potato production of the Great Mekong Subregion (Work group potato research and training, 1 Feb 2007). It had the total land area of about 67.68 million ha. Between them, estimate 11.34 million hectares (28.03 million acres) or 16.78% of the whole land area was used for agricultural productivity and normal farm size was nearly 2.3 ha (5.8 acres) (MOAI 2008). Potato is regarded as one of the major culinary crop for Myanmar occupying 0.35 million ha and the most promising crop for export item as raw potatoes and processed products. In the local market, potatoes are classified by traders and consumers depend on origin of produce, especially Shan production (hilly region) and central dry region production (plain region).

The majority of the crops in the Shan State were produced by traditional methods of slash and burn shifting cultivation, with ever-shortening fallow periods. Some farmers were permanent upland rice-based cropping systems. Other important crops were grain crops – maize, wheat; edible oil crops – groundnut, soybean, niger; roots and tuber crops – potato, onion, garlic, chilli; horticultural crop – tomato, cabbage, cauliflower, raddish , lettuce, mustand, carrot; industrial crop – sugarcane; fruit crop – mango, banana, orange, pear, citrus, lime etc;. Small areas of lowland rice occupy seasonally flooded lowlands, which are unsuitable for other crops in the rainy season. In upland areas, Potato is by far the most important tuber crop and is used either for home consumption or for sale as a cash crop.

Southern Shan State in the mountainous areas is by far the highest potato production area about 16.14 thousand ha in Myanmar. (Myint *et al*. 2007) reported that potatoes were

grown in Southern Shan State under upland area with upland rice, niger, vegetables (Cabbage, Cauliflower, etc) and under lowland area with lowland rice.

1.2 Problem statement

In Southern Shan State, hilly region, land degradation is one of the most important problems resulting in diminished crop productivity. Most of land degradation results from erosion caused by human activities, for example the nutrients removed by crops yield every year are not returned to the soil. In addition, improper crop residues management has substantiated this process (Pookpakdi, 1992). Thus, soil erosion, nutrient leaching, yield instability, and weeds are inherent problems.

Upland farmers' main problem is reduced producing because of degraded soil fertility, limit of awareness of applicable farming practices (suitable cropping system) to resolution of the dilemmas points definitely, and inadequate farm inputs. In fact, the crop yielding decreased in time after time and the farmers are converted to destitute (Thin, 2009).

The potatoes influence to be an input-intensive crop, generally cultivated in frangible mountain surroundings (Ezeta, 2008). Chemical input use such as fertilizers and pesticides is bulk, growing land may be precipitously sloped, and deterioration of environments is a main disputed point. (Ezeta, 2008). The limit of a predictable and available source of good quality seed tuber is a main problem in the whole potato producing surroundings noticed in the area (Ezeta, 2008). Potato production in Southern Shan State is regularly the economic pillor in accelerated small-farm, large amount of horticulture systems. Potato producing frequently utilizes more inputs such as fertilizers, fungicides and pesticides than other crops in the system. The residual effects of pesticide and fungicides cause the health of human beings. The intensive movement of soil to cultivate potato attends to soil deterioration particularly in the hilly area of Southern Shan State.

In addition, the increase population overtimes had decreased farm size into an uneconomic scale (Tatsanee, 2006). Therefore, multiple cropping systems have become adapted because of increasing population growth as the time is going on. Thus increasing population and apply of high agricultural practices have attend to bulky utilize of agro-chemicals that makes the ecosystem imbalance.

Moreover, low potato productivity, declining per capita arable land, perpetual late blight epidemics, inadequate availability of quality planting material, depleting soil fertility and falling groundwater tables, lack of adequate cold storage facilities and potato processing industries, and lack of market integration for potatoes are some of the major impediments in potato development in the region (Pandey, 2008).

Because of those reasons, assessment of potato-base cropping system in productivity, profitability, constraints and socio-economic appearance should be emphasized as the greatest arrangement in the domestic improvement as an important issue.

1.3 Rationale of the study

In Southern Shan State, most of potato is grown by smallholding farmers for household consumption and selling the surplus to earn some income. Although the potato is an input-intensive crop, commonly cultivated in frangible hilly surroundings, enhanced potato production is to have favourable profit the destitute farming families on incomes. However, potato producing utilizes more fertilizers, fungicides and pesticides than other crops in this system. Small commercial growers are especially sensitive to price instability and commonly are forced to depreciate cost by reducing inputs which in turn attend to low yielding.

At present, potato-based farmers are facing low potato productivity, declining per capita arable land, continuous late blight growth, inadequate availability of quality planting material, reducing soil fertility, lack of sufficient cold storage facilities and potato processing plants, and limit of market assimilation for potatoes.

In order to face this situation, potato-based farmers need to adjust their farming system strategies for cumulation the capability of production which can provide their sustainable livelihood.

Observed of this research can supportive to the smallholding potato farmers; decision making process to create options for suitable farming performances under the present indefinite situation on the way to proceeding farm production and reducing farm risk of poor arrangement practice.

1.4 Research questions

(1) Which farming practices are pursuing by the farmers in potato-based cropping system?
(2) What is the socio-economic condition of the potato-based farmers?
(3) What are the differences between productivity and profitability of potato-based cropping system among upland and lowland in study area.
(4) What are the constraints in potato-based cropping system?

1.5 Research objectives

The objective of this study was to assess the strength and weakness of potato-base cropping system in Southern Shan State in order to increase the farmers' knowledge and productivity in this cropping system.

The specific objectives of the study are;

(1) To identify the current farming practices and socio-economic condition of the farmers
(2) To identify the productivity and profitability of current potato-based cropping system in study area.
(3) To study constraints of the crop production through assessing farmers' knowledge and practices in farming

1.6 Scope and limitation of the research

Although potato-based cropping system in the Southern Shan State does not play significant role in Myanmar's economy but it is one of the predominant cropping system as cash crop for local people. This study presented the cost and return of selected other crops and cropping pattern, production and marketing constraints of potato cultivation and their farming practices. Those are hoped that will be helpful to government policy makers and to know which cropping pattern is most profit in the all and to adjust their farming system strategies for increasing the capability of production.

The presented study had been conducted in monsoon season in the study area, besides this year was heavy rain in Kalaw as well as most of the country. The study area had two villages: Heho' and Myaechar. Heho' is beside of the highway road and Myaechar is stand on the hilly slope area about 7 miles from the highway road. Its difficult to go to collect the data due to slope land and heavy rain. As a result, the study was confined to 74 respondents in two villages only. The respondents were grown many crops in their small land. They attended for their household use. Among them, potato is only one crop for cash. Therefore, researcher faced in difficult to record exactly to a cropping pattern. In fact, researcher recorded the predominant cropping pattern and calculated the selected other crops as mostly grown in economic analysis. Moreover, some of the respondents in Myaechar village could not speak in Burma lauguage. Therefore, the researcher collected the data from them with translator who is extension workers and other farmers.

Chapter 2
Literature Review

2.1 Potato production in the world

Potato (*solanum tuberosum*) is an important food crop of the worldwide. It is used as vegetables, basic animal feed and in industries for produce starch, alcoholic drinkable and other operated produce. Potatoes like main temperate crop have been adapted well for production under sub tropical conditions. Potatoes were ancient though to be confined mainly to the developed countries. Therefore, the acceleration of potato producing was moving from Europe to Asia and other segments of the developing countries at a dominant pace. Developing world in 1961 accounted for about 11% of the worldwide output. In 1991, developing world produced round about 32% of the global potato production. In 2007, 51% - half of the global output of potato is in the developing countries (FAO, 2007). This significant growth rate of developing countries confirms its proceeding importance as an orgin of food for increasing populations, rural occupation and income.

2.2 Potato production and consumption in GMS countries

"Work group of research training" exposed that the potato production of GMS countries is presented in the table 2.1. China is the highest potato production among the GMS countries. Myanmar is the third highest production, it is followed by Vietnam.

Table 2.1 Potato production in GMS countries

country	Area			Yields(ton/ha)			Annual production (ton)
	Total	Rainy	Dry	Year Ave.	Rainy	Dry	
Laos	-	-	-				
Cambodia	-	-	-				
Myanmar	34830	16820	18010	13.75	15.08	12.51	478620
Thailand	6850		6850	14		14	97400
China (Yunnan)	630280	515280	115000	12.53	12.9	10.87	7895500
Vietnam	42000		42000	12		12	504000
Total	713960	532100	53650	12-14	13-15	11-14	881560

Source; Work group on Potato Research and Training- Kunming, Yunnan, China, 30 Jan.-1 Feb.2007.

(Win. *et.al* 2007) revealed that potato in china was more competitive than all three studied crop(wheat, rape and sugarcane) due to giving higher net profit (4.8 fold of wheat, 3.8 fold of rape and 4 fold of sugarcane).

In Myanmar, potato crop required higher input(1.82 times of cabbage, 3.8 times of summer rice, 4.31 times of wheat and, 8.9 times of mung bean) mainly due to seed cost fertiltzer cost pesticide/ fungicide cost for all 4 competitive crops and more labor cost except cabbage. However, potato gives higher net profit (3.06 fold of cabbage, 8.84 fold of summer rice, 10.99 fold of wheat, and 2.44 fold of mung bean…). Among bhese important crops, mung bean is likely to become as a competitive one because of its high net profit with lowinput and less care.

In Vietnam, of the 5 crops studied, potato give a profit only higher than winter soybean, but lower than cucumber, tomato and cabbage. The competitiveness of potato was really a problem if the reduction in seed input is not meet.

In Thailand, potato is grown in the same dry season with other crops such as shallots, garlic, bulb onions, baby corm, and sweet corn, but the return from these crops are lower than the potato at about 1-5 times. Since the government recognized the market potential of potato, and there are processing companies that could readily purchase the harvest, the reduction of production area for garlic substituted to potato had reached to 10,000 rais in the year 2007.

2.3 Major problem of potato production in GMS countries

(1) In availability of good quality seed tubers

- Vietnam: 65.0% of current seed demand was supplied by so-called seed imported from South China, local seed production is 16%, some 18% is imported from other countries. 9-months storage under heat stress humid conditions.

- Thailand: the demand of total seed for 42.817 raised in 2005, 6300 tons of potato seed was imported.

- Myanmar & possibly Yunnan: High infected level of seed- and soil-born-diseases. Currently reported, there is no seed production organization, particularly for Myanmar farmers to utilize TPS.

- Laos: Clear and solid information is not available, however, clean early generation seed is experimentally produced, using apical shoot cutting through in-vitro techniques.

- Cambodia: Potato plantation is not in place, but, according to Yunnan Academy of Agricultural Sciences (YAAS), there is evidence that potato can be grown in Cambodia in some cool hilly areas.

(2) Doubts about economical viability and competitiveness of potato in GMS cropping systems

(3) Lack of knowledge and skills for intensive and profitable production

- Clean seed production and handling
- Crop management, pest and disease control
- Potato marketing

(4) **Lack of cost-effective processing knowledge and facilities**

2.4 Potato-based cropping system in Myanmar

2.4.1 Potato production in Myanmar

Potato cultivation of Myanmar started before hundred years ago in Shan State. In 1882 , it planted variety from England in Kayan State. In 1892, potato varieties from Indian grew in Taungyi and Pintaya in surrounding of Southern Shan State. Among these varieties, Up-to-date or sit-po in local called were the mostly grown to get high yield in Kalaw Township. The potato cultivated areas of Myanmar are Heho, Aungban, Pintaya, Pinlaung, Nyaung Shwe and Naung Cho Townships in Shan state as abundantly grown and Bamaw, Myintkyina, Magwe, Tatkone, Minbu, Mandalay, Monywar and Rachine State as normally grown.

Potato is one of the major culinary crop for Myanmar. In the domestic market, potatoes are arranged by traders and consumers depend on source of products, especially Shan product (hilly region) and lower Myanmar (low land). More than 70 percent of the potato growing area in Myanmar is in hilly region. The remained area is in central region and lower region of Myanmar (Myint, et al., 2005). In 2005, potato was grown in about 34.83 (000'ha). The distribution of potato production of Myanmar by region is shown in figure 2.1.

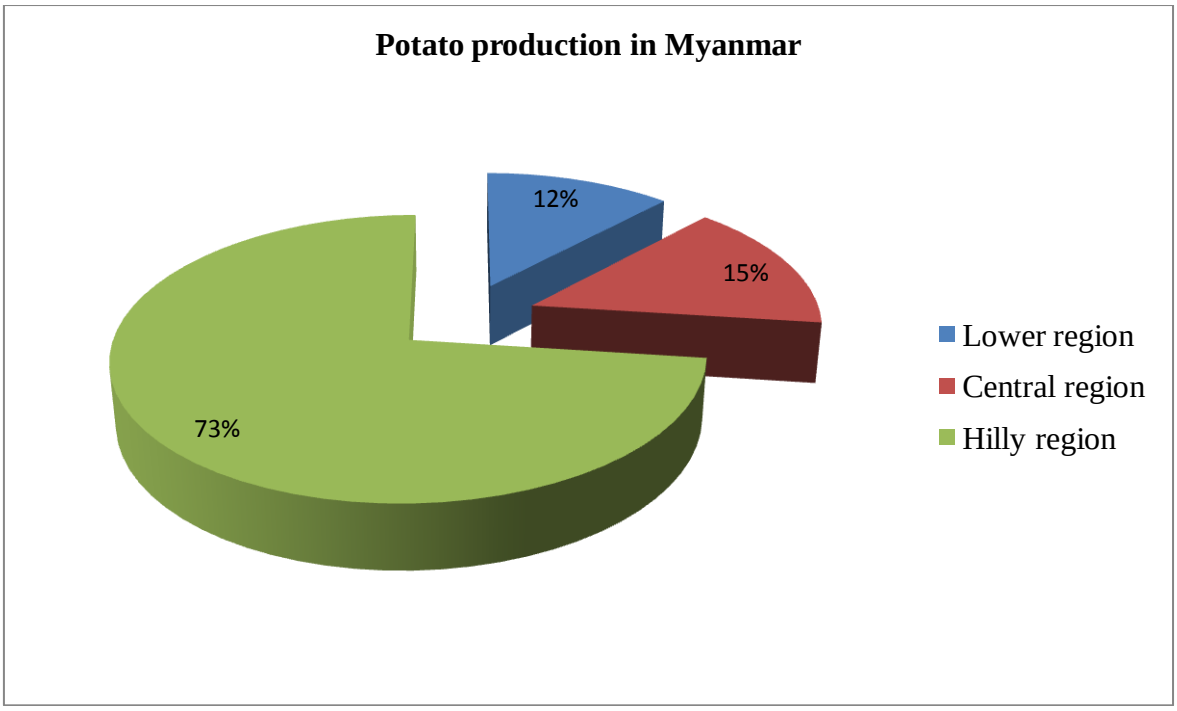


Figure 2.1 Distribution of potato production by region in Myanmar.

In Myanmar, potato is grown all the year round due to the different geographical locations and the climatic conditions. According to the season of planting, it can be divided in t 4 groups; summer crop (jan. /Feb. ~ Apr. / May), rainy crop (Apr. /May ~ Aug. /Sept.), post monsoon crop (Aug. /Sept. ~ Dec. / Jan.) and winter crop (Oct. /Nov. ~ Jan. /Feb.). Of the total area sown, 50% of potato is grown during rainy season and the rest is planted during winter and summer. The summer crop is grown under irrigation on peaty and clay loam soil in Shan State (Heho region) after rice. The average yield of summer crop is over

15mt/ha. Potato production of States and Divisions in Myanmar is showed in the table (2.2).

Table 2.2 Potato production of States and Divisions in Myanmar (2005)

No.	State/ division	Rainy potato			Winter/summer potato			Total (Rainy + Winter)		
		sown Area (000' ha)	yield (mt/ ha)	Production (000' mt)	sown Area (000' ha)	yield (mt/ ha)	production (000' mt)	sown Area (000' ha)	yield (mt/ ha)	Production (000' mt)
1	Kachin	0.07	6.14	0.45	2.56	11.28	28.92	2.63	11.14	29.37
2	Kayah	0.17	7.19	1.22	0.37	7.21	2.64	0.54	7.20	3.86
3	Chin	1.40	5.96	8.32	0.15	5.03	0.77	1.55	5.87	9.09
4	Sagaing	0.12	14.3	1.66	2.25	16.66	37.47	2.37	16.55	39.13
5	Bago	-	-	-	0.23	6.67	1.53	0.23	6.67	1.53
6	Magway	-	-	-	1.64	16.95	27.93	1.64	16.95	27.83
7	Mandaly	0.31	10.1	3.25	1.04	18.30	19.11	1.35	16.52	22.36
8	Rakhine	-	-	-	3.96	1.19	28.45	3.96	7.19	28.45
9	Shan (Southern)	13.3	16.9	224.6	2.83	18.80	53.12	16.14	17.22	277.72
10	Shan (Northern)	0.92	10.1	9.50	2.34	8.52	19.89	3.26	9.02	29.39
11	Shan (Eastern)	0.52	8.50	4.38	0.63	8.60	5.42	1.15	8.55	9.80
12	Ayeyarwady	-	-	-	0.01	10.88	0.09	0.01	10.88	0.09
	Total	16.8	15.1	253.4	18.01	12.51	225.24	34.83	13.75	478.62

Southern Shan State in the mountainous area is by far the greatest potato production area and is where potato can be grown more than two times in a year. In lowland area, it was mostly cultivated as a summer season crop, the producing of which is reasonably big-scale (Kyi 2006).

2.4.2 Potato-based cropping patterns in Southern Shan State

(1) Potato-Niger/upland rice-Niger
(2) Potato-Niger
(3) Potato-Upland rice
(4) Potato-Vegetables (Cabbage, Cauliflower, etc.)
(5) Lowland Rice – Potato (Irrigated Area)

2.4.3 Potato production is economically viable and competitive to other crops in Myanmar

According to the Work Group on Potato Research and Training (Presentation –findings and Suggestions,1- Feb.2007), potato crop requires higher input (1.82 times of cabbage, 3.8 times of summer rice, 4.31 times of wheat and, 8.9 times of mung bean) mainly due to seed cost, fertilizer cost, pesticide/fungicide cost for all 4 competitive crops and more labor cost except cabbage. However, potato gives higher net profit (3.06 fold of cabbage, 8.84 fold of summer rice, 10.99 fold of wheat, and 2.44 fold of mung bean…). Cost and return in potato production as compared to some others crops in Myanmar is showed in Table 2.3.

Table 2.3 Cost and return in potato production as compared to some others crops in Myanmar

Crop	Total Production (US$/ha)	Yields (ton/ha)	Selling Price (US$/ton)	Total Return (US$/ha)	Net profit (US$/ha)
Potato (R)	1171	16.9	153	2582	1411
Cabbage (R)	634	34.3	33	1137	503
Rice (R)	308	3.35	120	468	160
Wheat (R)	270	4.36	92	400	130
Mungbean (R)	230	1.61	500	805	575
Potato (Dry)	1190	16.65	143	2420	1230
Cabbage (Dry)	657	34.3	33	1137	480
Rice (Dry)	308	3.87	139	540	232
Wheat (Dry)	293	1.45	306	443	150
Mungbean(Dry)	251	1.51	500	755	504

Potatoes are divided by traders and consumers depend on source of product in the local market, especially Shan produce and Myanmar produce. Southern Shan State in the mountainous area is by far the greatest potato producing area and is where potato can be grown more than two times in a year. In lowland region, it was mostly cultivated as a summer season crop and is fairly large-scale production. Table 2.4 showed that the potato cultivation by season in Shan, Magway and Mandalay division produce.

Table 2.4 Potato production in Myanmar based on seasons

Cultivated area	Sowing time	quantity (High/middle/low)	season	Land type
Southern Shan	May-June	High	Rainy season	Upland
Southern Shan	July-August	High		Upland
Magway	Nov-Dec	High	Cool season	Lowland
Mandalay	Nov-Dec	High		Lowland
Southern Shan	Jan-Feb	Middle	Summer season	lowland

Source: (Kyi 2006)

(Kyi 2006) revealed that the production cost such as agro-input, labor cost, transportation and holding cost of agro-input, land charges, interest rate, marketing cost and profit margin per hectare. In this result, percentage of buying agro input cost was the highest cost about 70% of production cost and labour cost was 25% in rainy season. In three season (rainy, mid-rainy and summer), rainy season was highest profit provide in Southern Shan State at

$ 262 per hectare. Summer season was the highest agro input cost and the profit is $ 158 per hectare. Summer potato producing is mainly in Southern Shan state. The detail cost of production and return are showed in Table 2.5.

Table 2.5 Production and marketing costs of potato production (kyat/hectare)

Southern Shan State				
Particular		Rainy Season	Mid-rainy season	Summer season
1.	Labour cost	139,147(25%)	130,666(31%)	81,888(10%)
2.	Cost of agro-inputs	370,586(70%)	276,084(65%)	566,353(68%)
	Urea	37,065	296,652	-
	TSP	24,710	19,768	-
	Murate of potash(MOP)	15,444	12,355	-
	Potato (seed tuber)	96,522	74,130	222,390
	FYM	77,219	61,775	118,608
	Bio composer	16,679	13,343	-
	Fungicides and pesticides	102,947	65,061	17,791
	Compound fertilizer	-	-	118,608
	Water fees	-	-	88,956
3.	Transport and handling cost of agro-input	46,237	19,768	35,681
4.	Land tax	3	3	3
5.	Interest of loan	-	-	148,260
6.	**Production cost**	**555,973**	**426,521**	**832,185**
7.	Marketing cost	17,359	At the farm	At the farm
8.	**Total cost**	**573,332**	**426,521**	**823,185**
9.	Yield (kg/ha)	10,086	6,051	14,523
10.	Market price (kyat/kg)	80	92	67
11.	**Gross return**	**806,880**	**566,692**	**973,041**
12.	Profit margin(kyat/ha)(11-8)	233,548	130,171	140,856
13.	**Gross margin(US$/hectare)**	**262**	**146**	**158**

Source:(Kyi 2005)

2.5 Review and analysis of agricultural development policies in Myanmar

Aung Kyi (2005) exposed that review and analysis of Agricultural Development Policies in Myanmar. There are as follow;

2.5.1 Land use policy

The land use policy is stipulated in the Land Nationalization Act 1953, Tenancy Act and Rules 1963, and Procedures Conferring the Rights to Cultivate Land 1963. Under this policy, all land belongs to the state but farmers are given land use or tillage rights on their holdings, which cannot be transferred, mortgaged, or taken in lieu of loan repayments. However, land right is legally inheritable by family members who remain as farmers and till the land by themselves but absentee ownership is illegal. The land use policy does not allow farmers o use their land as collateral to borrow money from bands. As most farmers' main asset is their land, the policy makes it difficult to access institutional credit for large-scale agricultural investment. The Myanmar Agricultural Development Bank (MADB) thus uses joint liability as the basis of loan guarantees. Using this approach however, farmers can only obtain small loans form MADB. In 1998, The State Law and Order

Restoration Council (SLORC) announced the end of the socialist economic system and introduced a marker-oriented economy. However, land laws have basically remained unchanged.

2.5.2 Procurement and market policy

In Myanmar both the public and private sectors play active roles in the procurement and marketing of agricultural products. In the public sector, State Economic Enterprises (SEE) under MOAI are responsible for procurement, processing and marketing of sugarcane, cotton, rubber, Jute, Cashew and Oil palm from the cultivators. The quota sold to SEE ranges from 15 per cent to 45 per cent of production. In 2002, paddy was officially procured at K 320/basket, while the prevailing market price ranged from K1000 to 1,500 per basket. It was a kind of implicit tax on the farmers which constrained the expansion of rice production, the government justifies the low price by providing high subsidies to farmers for the purchase of fertilizers, pesticides and other agro-inputs. This justification no longer holds since subsidies on imported fertilizers and pesticides have been removed since 1993-1994. Domestic bio-fertilizers, which continue to be sold at a subsidized price to farmers, constitute only a part of the fertilizers sold in the market. Compared to rice and other industrial crops such as sugarcane, CGPRT crops could enjoy exemption from government procurement at low prices and could be one of the major factors to promote the expansion of other crops sown area within a short period of time. At present, paddy crops also escape from government procurement at low prices.

2.5.3 Investment policy

With view to improve agriculture sector and to uplift the national economy, an agriculture policy was established in 1992, which declares;

- Production of food crops and industrial crops with no restriction
- To permit the production of industrial and plantation crops on commercial scale
- To allow private investors and farmers to expand agriculture production in cultivable waste land
- To encourage the participation of private sector in the distribution of farm machineries and other farm inputs
- To utilize agriculturally unproductive land for other production programmes.

To achieve its policy objectives, the government adopted five specific strategies for agricultural development and they are (1) Development of new agriculture land (2) Provision of sufficient irrigation water (3) Provision and support for agriculture mechanization (4) Application of modern agricultural technologies (5) Development and utilization of modern varieties.

2.5.4 Development of new agricultural land

Myanmar has the plenty of cultivable land. Thus, the existing fallow land and wasteland can be converted into extend its cultivated land. However, it is difficult to manage, these area will need large investment to be productive land in flood control, heavy weeding, drainage management and infrastructure. Therefore, the government allowed confession legal to large private sectors (local and international) to planting main crop as paddy and perennial as sustainable crop of environment for 30 years on these wasted land and fallow land.

2.5.5 Provision of sufficient irrigation water

Irrigation is one of the important factors of the productive yield for the modern cropping practices. Therefore, the government provided high concentration to sufficient irrigation for crop development. With ten years, the government improved public investment in irrigation development and extended cultivated area under irrigation from 1 million to 2 million hectares, that was presently estimated in 20 percent of the total cultivated area.

2.5.6 Provision and support for agricultural mechanization

As population increase, crop productivity is more needed to fulfill the food security. On the other hand, it is needed to extend the cultivated land and increase the yield per unit area. Intensive farming is the modern farming practice in the developing world. The government also supports machines instead of traditional operation to apply for ploughing, harrowing, planting, harvesting and post harvest processing. Firstly, standard villages in about 23 had been launched to presentation the advantages of using mechanization. In addition, a high number of four –wheel tractors, power tillers, harvester and threshers had been sold with easy terns in installments.

2.5.7 Application of modern agricultural technologies

To improvement of the technologies, the government highlights the valuable of farming practices transfer through extension worker to farmers involving promoted appropriate cultivation practices such as profitable and sustainable cropping patterns, suitable rate of fertilizers application ,combination of chemical, biological and mechanical in plant protection program and to practice the high yielding varieties or hybrid. Severe methods of approaches such as a lot of media (journals, radio, neighbor , newspapers and television): distribution of handouts: effective training from the extension worker arrange by agriculturist to growers, demonstration plot on farmer field are used for the dissemination of advanced technologies.

2.5.8 Development and utilization of improved varieties

To successful of crop production in the country, the government provides the maintenance of exiting high yielding varieties, the breeding of hybrid varieties and the installation of the new strains of productive crops, fruits and vegetables from other countries.

In agricultural sector of Myanmar, the government had approached five definite strategies to development of agriculture in country and private supporters have being encouraged to entrust in agriculture. Nevertheless, most of the growers have small-farm holding and destitute. The existing land use policy have not accord farmer for utilize their own farm as coordinate to loans from banks. As farmer' main possess is only their own farm, their policy create that is not easy to attain the community right for comparably large producer in agricultural.

2.6 Physical and agro-technical aspects of potato-based cropping system

IRRI (1978) gave a complete meaningful of a cropping system: "....the management of crop production of a farm. That is included overall cropping patterns cultivated on the farm and their relation with farm product, other off farm activities and the phenominal, circus of living being, advance technique and socioeconomic conditions or surroundings".

(Biswaw 2006) wrote that cropping Systems containing potato provided the highest levels of crop productivity, profitability and energy productivity. However, energy use efficiency was decreased because of larger energy utilization in included potato systems.

In Asia, potato is the preferred crop and is therefore grown wherever possible. Farmers a higher altitudes can time their production to meet the demands of two planting seasons per year, whereas farmers at lower altitudes and equipped with irrigation facilities can plant practically all year round (Joerdens-Roettger 1987). The physical and agro-technical aspects of the potato-based cropping system as following;

2.6.1 Soil and climate

The potato is important of a "cool weather crop" and temperature is the major restrictive factor. In tropical areas, potato should be grown where the climate is tempered by altitude (1500-4200 m) or at lower altitudes provided the crop is grown during the cool season. The ideal condition for tuberization is a night temperatures are in the 18°-20° C range. When temperature is over 27° C, the rate of tuberization will decrease. The optimum annual rainfall is 40-80 inches. Loose, moist, well-drained and the best suitable pH range between 5.0 to 5.5 or volcanic upland soils are preferred. The water supply for the potato crop should be regular, especially from the stage of tuber initiation until the end of tuber enlargement.

2.6.2 Soil fertility management

Potato should be cultivated with organic fertilizer such as farm yard manure, green manure where available and as suitable. Organic fertilizer often enhances the ability of inorganic fertilizers, increasing crop yields extensively and also amending soil health, which could be a effect by helping to decrease soil borne disease. Potato has the good response to FYM in all field crops. Use completely decomposed FYM at a rate of 10 tonnes per hectare or more, if possible. Avoid applying fresh, incompletely decomposed manure because it will be active too late in season and may decrease dry matter content, delay maturity and disseminate diseases.

2.6.3 Nutrient management

Nutrient requirement in potato such as nitrogen, phosphorus and potassium depend on the soil type, its nutrient condition, variety, cropping pattern and nutrients' sources. Start application of nitrogen or irrigate when tuber formation is start. More than two nitrogen applications of 35 to 45 lbs/acre in one time may be required. Extra nitrogen application causes plant damaging and reduce tuber yield. The former large quantity of nitrate-nitrogen fertilization, manure from plant and animal in cultivated soil will need less nitrogen fertilizer. Potassium sulphate is favored to potassium chloride as the potassium resources, since color of skin and distinct gravity may be negatively affected by potassium chloride (HLA 6028).

2.6.4 Cropping patterns

Short for growing period and wide adjustability in sowing and harvesting time are potato's valuable features that provide in suiting this crop in different intensive cropping patterns. Wheat, rice, maize, sugarcane, Jute, Pulses and vegetables are some of the major crops in

the potato growing region. Potato-based cropping system involving these crops have been developed and evaluated. It is rotated mostly in one year rotation. (Hla 6028) revealed that the common cropping patterns, taking potato as the base crop are as follows:

(1) Potato-Maize-Millet
(2) Potato-Maize-paddy
(3) Potato-Maize-pulses
(4) Potato-paddy
(5) Potato-pulses
(6) Potato-vegetables

2.6.5 Varieties

Even though the tubers become in many varieties with large different in colour, size, shape, texture, characteristic of cooking and eatable quality (FAO 2008), the potato cultivated in the world applies to just on species, solanum tuberosum. Currently, Up-to-date, Kufri Jyoti and CIP 24 are common varieties of the Myanmar. Potato cultivation costs are huge to risk using noncertified seed. Best quality of certified seed planted and produced the greatest yields, the good quality tubers, and reduced disease problems (HLA 5028). The true potato seed (TPS) technology improved and adapted in India has a great potential in this areas. The true potato seed (TPS) cost is unimportant when compared to seed tubers. In addition, it can recover the whole transportation cost of seed tubers from long way (Pandey 2008).

2.6.6 Water management

Water insufficiency of potato production is usually one of the most important constraints to predictable yields. Reaching better yields requires a sufficient water supply from sowing until maturity. The main effect of drought or water stress on potato is yield and size reducing. Regular irrigation is one of the important factors to reduce the appearance of the tuber malformation. For the potato, the critical period for water deficit is during tuber development. Inadequate of water in the early phase of tuberization makes the appearance of slender shape tubers (more maked in oval than in round tuber varieties) and, depend on the irrigation, cam result in burst tubers or “hollow hearts” tubers.

2.6.7 Weed management

Weeding should be acted after emergence of plant or about four weeks after planting and after the plants have reached a height of about 20 cm to get the crop a competitive advantage. Slight crimping is done frequently to inhibit the stolons becoming aerials, and to protect tubers against insect pests, disease infection and greening. Crop rotation and attentive chemical control with herbicides, applied at minimum lethal doses, may be part of an associated weed management system, although in most developing countries weed management is usually carried out manually (Sustainable potato production, 2009).

2.6.8 Pest and disease management

To achieve great yield and high quality, the prevention of the pest and disease attack is one of the good management practices. They involve crop rotation, use of resistant varieties and in good condition, certified seed tubers (if available or at least seed from a assumed source or through positive selection), and assimilated pest and disease management, which

includes common monitoring of aphid and thrips vectors, other insects and native enemy populations, and chemical application only when needed. The applied of chemical pesticides on potato is in greater to extend in developing countries, as farmers become more intense production and extend plantation into regions and growing seasons beside the potato's traditional range. The frequently application of chemical in pesticides and fungicides are highly hazard and used in less or lack shielding equipment.

2.6.9 Harvesting and post harvest

Harvesting should be done with great care so that no injury to tuber is caused by tools and implements or transportation. The damage tubers or else get infection of soft rot or dry rot. In the multiple cropping systems there is repeatedly a time limit for harvest and post harvest processing since the second crop should be grown within 3 weeks of the harvest of the first crop and post harvest such as carrying to store stock coincide with high labor requirements for the growing for the second crop. Different European countries, the potato is abundantly produced in most of the Asian countries in winter and stored meanwhile the long hot summer. The potato being a semi-decomposable crop rots at higher temperature/. The storage constraints alter to more intense as one change from north to south in Asia. This needs the storage of potatoes in cold condition at 2 to 4 oC. However, cold storage includes substantial costs and growers in the poor Asian countries cannot incur these. There are traditional low-cost and non-cold storages conditions which are in use in many countries of the area and these could be adapted in other countries with like climatic conditions (Pandey 2008).

2.7 Socio-economic aspects of the potato-based cropping system

The potato is actually a global crop grown in nearly 150 countries and fourth in ranking after the main staple food crops maize, wheat and rice. The socio-economic point of view in the potato-based cropping system as following:

2.7.1 Commercialization

Potato is an important food that provided the energy and nutritional needs of more than many thousands of people in the world. Potato plantation and post harvest processing activities create the occupation and income opportunities in rural regions and especially for women in developing worldwide. Potato can be used as a food security crop, a cash crop, as feed for livestock, and as a origin of starch for many manufactory utilizes. Potato producing in developing countries is economically leaded with more than 80 percent of the cultivated crop being sold (Ezeta 2008). A traditional way of processing potatoes in rural Myanmar has been the production of fried potato, potato chips as snack and this is still a current practice at household level and is commercialized in local markets (Kyi 2006).

2.7.2 Access to market

The market for fresh consumption of potatoes is expanding in most of Asia in response to income growth and urbanization. The potato is a bulky product difficult and expensive to transport long distances. The international market for fresh potatoes in the region is mostly restricted to cross-border trading among neighbouring countries and this has intensified in recent years with the building of better roads (Ezeta 2008).

Improved post harvesting technologies and high quality of tuber potato production can create the extend exports and promote the processing activities. These factors are market opportunities of the small-farm growers to extend potato production and price stabilities. However, approach of small-farm growers to the mass production market for industries had been restricted because industry suppliers favor to chance in a group number of large producers. Besides, most of potato fries were applied by transnational fast-food corporations and franchises are imported from developed countries. The opportunities of constructing domestic operating factory had been handicap by the limit competitive effective of local basic material that does not have price prediction or good quality.

2.7.3 Production cost and income

Potato production in South Asia and Southeast Asia is generally the economic pillor in intensive small-farm, valuable agriculture systems (Ezeta 2008). Production is large labour intensify, and small farms may create extensive use of hired labour in potato platation, employing landless labours (Ezeta 2008). Because of the seasonal production in many areas in which population densities are generally low, the major constraint to extensive of cultivation is more labour than land.

Large potato production needs to apply the large amount in agro-inputs such as quality seed, fertilizers, farmyard manure, fungicides and pesticides to successful yielding. Besides, potato growers in developing world have high transaction and financial costs to purchase agro-inputs and worker as well as to keep and sell their produce (Yi Wang). Small-farm growers are especially sensitive to price instability and repeatedly are forced to decline cost by decreasing inputs which make to low produce.

Potato can support the basic requires: food, occupation for income. Potato growers in developing world can profit from potato processing, however, most of the farmers have small-farm holding size, stand on marginal lands, and at the lower end of the economic scale.

2.8 Factors constraining the potato-based subsector

(Lutaladio et al., 2009) summarized the factor constraining the potato-based subsector as following:

2.8.1 Technical factor

(a)Potato biological characteristics

The various constraints came down the potato of biological characteristics by itself. These contain the low multiplication rates of seed tubers, and the scientific difficulties and costs accomplished with controlling seed quality through succeeding multiplications, have an obligation to the potato's sensitivity to soil and seed-borne pests and diseases. Seed tubers are also heavy; two to three tons per hectare is the typical seed requirement. Stringent phytosanitary restrictions limit the movement of potato germplasm, seed tubers and fresh ware potatoes. Potatoes have great fertilizer requirements but low utilization efficiency. Post-harvest, fresh potato tubers debilitate quickly in tropical and subtropical ambiance, especially in the lowlands.

(b)Lack of efficient seed systems

Many developing countries, limit effective systems for the habitual multiplication and dissemination of certified seed tubers and the fast development of new, improved varieties. Causal factors include the limited technical ability of human resources, lack of authoritative expertise and insufficient resource allotment to seed systems and the potato subsector in common. As a result farmer-based seed flows are still general, and have planned to provide planting material of limited quality bygone the years, and dispensed to extending cultivation of the crop. farmer seed flows face many confrontation, but also offer and opportunity to enhance seed supply, provided suitable training is available and links with academic sector are established.

(c)Diseases and insect pests

Diseases and pests are the important constraint of the potato production. Late blight of potato is a very serious profitable risk in the mass greater part of potato farming systems, similarly bulky tomato farming systems in the world (Maddan 1983). Bacterial wilt is second to late blight in main disease, especially in hoter, more tropical areas. The affected of pest varies between regions. Major pests contain aphids, leaf miners. tuber months, 28 spotted beetles and Andean potato weevil.

2.8.2 Socio-economic factors

(a)High production costs and lack of credit

Production of potatoes compared to other food crops is ample intensive, requiring the buy of big quantities of heavy seed and the used of high-cost input such as fertilizer, fungicides and pesticides. With confined access to credit and exiguous means of alleviating the risks of taking out loans, small-scale growers find it hard to do to full in potato production. The present global monetary crisis could leave a large number of potato growers by limit fund and no supporter to afford in potato cultivation.

(b)Price instability

Small-scale potato farmers are susceptible to rude changes in input and output prices with potato becoming to a greater extent a cash crop. Seasonal and year-to-year price changing can impinge particular small farmers who limit the financial sources and flexibility of larger producers and collaborative.

(c)Inefficiency of local markets

Supply and demand usually determine potato prices, not depend on the international markets like cereals. It is a crop which can service low revenue growers and customers to afflict out section of food price expansion, such as that accomplished worldwide in 2007-08. However, the yielding profit of potato replies upon efficient domestic markets and measures to control overproduction.

(d)Limited access to higher value markets

Small scale potato growers need approach to profitable rise up local markets- such as in the rush growing processing portion- as well as to potato export market. However, access

to local markets is regularly inhibited by the marketing ability of aboard suppliers, while exports are banned by trade constrains in developed countries to processed products from the developing world. However, there is strengthening that emphasized how small-scale builders can enhance production and magnify their market contribution. In India, potato farmers who suited new technology with the support of McCain foods Ltd more than duplicated their produces and incomes. Other private manufactories, including small businesses, have set in motion potato chips arrange from coloured potatoes that were originated by CIP in order to improve the reasonable use of biodiversity in the Andean Region. Current legislation in the USA and Europe support greater approach to agricultural commodities from the developing world.

2.8.3 Policy and institutional factors

(a)Neglect of the potato subsector

Most developing countries except as Ethiopia have policies toward the potato subsector, and particularly small-scale producers. Little or no public contribution is intended at consolidated approaches for crop development, value addition and marketing plans or the potato production-processing-marketing sequence. Many countries limit adequate seed production schemes backed by confirmation and seed laws. Breeding rights are generally not regarded, reduction incentives to breeders to beget new adapted and resistant varieties. In many field, poor infrastructural facilities and poor approach to markets are also main confrontation to expansion of potato production and its profitableness.

(b)Inadequate capacity building initiatives

In only a few countries, the private investment sector interested the potato in the central area of seed multiplication and seed systems. Programmes supporting for the distribution of new varieties and the going up of remaining integrated disease and insect pest management technologies and methodologies were commonly not enough. Planning to enchance the aptitude of potato growers required to be balanced by government efforts to create, leader and enforce regulations on pesticide use and the spreading of pesticide or fertilizer residues into water supplies, which are superior constraints to the stable of potato production systems.

(c)Lack of support to farmer organizations and entrepreneurs

In many countries, potato farmer groups and organizations and for local entrepreneurs was lacking. In Bangladesh and Pakistan, authoritative lobbies represent the most genuine obstacle to the improvement of a local seed potato industry. However, Argentina where efforts were being made by private and public sector to increase seed quality and improve variety development and to alteration technology for organized crop management to it’s contract farmers.

2.9 Advantages and disadvantages of intensive farming

Of the agricultural systems, intensive farming is goals to produce highest yield form given land. This farming is applicable to the produce of the livestock also. Food is produced in huge quantities with the applied of chemical fertilizers, fungicides and pesticides. The products such as eggs, meat and many agricultural products accessible in abounding supermarkets are produced practicing modern intensive farming. This farming is used

widely by many of the developed economies of the world. Nonetheless, intensive farming has both the positive and the negative impact.

2.9.1 Positive impact of intensive farming

One of the major positive impacts of intensive farming is that its produce is high. The farm products such as fruits, vegetables and poultry products have developed into less expensive in practicing of intensive farming. Therefore, small-farm growers can apply a neutralized and nutrition in diet. Many assume, food in good agricultural practice is eatable for the wealthy and the selected level of the community. Separately, ample cultivation areas are needed for planted organic crops applying common compose. Nevertheless, by practicing of vast production, the area requirement in cultivation is lower. In addition, positive impact is which great production of food is available in smaller quantity of cultivated area. Therefore, it would be to confront the always increasing necessity for food supplies.

2.9.2 Negative impact of intensive farming

Intensive farming practices the applied of different kinds of chemical inputs such as fertilizers, fungicides and pesticides. Besides, intensive farming is also correlated along farms which care of livestock upon their having ability and it could ahead to infection and many kinds of diseases. Intensive farming affected the present environment in the natural forests. Application of large amount of fertilizers polluted water anatomy including streams, ponds and rivers along the land of plantation.

The fungicide and pesticides applied on cultivated crops affect in pests, injure the crops and destroy effective insects. Ultimately, these chemicals are moved on to the human being. The goods such as tubers, cereals, vegetables and fruits from farms which improve intensive farming are contaminated by not visible pesticides. Those are difficult to clean out. The residual effect of pesticides affects the health of human beings.

2.10 Environmental hazards of potato production

The improved international trade and intensification of the potato crop examined at an end the previous century especially the potato plantation and market in the worldwide attitude a noticeable objection to the agricultural sector of the developing world. Intensive farming with used agro-chemicals can have harmful effects on natural sources and the whole surroundings situation. The application of precipitously slope on hillsides for seed producing in the tropics and subtropics would ahead to desertification, soil deterioration, sedimentation and water pollution due to chemical and disappear of water reservation ability of catchments. Same crops grow in many years in many region had growth nematode dissemination to balance which does not possible to yield with bulky application of highly toxic content of nematicides as chemicals. The destruction of variety diversity of potatoes are chained to the diminishing of the genetic base produce from breeding schedules leaded to comfort the need of the greatest and extent in beneficial sectors of the market. The international trade of high amounts of stock and seed potato cultivation has comforted diffusion of extraneous diseases and pest to many cultivation areas. Besides, the impact of the exception of small-farm growers from potato cultivation, by decreasing income and employment probabilities to much rural community, could activate the degenerate compass of deficit informally related to the deterioration of national surroundings.

Chapter 3
Research Methodology

3.1 Types of research

The research methods in this study was the composition of both exploratory and evaluation type.

3.2 Research design

The research design was the composition of a survey design and a non-experimental design.

3.3 Selection of the study area

Southern Shan State is an important potato cropping area in the Shan State, eastern part of Myanmar as well as the largest production area of the whole country. The total potato production of Myanmar is 34.83(000'ha), among them 16.14(000'ha) is included in the Southern Shan State. Of the total area sown, 79% of potato is grown during rainy season (upland area) and the rest 21% of potato is planted during winter and summer (lowland-irrigated area) where potato can be grown two (or) three crops per year. This has made Southern Shan State an ideal representative study area for the study.

- Most of the potato production area of Southern Shan State was occupied in Taunggyi district at 96.63% among three districts.
- 29.57% of the total potato production area of Taunggyi district was in Kalaw Township among 13 Township.
- Two villages in Kalaw Township were selected by a simple random sampling method.
- Households from each selected villages were selected by a simple random sampling method.

3.4 Sampling design

Table 3.1 Sampling procedure and method

Step	Study area	description	Sampling method
1	Southern Shan State	Selected State	Purposive sampling
2	Taunggyi District	Selected district	Purposive sampling
3	Kalaw Township	Selected Township	Purposive sampling
4	Heho' and Myaechar	Selected villages	Random sampling
5	74 households	Selected household	Random sampling

3.5 Sampling size

The researcher was firstly noticed the potato farmers' field conditions to divide the upland and upland + lowland potato-based respondents. Because Kalaw Township is mountainous region, it can not to separate the upland and lowland farmer. Some of farmers had in only upland cultivated land and some had in both upland and lowland cultivated land. Therefore, the sample size of the upland farmer number was 38 and the number of the upland + lowland farmers was 36. All respondents were 74 farmers.

3.6 Data collection

3.6.1 Primary data collection

Primary data was collected by household level questionnaire survey, focus group discussion and key informants interview.

Questionnaire was prepared to obtain all of the information about resource base data include farm size, land tenure, irrigation facilities, machinery, farming practices, skill and knowledge. The household data included family composition, age structure, education, occupation and other non-farm activities. Resource utility data include crop varieties, area, duration, cultural practice and management, material input used, capital use, and labor use and credit information.

Key informant interview included government officers who assisted in providing support service in this area such as extension worker, and village leader. The interview aim at gathering information on their services to potato-based cropping system and information on historical background of the community including physical factors, socio-economic, socio-cultural of potato-based cropping system in the study area.

Group discussion was made to know some opinions and their believed of the people in the study area including skilled people on the cultivation practices, such as constraints about potato-based cropping system practices in the study area.

3.6.2 Secondary data collection

Secondary data was consisted of two parts. Firstly, relevant maps including topographic maps, land use maps, soil maps and others will gather. Secondly, agriculture concerned data of cropping pattern, soil fertility status, irrigation systems; and socio-economic, institutional and policy related documents were extracted from relevant government departments as well as from published and/or non-published books, journals, magazines, seminar reports, thesis and dissertations, etc.

3.7 Data analysis and techniques

This research involved both quantitative and qualitative data. Excel and Statistic Package for Social Sciences (SPSS for windows) software were used as follows;

3.7.1 Descriptive statistics

Descriptive statistics like mean, standard deviation, percentages applied for data analysis in terms of general information such as demographic data, land holding size, labour, input using yield, income of farm and household etc. pie charts, graphs, figures and tables were applied for data arrangement describing the performance of potato-based farming systems.

3.7.2 Analytical statistics

- Chi-square test was used to measure the statistical differences and similarities between the farming practices, farm income, level of input use, farm labor etc…in each study area.

- T-test test was applied to analyse the significant difference between means of farming practices such as cost of fertilizers, fungicides, seed rate, weeding and labors etc.

- Multiple response was applied to measure with frequency and percentage of the constraints of potato production and marketing in the study area.

3.7.3 Cost and benefit analysis

Selected crops and cropping pattern profitability were calculated by using cost and return analyses. Household income and farm income were analysed by using cost and benefit analysis to examine the stage of contribution of farm income in total household income under examination of selected cropping pattern. The following profit examinations were applied in this study.

3.7.4 Economic or profitability analysis

1. **Gross margin or net farm income analysis**

Gross Margin (GM) = Gross Return (GR) – Total Variable Costs (TVC)

Where,

Gross return	=	produced yield product into market price of product
Total variable cost	=	total production cost (amount of input used* price of input

2. **Annual net farm income and annual household Income**

3.8 Overall methodology

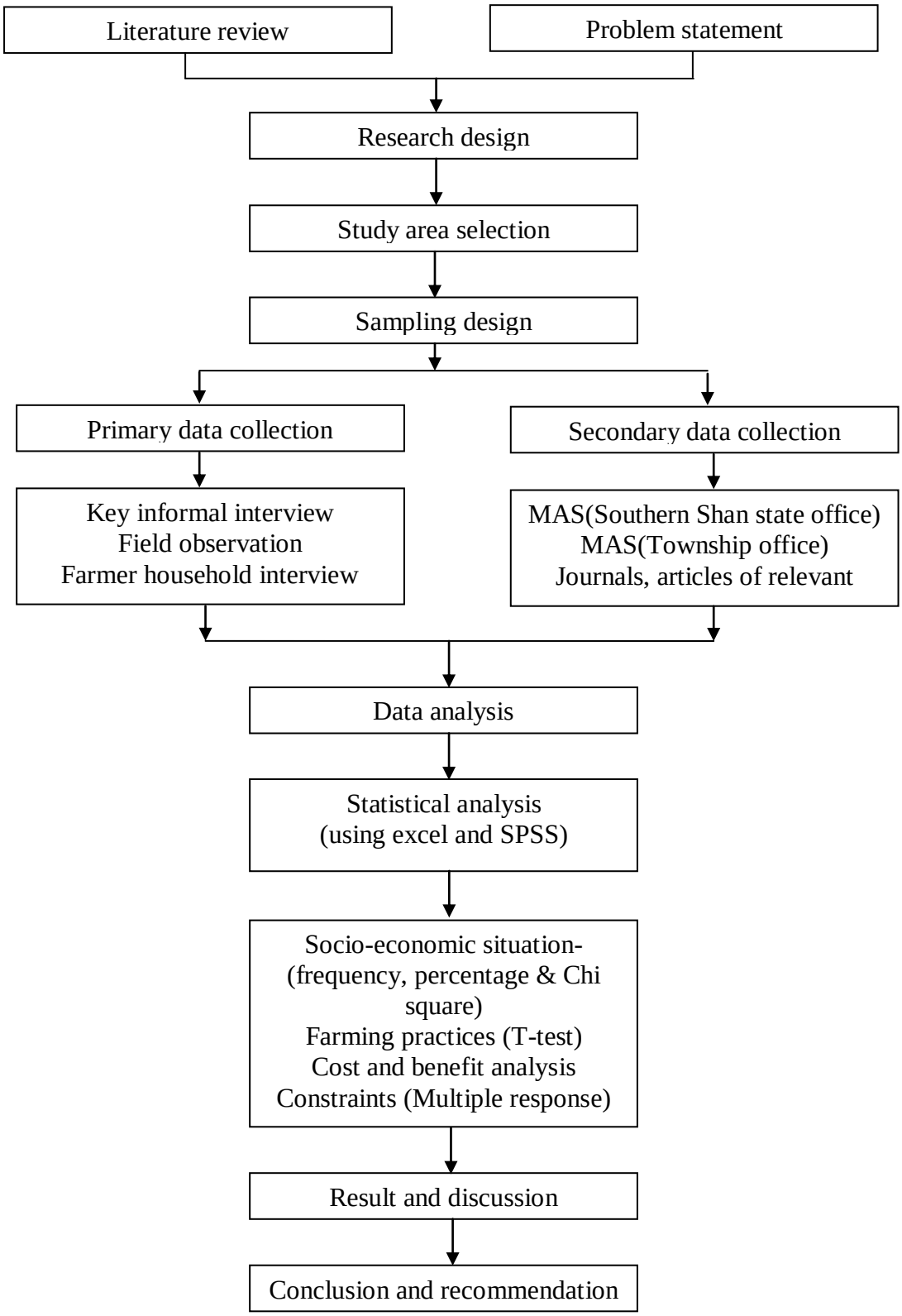


Figure 3.1 Overall flowchart of research methology

Chapter 4
Characteristic of study area

Southern Shan State in eastern part of Myanmar was chosen for the described study. This chapter contributes the general information and agricultural production system of study area.

4.1 Geographical location of Southern Shan State

Southern Shan State is located on the eastern part of Myanmar between 96º and 97º East longitude, 20º and 21º North latitude. The total area of state is 5.59 million hectares and shares boundary to the eastern and northern Shan State, the south with Kaya state and the west with Naypyitaw which is a capital of Myanmar and Mandalay Division. The landform of Southern Shan State is broadly undulating with hills, slopes and elevation is between 900 m to 1500 m above sea level.

Southern Shan State is officially divided into 3 districts in which 24 townships and 10 sub-townships and consists of 411 village tracts. The three districts of the state are Taunggyi, Loilin and Linkhae. Taunggyi district is comprised 13 Townships including Kalaw Township. It is the target area of this research.

4.2 Study area location

Kalaw Township is stood between 20º24′ and 21º 0′ latitude, 96º26′ and 96º50′ longitude. It is widely 582.13 square miles and the altitude is 1308 meters or 4315 feet above sea level and consists of 257 villages within 27 village tracts. Currently, the population of the Kalaw Township is about 146216, in which male are 74966 and female are 71250 respectively. In this population, 15755 households persisting in urban and 22737 households are persisting in rural area in all of households 38492.

One of the study area, Heho' villiage, it is along the railway and highway road from Taunggyi to Yangon. Presently, the population of Heho' is 14571 out of which 6745 are male and 7466 are female respectively. It has both lowland cultivated area in Heho' valley and upland one on the hilly region. Most of the soil nature is red laterite whereas that in Heho' valley is peaty and clay loam.

Myanchar village is the another study area of the research. It is located on the mountainous region and about 7 miles far from the highway road from Taunggyi-Yangon. The population is 519 in which 233 are male and 286 are female respectively. Myanchar has only upland cultivated area especially slope land on the hilly region. Soil nature of the potato cultivated area is red laterite.

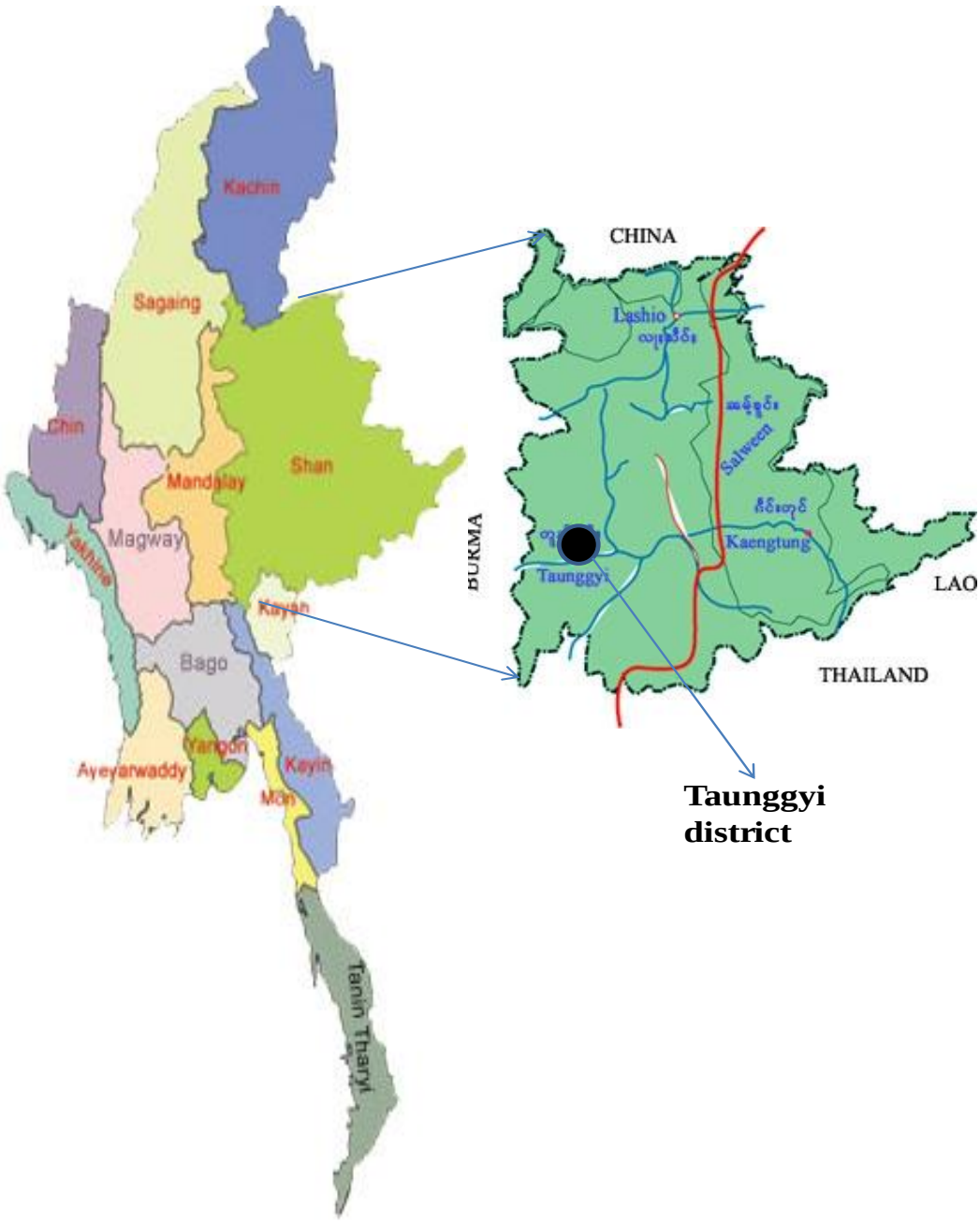


Figure 4.1 Map of Myanmar Southern Shan State

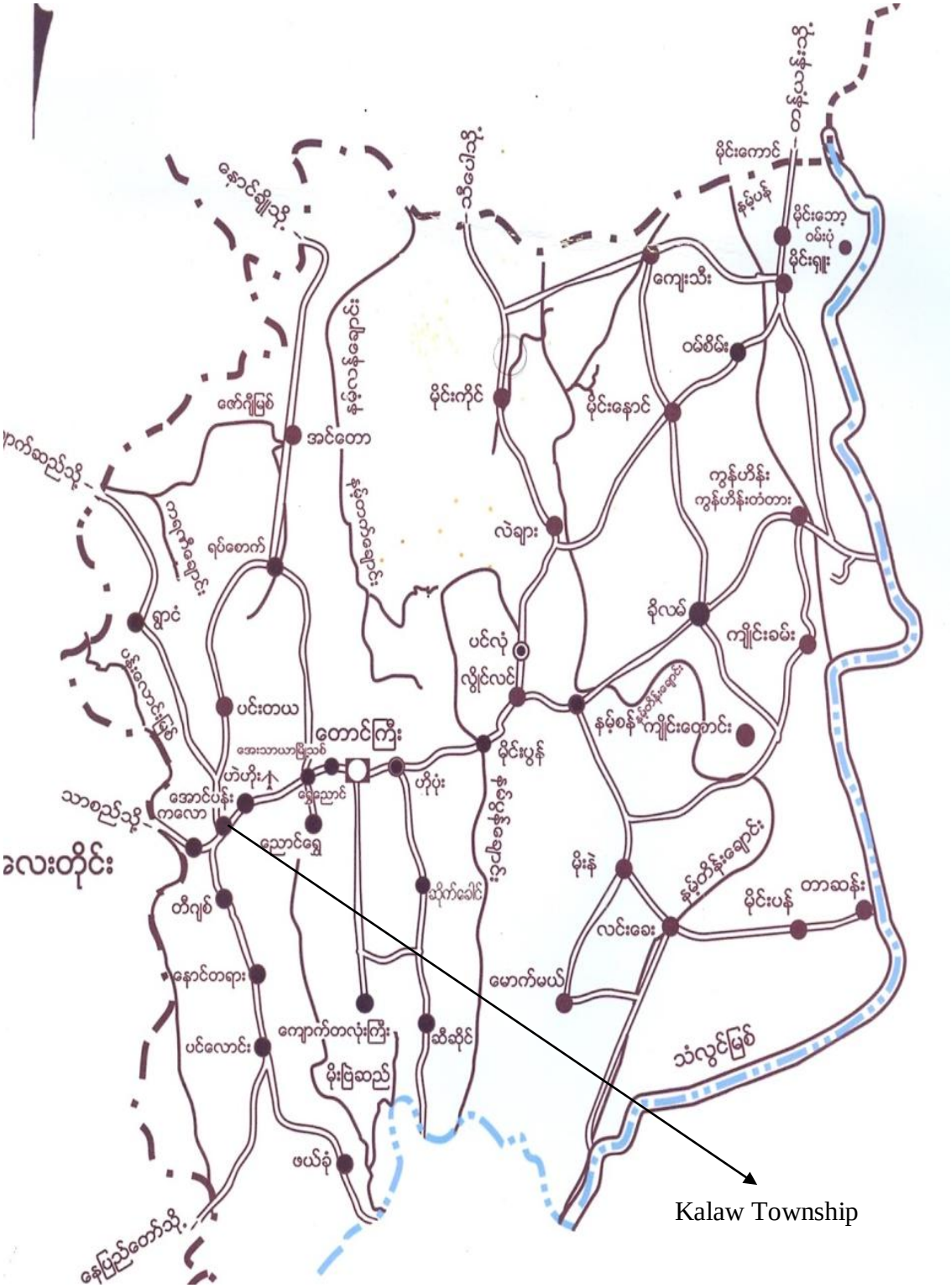


Figure 4.2 Map of Taunggyi district (Kalaw Township)

4.3 Climate

Kalaw Township is placed sub-tropical climate. It has three seasons; rainy season from last April to the middle of November, winter season from end of November to last February and summer season from first March to end of April. The average total rainfall and rainy days are 85.17mm and 91 days. The highest rainfall is in May at 202.95 mm while the lowest is in January at 4.06 mm. The average maximum mean temperature reaches 30.65 ˚C in May and minimum is 4.25˚C in January. The total average annual rainfalls and rainy days different according to year arranging from 882.90 mm to 1212.85mm and from 78 days to 106 days that shows Figure (4.1).The variation of the highest, lowest and average temperature is showed in figure (4.2) and then average rainfall mm and rainy days by months in the year 2000 to 2010 in Kalaw Township are present in Figure (4.3) and.

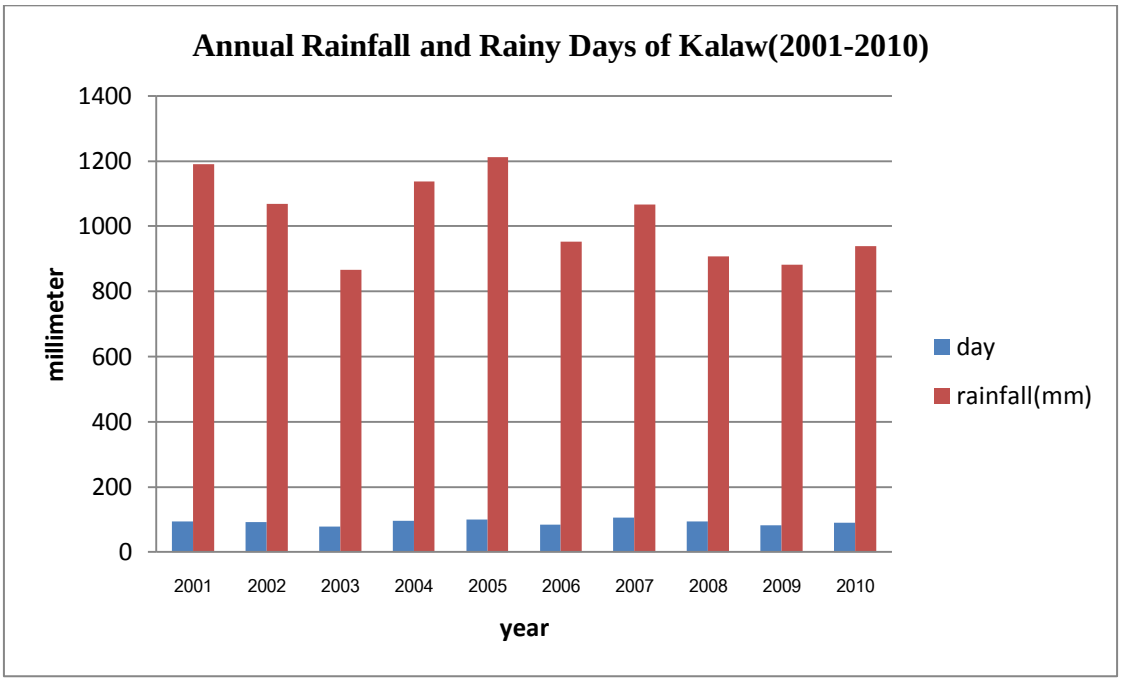


Figure 4.3 Annual rainfall mm and rainy days in Kalaw from 2001 to 2010.

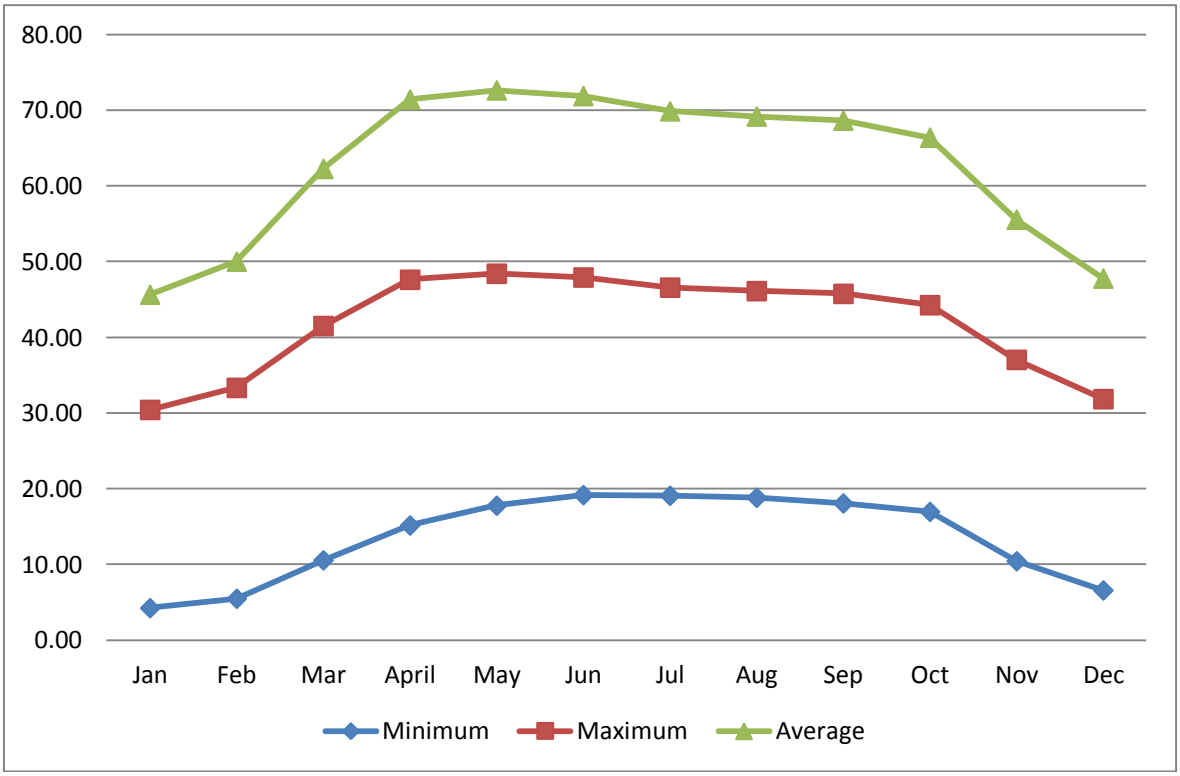


Figure 4.4 Average monthly variation of temperature in 10 years period (2001-2010)

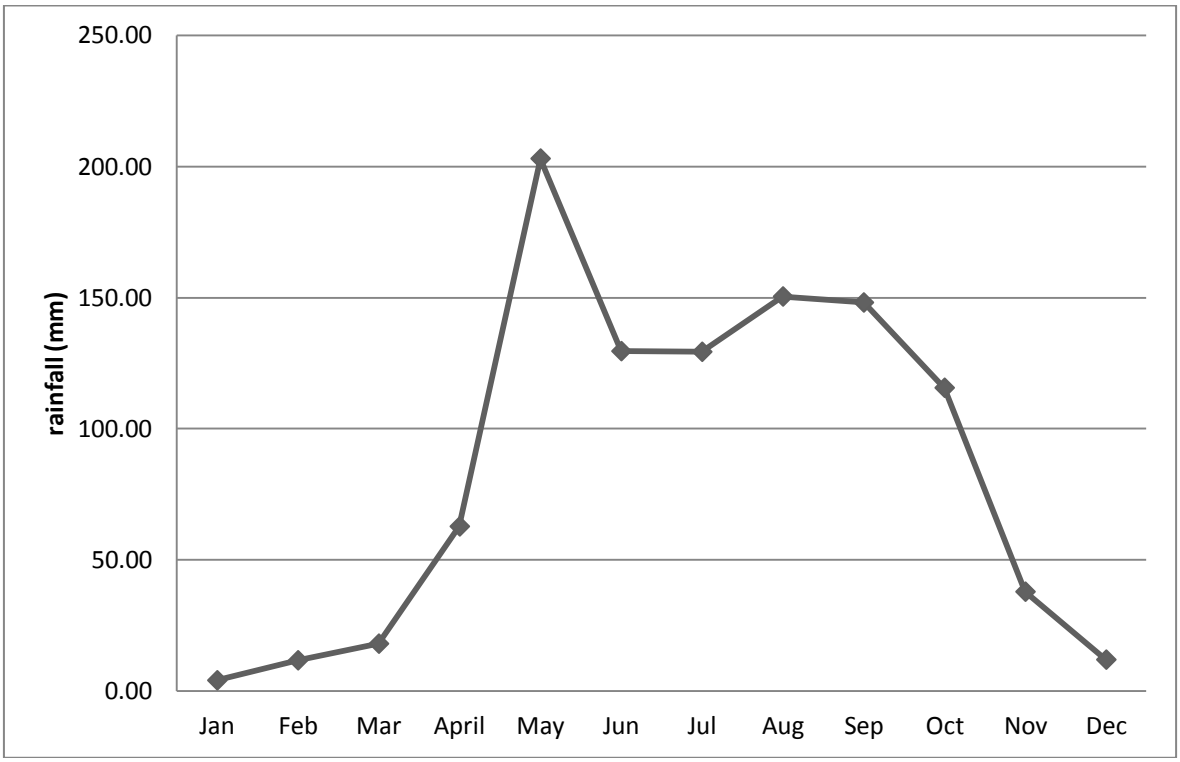


Figure 4.5 Average monthly rainfall mm in 10 years period (2010-2011)

4.4 Land utilization of Kalaw Township

According to the department of settlement and land records, the area in 29480 hectares, which is about 19.54% of the Township's total land area of 150835 hectares, is cultivable in 2010. 1.23 % (1853 ha) of total study area is fallowed, reserved forest area and other forest were located about 21.38% (32252 ha) and 18.52% (27931 ha) respectively.

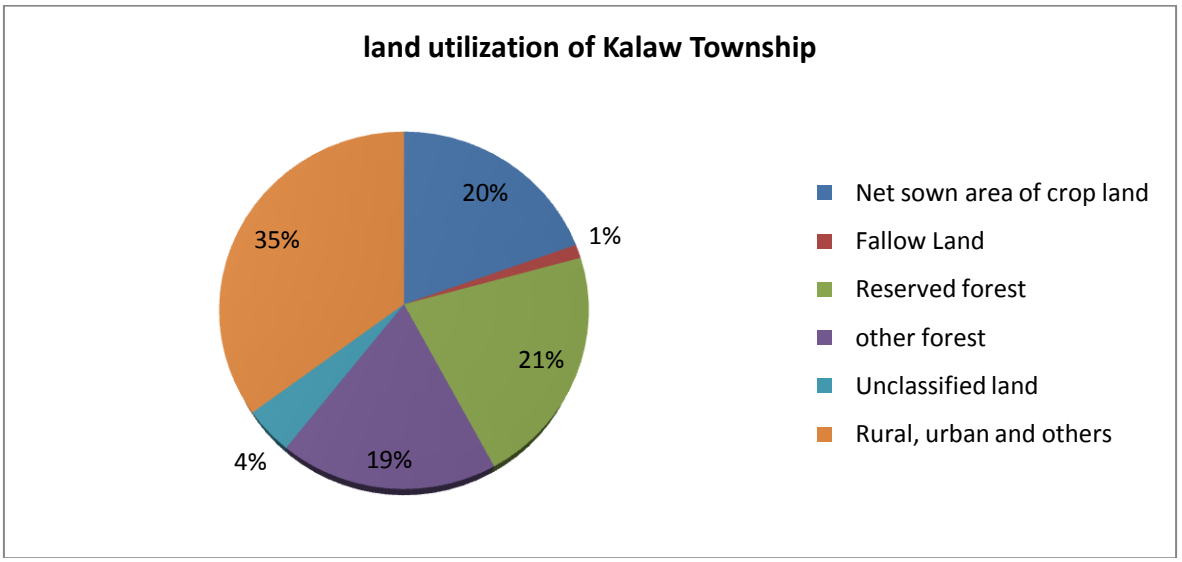


Figure 4.6 Land Utilization Kalaw Township

4.5 Soil resources

Based on the topography, landforms and climate, soil groups in Myanmar are classified into six geographical regions. Among them, the soils of Southern Shan State are classified as Red Earths and Yellow Earths, lateritic soils, degraded soils and peat soils. The large parts of the Southern Shan State are influenced by the Red Earths and Yellow Earths in Myanmar classification system (Tha Tun Oo 1990). In Kalaw administration area, Red Earths and Yellow Earths classified as Acrisols in the FAO system(MAS-LUD,1994), are the most common soils. But most of the soil type of potato growing area is red laterite whereas that in Heho' valley is peaty, clay loam (Myint 2004).

4.6 Irrigation

The availability of adequate water is an important constituent in intensifying crop productivity. The irrigated area of the study area was 8.26 per cent of the net sown area by 2010-2011. Water source for irrigation came down from small dams and steams such as Heho', Tanunglar, Kalaw, Myinmathei, Nanthe, Yaephyu stream. The study area, Heho' is available to cultivated area in the whole year due to closing the Innkhaune dam.

4.7 Agricultural production

The total potato cultivated area of Myanmar is 35000 ha. Among them, 17246 ha is about 50% of the total potato planted area and 80% of the rainy crop of the country. It is stood in the Southern Shan State. The potato growing area of the Kalaw Township is 4928 ha in which 4085 ha are monsoon crop and 843 ha are summer crop. Therefore, nearly 25% of total potato cultivated area of Southern Shan State is established in the Kalaw Township. The monsoon and summer potato cropping area, yield and production in the Kalaw Township in six years period (2004-2010) are presented in the table 4.1. In summer crop, yield 19tonnes/ha and in rainy crop, yield was 21-22 tonnes/ha.

Table 4.1 Potato cultivated area, yield and production of potato in Kalaw Township for Six years from 2004-2010

Year	growing season	Cultivated area(ha)	Yield ton/ha	Production (ton)
2004-2005	Monsoon	3927.94	19.41	76246.72
	Summer	878.54	21.70	19060.38
2005-2006	Monsoon	4028.34	19.36	77995.07
	Summer	880.57	21.72	19123.69
2006-2007	Monsoon	4030.36	19.56	78814.73
	Summer	880.57	22.23	19575.91
2007-2008	Monsoon	4059.92	19.60	79560.48
	Summer	887.45	22.27	19765.45
2008-2009	Monsoon	4083.40	19.60	80049.22
	Summer	814.57	22.28	18148.58
2009-2010	Monsoon	4083.40	19.62	80099.65
	Summer	874.49	22.28	19486.62

Source: Annual report, Myanma Agriculture Service, Kalaw Townshp, 2011.

In the Kalaw Township, the lowland and upland rice is the sole field crop for household use. The potato-paddy is the effective cropping system in the valleys and gentle slopes where TRC (terrace rice cultivation) are practiced. Most of the potato is grown in hills under rain-fed conditions. A small field is cultivated in foothills-valley (lowland) in summer under irrigated conditions. Potato is largely grown in steep slopes as a monocrop.

Niger, canola, groundnut and some vegetables such as cabbage, cauliflower are grown on slightly slope after potato harvested. Moreover, there are grown other crops such as wheat, maize, soybean, pigeon pea, lentil, chit pea, sunflower, chilli, castor, taro, sweet potato,tomato, banana, medicine plants and so on. In more mountainous slope lands, perennial crops which are coffee, tea, orange, mango and peach are also grown. The cropping intensity of Southern Shan State is 120.59 and 212.56 in Kalaw Township. In table 4.2 is shown that the important crops' harvested area, yield and production in the study area.

Table 4.2 Harvested area, yield and production of important crops grown in Kalaw Township, Southern Shan State, 2010-2011.

Type of crop	Crop	Cultivated area (ha)	Yield ton/ha	Total production
1.Cereals	Lowland Rice (R)	3078.95	5.33	16398.30
	Upland Rice	10841.70	2.64	28655.67
	Wheat	1103.24	2.22	2449.19
	Maize	1227.13	3.39	4166.05
2.Pulses	Soybean	995.95	1.50	1493.81
	Pigeon pea	315.79	1.35	427.23
	Lentil	228.74	1.07	244.80
	Chit pea	42.11	1.15	48.34
3.Oil seed crops	Groundnut	1181.78	1.36	1610.31
	Sunflower	364.78	1.18	430.61
	Niger	3726.32	0.53	1990.37
	Canola	370.85	0.40	148.85
4.Calinary crops	Potato (R)	4085.02	19.47	79545.52
	Potato(dry)	842.91	21.34	17989.10
	Ginger	878.54	20.05	17616.78
	Cabbage (R)	774.09	34.30	26551.26
	Cabbage (dry)	305.67	34.30	10484.41

Source: MAS, annual report of Kalaw Township, 2011.

4.8 Cropping patterns and cropping calendar

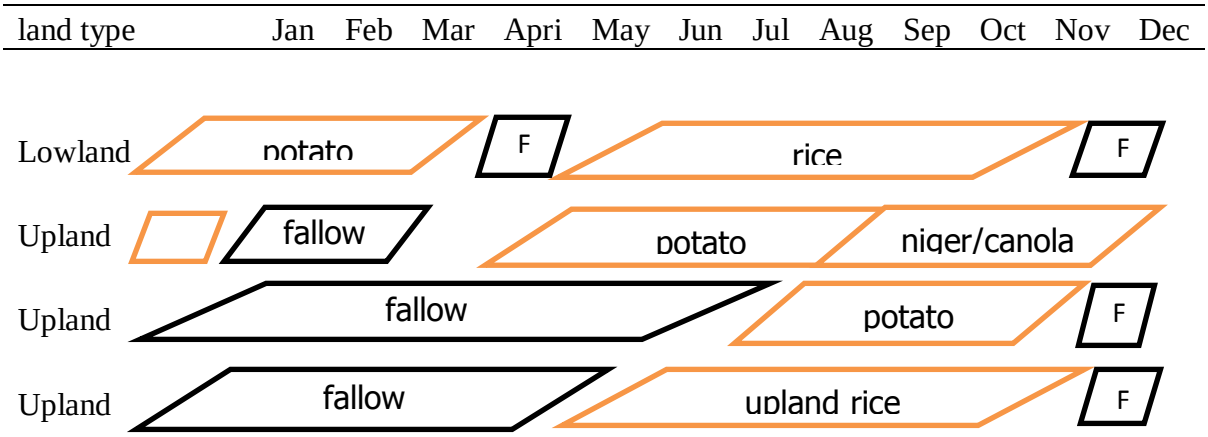
Cropping patterns in Kalaw Township

(1) Potato-Canola
(2) Potato-Niger
(3) Potato-Groundnut
(4) Rice-potato
(5) Potato-fallow
(6) Upland rice-fallow

Although there are grown more than 20 crops in the Kalaw Township, the frequently cropping patterns are about six patterns. However, the most common cropping pattern on the upland hills area fallow a two-year rotation. In the first year, potato is normally planted in April and harvested in July-August. Because of its great nutrient demand, it is sowed as a first crop after the fallow period in upland hill area. After potato, niger (or) canola is grown and harvested in January on the residual moisture.

The land is fallowed during the dry period before the next growing season. In the second year, during May-June to October-November, upland rice is grown and then the land is left fallow again for a year. In the steep slopes area, potato is grown in August to November-October as post monsoon crop and then the rest period is followed for the first year. Next year on that land, only maize or maize and pigeon pea as intercropping is planted. In contrast, the lowland valley area is practiced in one year rotation. Rice is sowed in June

and harvested in November and then fallow about one month. After rice, potato is grown in January and harvested in April. Some farmers are practiced garlic after rice in that land.



F = follow period

Figure 4.7 Cropping calendar related to amount of rainfall in the study area.

Chapter 5
Socio-economic status and comparison of crop management practices by the growing seasons

Farmers survive under diverse socio-economic conditions in terms of household size, land holding size, land area allocated for potato cropping , input use such as farm yard manure, chemical fertilizers, fungicide and livestock composition. All these factors have some kind of relationships with management of farm level resources. This chapter emphasized concise discussion on these socio-economic factors of the two villages and crop management practices of the potato cultivation according to the growing seasons.

5.1 Socio-economic status

5.1.1 Ideographic aspects

a.Gender

In gender distribution of respondents of the study area, male respondents are interviewed presented about 81 percent of the sample households while female represented the remaining at Table (5.1). In the table, 11.1% of respondents of Heho' village are female and 26.3% of Myaechar village are female. All of farm in Myaechar village are upland farm which is situated the hilly mountains. Some of cultivated farm are so far from their house. Therefore, some of the male are not available at their house to care of post monsoon crops.

Table 5.1 Gender distribution of the respondents

Gender	Heho'		Myaechar	
	N	%	N	%
Male	32	88.9	28	73.7
Female	4	11.1	10	26.3
Total	36	100	38	100

Source: Field survey, 2011.

b. Ethnic group

The respondents of Heho' village are Pao 16.7%, Burma 47.2% and Danu 36% respectively. Burma respondents are majority because they were the migrated of the lower Myanmar as the government staff in this area. All of respondents of Myaechar village are Pao. They are inherited from the ancestor.

Table 5.2 Ethnic group distribution of respondents

Ethnic group	Heho'		Myaechar	
	N	%	N	%
Pao	6	16.7	38	100
Burma	17	47.2	0	0
Danu	13	36.1	0	0
Total	36	100	38	100

Source: Field survey, 2011.

c. Age

All age of respondents were classified into four groups which are shown in Table (5.3). About 80% of respondents in Heho' are in 41-60 years age group as majority. In Myaechar village, 20-40 years and 41-60 years age group are 47.4% respectively as majority. The rest percentage of all respondents is in over 60 year group.

Table 5.3 Age distribution of respondents

Age(year)	Heho'		Myaechar	
	N	%	N	%
20 - 40	2	5.6	18	47.4
41 - 60	29	80.6	18	47.4
Over 60	5	13.9	2	5.3
Total	36	100	38	100

Source: Field survey, 2011.

d. Education

All respondents' education level can be observed in table 5.4. In Heho' area, about 44.4% and 38.9% of respondents had finished primary and middle school. The rest respondents have high and University level at 8.3% respectively. In Myaechar area, over half of respondents are in primary education level at 63.2%. Nearly 31.6% of respondents completed middle grade and only 5.3% of sample farmers finished higher grade. University level is not contained in this village.

Table 5.4 Education level of respondents

Education	Heho'		Myaechar	
	N	%	N	%
Primary	16	44.4	24	63.2
Middle	14	38.9	12	31.6
High	3	8.3	2	5.3
University	3	8.3	0	0
Total	36	100	38	0

Source: Field survey, 2011.

e. Farming experience

Depend on farming experiences in years, it grouped into five categories as presented in Table 5.5. In the Heho', nearly half of all respondents had 31-40 years of farming experience while 22.2 per cent and 16.7 per cent of the respondents had 21-30 years and 11-20 years experiences in farming. Whereas, 8.3 per cent of respondents had very low experience (1-10 years) and the rest 8.3 per cent had highest experience (over 40 years). Nearly one third of all respondents of Myaechar had 21-30 years experience and about 21% of respondents had 11-20 years and 31-40 years of experience respectively. The rest had lowest (1-10years) and highest above 40 years in 5.3 and 3.2 per cent. It can be shown that majority of the heho' village had farming experiences of 31-40 years and the left one had experiences in 21-30 years. Nevertheless, average farming experience of all respondents is 28.5 years.

Table 5.5 Farming experience of respondents

Farming experience(year)	Heho'		Myaechar	
	N	%	N	%
1-10	3	8.3	2	5.3
11-20	6	16.7	8	21.1
21-30	8	22.2	14	36.8
31-40	16	44.4	9	23.7
Over 40	3	8.3	5	3.2
Total	36	100	38	100
average	28.57		28.5	

Source: Field survey, 2011.

5.1.2 Demographic aspects

a.Family size

The family size 4-6 members group is the highest group in both of the villages, 69.4% and 50.0 % respectively. The second highest is 7-9 members group in Heho' at 19.4% and 1-3 members group in Myaechar at 42.1%. In Myaechar, it had only three groups of family size and about 7.9 % has the 7-9 family size. The average family size is 5.57 in Heho' and 4.37 in Myaechar.

Table 5.6 Family size of respondents

Family size	Heho'		Myaechar	
	N	%	N	%
1-3	2	5.6	16	42.1
4-6	25	69.4	19	50.0
7-9	7	19.4	3	7.9
9-11	2	5.6	0	0
Total	36	100	38	100
average	5.57		4.37	

Source: Field survey, 2011.

b. Family labor

1-3 persons of most of the respondents in both villages comprise in their farming activities of the whole year about 63.9 per cent and 65.8 percent respectively. One third of all respondents have 4-6 family labours. About 5.6 percent of Heho' respondents applied their farms by the 7-9 family labours. In the crop growing season, farmers can be borrowed and changed off-farming labors while they require to work in their operation. However, average family labour of household in two village is round about 1-3 numbers

Table 5.7 Distribution family labour of respondents

Family labor	Heho'		Myaechar	
	N	%	N	%
1-3	23	63.9	25	65.8
4-6	11	30.6	13	34.2
7-9	2	5.6	0	0
Total	36	100	38	100
average	3.17		3.10	

Source: Field survey, 2011.

c. Land holding size of household

Most of the respondents in the two villages had only less than 2.001 ha of land holding size accounting 44.5% and 44.7% respectively. One third of all respondents owned the farming area between 2.001 ha and 3 ha. The rest two owned farming land under 1 ha in 4% and 6%, above 3 ha in 4% respectively. Heho' has the unique characteristic of having the average land holdings, 2.5 ha, which is higher than the Myaechar average 1.6 ha. Because Heho farmers have both lowland and upland farm.

Table 5.8 Land holding size of respondents

Land holding area	Heho'		Myanchar	
	N	%	N	%
Under 1 ha	4	11.1	6	15.8
1.001-2 ha	16	44.5	17	44.7
2.001-3 ha	12	33.3	11	28.9
Above 3 ha	4	11.1	4	10.6
Total	36	100	38	100
average	2.5		1.6	

Source: Field survey, 2011.

Lowland Area

As Kalaw Township is located in the hilly region, lowland was located on lower foot plain and valley between mountains. In heho' village, most of the respondents possessed lowland under 1 ha land size. Myaechar village is located on the hillside on the mountain, therefore, they don't have lowland area for cultivation.

Table 5.9 Distribution of lowland area of respondents

Lowland area	Heho'		Myaeyar	
	N	%	N	%
Under 1 ha	23	63.9	0	0
1.001-2 ha	10	27.8	0	0
2.001-3 ha	0	0.0	0	0
Above 3 ha	3	8.3	0	0
Total	36	100	0	0
average	1		0	

Source: Field survey, 2011.

Upland area

About 77% of total cultivated area of the Kalaw Township is upland and only 14% of those areas are lowland. Most of the farmers in the study area depend on upland cultivation for their persistence and source of their revenue. In Heho' area, half of the farmers had less than 1 ha and one fourth of the farmers had upland from 1.001ha to 2 ha and the rest had 2.001 – 3 ha (only 6%) and more than 3ha only 5.5%). In Myaechar, most of the farmers (42.1%) owned 1.001-2 ha and one third of farmers(31.6%) owned 2.001-3 ha. Only 15.8% and 10% of farmers owned less than 1 ha and later one is more than 3 ha. Nevertheless, the average upland owned size of villages is 1.5 ha.

Table 5.10 Distribution of upland area of respondents

Upland area	Heho’		Myaeyar	
	N	%	N	%
Under 1 ha	18	50.0	6	15.8
1.001-2 ha	10	27.8	16	42.1
2.001-3 ha	6	16.7	12	31.6
Above 3 ha	2	5.5	4	10.5
Total	36	100	38	100
average	1.5		1.6	

Source: Field survey, 2011.

5.2 Farm equipment of ownership

The possession of harrow, plough, cow and bullock cart of respondents build upon their possessed keeping livestock. The prevalent form of tillage is by bullocks although a small quantity is cultivated by tractors. Therefore, harrows, ploughs and bullock carts of respondents of two villages were more possessed numbers than other equipment such as tractor, trolley and power tillage. In Heho’ area, respondents owned three tractors, 11 power tillers and 10 trolleys that used not only on owned land but also hire to other land. In Myaechar, respondents owned six power tiller and six trolleys to owned use and hire. The possessed numbers of farm equipments in the study areas are shown in Table 5.11.

Table 5.11 Ownership of farm equipment

Possessed farm equipment	Heho		Myaechar	
	N	%	N	%
Tractor	3	8.3	0	0.0
Power tiller	11	30.6	6	15.8
Harrow	29	80.6	28	73.7
Plough	24	66.7	24	63.2
Bullock cart	25	69.4	30	78.9
Trolley	10	27.8	6	15.8

Source: Field survey, 2011.

5.3 Livestock ownership

Livestock, particularly draught animals, play an important function in local farming system. Cow, buffalo, pig and poultry are the main livestock keeping by study areas (Table 5.12). Cow and buffalo are used mainly cultivation and transportation with cart. Besides, farmers used them for to produce farm yard manure to apply their cultivated land. Pig and poultry were keeping for selling and for meal. But Myaechar area was not found that no keeping pig and poultry due to the habited.

Table 5.12 Distribution of livestock owner ship

Type of livestock	Heho'	Myaechar
Cow	96	118
Buffulo	0	18
Pig	10	0
Poultry	70	0

Source: Field survey, 2011.

5.4 Economic aspects

a.Source of credit of respondents

Nearly 40 percent of all respondents borrowed from others such moneylenders, merchant and other farmers with different interest rates arranging from 5% to 7% per month. In Heho' village, respondents had loan from NGO at 7 % and GO at 1.42% per month in which 19.4 % respectively. In Myaechar, over 50% of respondents had not received in loan. The source of credit status in the study area is showed in table 5.13.

Table 5.13 Source of credit status of respondents

Source of credit	Heho'		Myarchar	
	N	%	N	%
Not received	5	13.9	20	52.6
GO	7	19.4	0	0
NGO	7	19.4	3	7.9
Both GO and NGO	1	2.8	0	0
Others(farmer)	16	44.4	15	39.5
	36	100	38	100

Source: Field survey, 2011.

b. Household annual gross income

Household annual gross income of respondents can be categorized into five groups like annual farm income that presented in Table 5.12. In Heho', over one third of the respondents(38.6%) had got more than $8000, nearly another one third (30.6%) had got $6001-8000 and rest respondents included income group $2001-4000 with 11.1% and $4001-6000 with 19.4% respectively.

Table 5.14 Household annual gross income of respondents

Gross household income	Heho'		Myaechar	
	N	%	N	%
Under $2000	0	0	4	10.5
$2001-4000	4	11.1	13	34.2
$4001-6000	7	19.4	5	13.2
$6000-8000	11	30.6	4	10.5
Above $8000	14	38.9	12	31.6
Total	36	100	38	100

Source: Field survey, 2011.

c. off farm income of the respondents

The mainly source of gross annual household income of respondents were from on-farm income of potato-based cropping system. Moreover, some income was earned with doing services with salaries and wage labors, hired buffalo and tractors as off-farm income. Over 50 percent of respondents earned in $0-200. In Heho' village, some of family member worked in other private company with salaries due to their education level. Besides, their tractors gave some income. Therefore, 30 percent of respondents of Heho' earned in $301-400 and 4 percent were in above $400 from off-farm income. In Myaechar, they got some

income from hired buffalo and wages by labors. Table 5.12 showed off farm income groups for two villages respectively.

Table 5.15 Annual household off farm income of respondents

Off farm income	Heho'		Myaechar	
	N	%	N	%
$0-200	19	52.8	29	64.9
$ 201-300	2	5.6	7	18.4
$301-400	11	30.6	2	5.3
Above $400	4	11.1	0	0
Total	36	100	38	100

Source: Field survey, 2011.

d. Contribution of potato-based cropping system (farm income) in total household annual income

Household annual farm income can be allocated into five groups that is showed in Table 5.15. In Heho', over one third of respondents (38.9%) earned above $8000 from their farm 27.8 % earned between $6001 and $ 8000, the rest percent earned $2001-$4000 and $4001-$6000 groups. In Myaechar, one third of respondents (34.2%) included $2001 - $4000 income groups and 26.3% earned more than $8000. The rests earned less than $2000(10.5%), $4001-6000(15.8%) and $6001-8000(13.2%) respectively. The farm income of potato-based cropping system can provide 97% of the total annual household income. The household annual gross farm income of each potato-based cropping pattern per hectare is exposed in the Table 5.14.

Table 5.16 Gross income, Total variable cost and Gross margin of the potato-based cropping patterns per hectare

items unit=$/ha	potatoI-canola	potatoI-niger	potatoI-groundnut	potatoII-fallow	potatoIII-rice(L)	rice(up:) fallow
1.Gross income	6646.24	6643.49	7391.69	6020.63	8151.23	491.25
2. Total variable cost	3366.23	3332.27	3865.4	3831.02	4631.99	302.58
seed	1324.54	1321.45	1389.38	1296.75	1562.28	37.05
FYM	210.44	210.44	313.36	275.67	368.37	77.19
fertilizer	261.63	261.63	364.55	370.94	653.62	35.51
pesticides	534.01	534.01	534.01	563.87	308.43	0.00
water fee	-	-	-	-	6.18	-
labor	689.73	658.86	871.9	957.13	1030.64	87.99
land preparation	191.42	191.42	234.65	256.26	392.11	55.58
interest of loan	46.40	46.4	46.4	46.40	211.56	-
transportation cost	108.06	108.06	111.15	98.80	98.80	9.26
3.Net farm income	3280.01	3311.22	3526.29	2189.61	3519.24	188.67

Source: Field survey, 2011.

Table 5.17 Contribution of potato-based cropping system in total household income

Gross farm income	Heho'		Myaechar	
	N	%	N	%
Below $ 2000	0	0	4	10.5
$ 2001-4000	4	11.1	13	34.2
$ 4001-6000	8	22.2	6	15.8
$ 6001-8000	10	27.8	5	13.2
Above $ 8000	14	38.9	10	26.3
Total	36	100	38	100

Source: Field survey, 2011.

5.5 Crop management practices of potato by growing seasons

The summer potato is cultivated on paddy field in lowland while the pre monsoon crop and post monsoon season crop are cultivated in upland. Summer potato production is the mainly Southern Shan State. Lowland of the study area occupies seasonally flooded areas, which are unsuitable for other crops in rainy season expect rice. Therefore, rice is usually grown in rainy season and potato is grown in summer at this area as rice-fallow-potato. In upland area, potato is grown base on rain-fed condition in which pre monsoon and post monsoon potato. In this section, study the comparison with the crop management practices of the summer season potato production and the rainy season potato production based on t-test analysis.

5.5.1 Land preparation practices

Land preparation is the first considerable factor to cultivation of potato for high yield. Most of the farmers who grow summer potato practice 4 hours in ploughed and 2 hours in harrowed per one times per acre by tractors. They totally have 4 times to complete the land preparation in cost accounting as 222.30 $/ha. There is significantly difference from the upland potato farmer in land preparation cost. Many upland farmers in hillside use cow and bullocks for plough and harrowing in land preparation. These costs are 115.05$/ha in average value.

Table 5.18 land preparation practices by growing seasons

Item	Growing season	Mean	Std. deviation	T-test
Land preparation cost ($/ha)	Summer potato	222.30	2.17	0.000**
	Monsoon potato	115.05	54.36	

Source: Field survey, 2011.
** = significant at p = 0.01

5.5.2 Farmyard manure application practices

Farmyard manure is combining to decompose of byproduct of cow, stubble, waste fodder, crops residues and tree leaves. In the Table 5.14, farmyard manure applied per ha by monsoon potato growers was revealed that the highest level of significant at 99% between the summer potato growers. In fact evidence that potato crop is a unique cash crop for their net income and then they applied FYM that purpose not only for potato crop but also for

next crop. In addition, the soil type of potato growing area in Heho valley is peaty soil. In fact, one of the reason of the less amount FYM was applied in this soil. This study found that the average cost of FYM per hectare of monsoon potato and summer potato growers as quantity for $236.03 and $197.69.

Table 5.19 Farmyard manure cost by growing seasons

Item	Growing season	Mean	Std. deviation	T-test
Farmyard manure cost ($/ha)	Summer season	197.69	28.54	0.000**
	Monsoon season	236.03	40.28	

Source: Field survey, 2011.
** = significant at p = 0.01

5.5.3 Fertilizer application practices

In the study area, fertilizer cost of monsoon potato crop calculated the average cost of pre monsoon and post monsoon crop. In the table 5.15 showed that the fertilizer cost is signify-cant difference between two potato growing seasons as accounting $497.71 in summer and $305.18 in monsoon. The reason of the difference is different population of two season crops that row spacing of summer crop is 24 inches and that of monsoon crop is 30 inches. Besides, summer potato is grown every year in dry season under irrigated condition, in fact, one of the reason of fertilizer used more. The fertilizers used in the cropping systems were Urea and Armo and Thesone compound fertilizers (N-P2O5-K2O) with formulas (15:15:15) and (10:10:5). The amount of Urea and compound fertilizer were applied 200 Kg/ha and 450 Kg/ha in lowland, 100 Kg/ha and 250Kg/ha in upland.

Table 5.20 Fertilizer application cost by growing seasons

Item	Growing season	Mean	Std. deviation	T-test
Fertilizer cost ($/ha)	Summer potato	497.71	105.19	0.000**
	Monsoon potato	305.18	62.30	

Source: Field survey, 2011.
** = significant at p = 0.01

5.5.4 Pest and disease management practices

The average fungicide cost per hectare of summer potato and monsoon potato was highly significant accounting as $ 51.60 and $ 447.46 respectively. The frequency of fungicide applications also varies according to the growing season (Myint 2004). It proved that fungicide is applied most frequently on post monsoon crops of which weather condition are ideal for late blight development. Fewer application tend to be used on monsoon crops especially pre monsoon ones of which climatic conditions are less favorable for the disease at early stage of the crops. The lowest frequency of applications is made on summer crops because the weather conditions are favorable only at later stage of the crops in early monsoon. Like this study results, the labor cost of fungicide application cost was significantly difference between two seasons in accounting as $195.54 and $ 286.65 respectively.

Late blight, early blight, bacterial wilt and root knot are the most found in study area. Among them, farmers guessed that the most serious disease is late blight followed by bacterial wilt. The fungicide used was Metalaxyl combined with mancozeb (66%), chlorothalonil accounted for only 13% and dimethomorph was rarely used (1.4%). (Myint 2004) revealed that most growers started fungicide spray before the emergence of late blight symptoms at about hilly upland in rainy crop and just after 100 percent appearance in post monsoon crop. The lowest fungicide applications were arranged on summer crops because the weather conditions are favorable only at later stage of the crop in early monsoon.

Table 5.21 Fungicide cost and fungicide application cost by growing seasons

Item	Growing season	Mean	Std. deviation	T-test
fungicide cost ($/ha)	Summer potato	51.60	15.47	0.000**
	Monsoon potato	447.46	81.48	
Fungicide application cost ($/ha)	Summer potato	195.54	56.39	0.000**
	Monsoon potato	286.65	45.32	

Source: Field survey, 2011.
** = significant at p = 0.01

5.5.5 Pesticide application

The application of pesticide cost per hectare between summer and monsoon potato growers was highest significant of at 99% accounting of mean as $190.65 and $99.13 respectively that is showed in Table 5.17. This point out that summer potato growers used more pesticide than monsoon potato growers. Because summer potato growers had not practiced in rotation pattern, it made the favorable conditions of the pest to host. (Myint 2004) presented that cut worm, 28-spotted beetle and tuber moth are major pests of the study area. Pesticides used was acephate, doza and furadan.

Table 5.22 Pesticide application cost by growing seasons

Item	Growing season	Mean	Std. deviation	T-test
pesticide cost ($/ha)	Summer potato	190.65	59.18	0.000**
	Monsoon potato	99.13	65.39	

Source: Field survey, 2011.
** = significant at p = 0.01

5.5.6 Weeding practices

To successful production, weeds should be prevented to potato fields. Weeds encourage insects and diseases to survive in being host and finally they make to reduce yield (HLA-6028web). In Table (5.18), the average weeding cost is significant difference between two potato growing season at 99% level as $61.75 and $143.00 respectively. Weeding cost of

monsoon potato cultivation is more than summer one due to two factors. First, it grows in rainy season that there is no water stress and second is using FYM that can include weed seeds and be encouraged to grow weeds.

Table 5.23 Weeding cost by growing seasons

Item	Growing season	Mean	Std. deviation	T-test
weeding cost ($/ha)	Summer potato	61.75	20.25	0.000**
	Monsoon potato	143.00	128.29	

Source: Field survey, 2011.
** = significant at p = 0.01

5.5.7 Utilization of seed tuber

The potatoes are generally sown in seed tuber, rarely practiced from direct seed - small tubers or part of tuber grown into a depth of 50 to 100 mm beneath the soil. Seed tuber cost of two potato growing seasons is highly significant amounting as $1512.88 and $ 1298.75 respectively, due to planting spacing. The summer crop is usually cultivated on lowland (le land) and planting practice 24 inches in row spacing and 3 inches in plant spacing according to the tuber sizes. Similarly, quantity of seed tuber determines population of plants in the field. The monsoon crops are always cultivated on upland (hillside) and practice 30 inches in row spacing and 3 inches in plant spacing according to tuber sizes. Therefore, lowland potato growers used larger quantity of seeds (tubers-700viss/ac - 2.88tons/ha) compared to those of upland one (tubers-600viss/ac - 2.47tons/ha). In fact, planting density is different between summer and monsoon crops.

Table 5.24 Seed (tuber) cost by growing seasons

Item	Growing season	Mean	T-test
Seed cost ($/ha)	Summer potato	1512.88	0.000**
	Monsoon potato	1298.75	

Source: Field survey, 2011.
** = significant at p = 0.01

5.5.8 Variety grown

Over half of the respondents are grown Up-to-date variety at 54.1% and the rest of them are grown Kufri Jyoti variety. Up-to-date variety is not resistant to late blight. In fact, resistant varieties such as CIP- 720088 and Kufri Jyoti were available in this region. However, farmers were not widely taken in the market due to frying quality. Moreover, there was tuber rot case during storage since these varieties are apparently susceptible to early blight. Therefore, (Myint 2004) wrote that 93% of the study area use Up-to-date variety. According to the survey result, using of two varieties were same quantity in about 50%.

Table 5.25 Distribution of potato variety used in study area

Variety	Kalaw Township	
	N	%
Up-to-date	40	54.1
Kufri Jyoti	34	45.9
Total	74	100

Source: Field survey, 2011.

5.5.9 Seed tuber flow

Among the three methods of potato cultivation, tuber to tuber method was used in the study area. Most of the potato growers in the study area practiced to use their own seed tuber. Pre monsoon potato was used as seed tuber by pre monsoon potato in last year, post monsoon potato was used by pre monsoon potato and summer potato was used by post monsoon potato.

Table 5.26 Seed tuber flow in the study area.

Growing season	Sowing time	Harvesting time	Seed tuber for season
Pre monsoon	March-April	August-September	summer
Post monsoon	July-August	November-December	Pre monsoon
Summer	Janrary-February	April-May	Post monsoon

Source: Field surver, 2011.

5.6 Cropping systems

Cropping system is a crop management practices by farmers. Double cropping system is common system of the lowland and upland in the study area. Lowland farmers are usually grown potato after lowland rice as double cropping system. Upland farmer practices that in first year, they grow potato and niger/canola as double cropping and in second year they grow upland rice as monocrop.

Table 5.27 Cropping system of the study area

Cropping system	Farmer participation			
	Upland		lowland	
	N	%	N	%
Double cropping	0	0	36	100
Mono + Double cropping	30	79	0	0
Mono + Intercropping	8	21	0	0
total	38	100	0	100

Source: Field survey, 2011.

5.6.1 Cropping patterns

There were six existing cropping pattern in crop year 2010-1011. The table 5.22 shows that the farmer practiced of cropping system in accounting for potato-canola (60.52 percent), potato-niger (7.89 percent), potato-groundnut (13.15 percent), potato-fallow(39.47 percent) and upland rice-fallow(73.68 percent) in the upland area. In the lowland area in the study area, lowland rice-potato is the major cropping pattern. Farmers in the upland area are mainly grown upland rice for their staple food. Therefore, upland farmers practiced that

paddy had grown on half of their owned area and potato-canola/niger had grown in the rest one as cash crop.

Table 5.28 Distribution of existing cropping pattern of the study area

Cropping pattern	Farmer practices			
	Upland		lowland	
	N	%	N	%
Potato-Canola	23	60.52	-	0
Potato-Niger	3	7.89	-	0
Potato-Groundnut	5	13.15	-	0
Potato-fallow	15	39.47	-	0
Upland rice-fallow	28	73.68	-	0
Lowland Rice-Potato	-	-	36	100

Source: Field survey, 2011.

5.7 Chapter summary

The majority of the all respondents were males. There were three ethnic groups such as Pao, Danu and Burma in the study area. Pao is a predominant group of the Myaechar and Burma is a majority of the Heho'. The respondents were the 41-60 years group in Heho' and the two groups (20-40, 41-60 years) in Myaechar. The education level of respondents was primary school in superiority. The average farming experience of respondents was about 28 years. The average number of family members in both areas was 4 to 6. Among the family members, the average numbers of contributed farming was 1 to 3. The average land holding size was 1.6 ha in upland area. The respondents practiced to tillage were by bullocks although the some lowland areas were by tractors. Therefore, their livestock ownership was mostly cow for bullock cart and tillage. The household gross income was mainly from gross mainly farm income. Off farm income contributed a little percent.

Crop management practices of respondents were different between the upland and lowland cultivation. The cost of land preparation, fertilizer applications, pesticides and seed were greater amount in lowland than in upland area. In contrast, the cost of FYM, fungicides, weeding and labors were more in upland. As land preparation, most of the summer potato farmer practiced that tillage was by tractor while upland farmer practiced tillage by bullock or buffalo. The farmer survey indicated that fertilizer used of lowland potato was more than in upland because potato was grown every year in lowland as summer crop. In contrast, farmyard manure used of lowland potato was less than in upland because upland farmers tend to two years rotation. Beside, cost of fungicide and labor cost of fungicide application in rainy crop were more than in summer crop due to weather conditions were ideal for late blight developed.

In addition, double cropping system is a common system, potato-canola in upland and rice-potato in lowland were the predominant cropping patterns.

Chapter 6
Productivity and profitability of potato-based cropping pattern in the study area

Profitability is a measure of proficiency of the economic or operation in using its resources to produce profit or net farm income (Edwards *et al*. 1999). Therefore, this chapter analyzes profitability of potato-base cropping systems, guideline used for the examination are crop productivity as returned by harvesting per unit area and benefit like net farm income.

Cost and returns analyses were calculated to determine the profitability of existing crops and cropping patterns within study area. In the analysis, benefit-cost ratio (BCR) was also computed. This indicated how much the gross returns from a given crop or cropping patterns by investing 1 $ in growing that crop and investing in a crop enterprise or cropping pattern with BCR of greater than one is profitable (Than 2002). The other profitability measures were net farm income ratio that indicate financial efficiency of production (Muangkaew 2006).

In the calculation of labor cost of all crop cultivation, labour costs included both family members in contribution of farm and hired labour from other. Because family labour was calculated as opportunity cost (Kyi 2005). Transportation cost referred that charges carried the farm product from farm to home as marketing cost because almost potato farmers sold their products in their home. Farm gate price for rainy season potato fluctuate with the demand, therefore, average farm gate price of a year was caught for the computation of financial returns.

6.1 Cost and return of selected crops per hectare in study area

Based on the field survey, profit margin returns for the selected crops that is most popular crops in the study area are including by production costs, produced per hectare and bargain price. The cost and returns of selected crops per hectare in study area is showed in Table 6.1.

Table 6.1 Cost and returns of selected crops per ha in study area

Crop	Yield ton/ha	Price $/ton	Gross income	Total variable cost $	Gross margin $
Lowland rice	2.94	359.45	1056.78	964.84	91.94
Upland rice	1.64	299.54	491.25	274.79	216.46
Summer potato	18.52	382.74	7090.28	3667.15	3423.13
Pre monsoon potato	16.29	382.74	6325.94	3182.53	3143.41
Post monsoon potato	15.73	382.74	6020.63	3865.82	2154.81
Groundnut	0.97	1102.30	1069.23	682.85	386.38
Niger	0.35	918.58	321.50	149.74	171.76
Canola	0.35	918.58	321.50	183.71	137.79
Maize	3.08	191.37	589.42	412.18	177.24
Pigeon pea	1.15	597.08	686.64	458.49	228.15
Lentil	0.71	765.49	543.50	314.93	228.57

Source: Field survey, 2011.

As exposed in Table 6.1, gross margins of potatoes are the highest compared to rice, groundnut, niger, canola, maize, pigeon pea and lentil. Moreover, total variable costs of potatoes are the highest compared with other crops due to seed cost, fertilizer cost, pesticide cost and labor cost. Nevertheless, potato gives highest net profit among those important crops. The figure is shown to be seen clearly in cost and returns of different crops with bar chart.

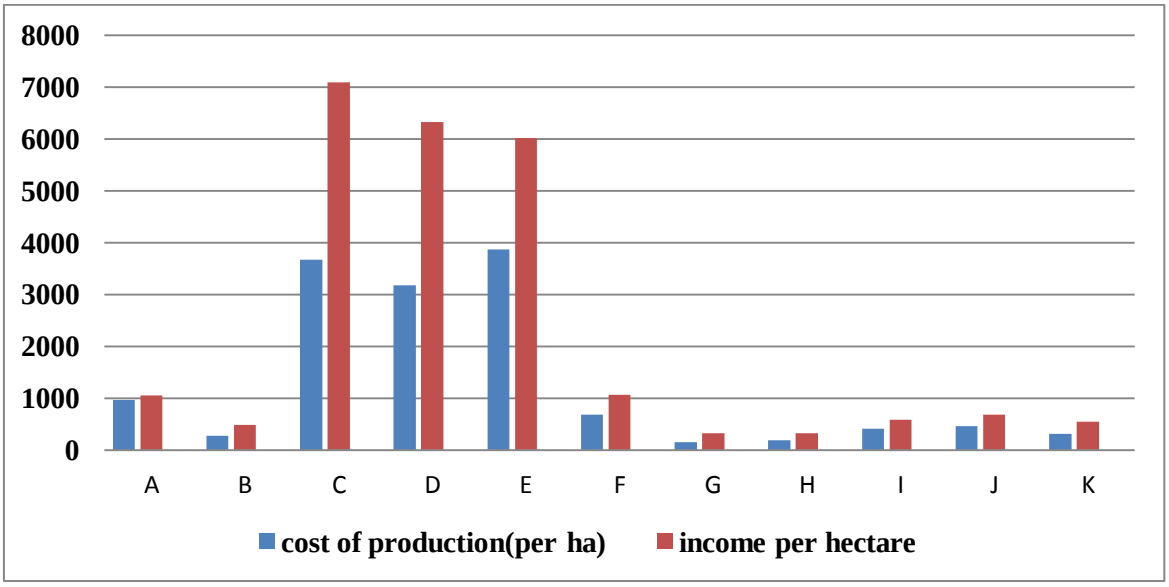


Figure 6.1 Comparison of cost and income of different crops in the study area

A = Lowland rice D = pre monsoon potato G = Niger J = pigeon pea
B = Upland rice E = post monsoon potato H = canola K = Lentil
C = Summer potato F = Groundnut I = Maize

6.2 Gross return, total variable and gross margin per hectare of potato production by different growing seasons

Net farm income is generally indicated for profitability measurement. There is considered by difference between total variable costs and actual gross farm income.

Results of the cost and returns analysis of potato cultivation in three growing seasons based on per hectare showed the table 6.1. In the table, the summer season potato is found to be most profitable as evident from its positive net profit $3423.13, pre-monsoon potato is the second most profitable crop of $3143.41 and post monsoon potato is the lowest profitable crop in $2154.81. In benefit cost ratio and net farm income ratio, the pre monsoon potato is 1.99 and 49.69 at largest, the summer potato is 1.93 and 48.28 and the post potato is 1.56 and 35.79 at lowest. Summer potato was the highest profit but BC ratio and net farm income ratio were less than pre monsoon potato. Because summer potato was more production cost than in pre monsoon. Post monsoon potato was the lowest in all measurements because it was also the highest production cost especially in pesticides application cost as labor cost and pesticides cost in all of them.

Table 6.2 Gross returns, total variable costs, gross margin (net farm income) per hectare of potato production by growing seasons.

Item (Unit=$/ha)	Pre monsoon potato	Post monsoon potato	Summer potato
1.Gross income	6325.94	6020.63	7090.28
2. Total variable costs	3182.53	3865.82	3667.15
Seed	1296.75	1296.75	1512.88
FYM	210.44	275.67	198.56
Fertilizer	261.63	370.94	503.88
Pesticides	534.01	563.87	246.68
Water fee	-	-	6.18
Labor	589.39	957.13	657.05
Land preparation	145.11	256.26	293.31
Interest of loan	46.40	46.40	211.56
Transportation cost	98.80	98.80	37.05
3. Gross margin(net farm income)	3143.41	2154.81	3423.13
4. Benefit : cost (1/2)	1.99	1.56	1.93
5. Net farm income ratio(3/1x100)	49.69	35.79	48.28

Source: Field survey, 2011.

6.3 Gross return, total variable costs, gross margin (net farm income) per hectare of potato-based cropping patterns in one year

The main cropping patterns of the study area are based on potato such as potato-canola, potato-niger, potato-groundnut and only potato on hillside area. In the lowland Heho' velley, rice-potato cropping pattern is common. This all cropping patterns are in one year rotation pattern. Results of the study exposed that lowland rice-summer potato pattern was the highest net farm income ($3519. 24/ha) and pre monsoon potato-canola/niger/groundnut patterns are $3280.01, $ 3311.22 and $3526.29 respectively.

Post monsoon potato pattern was the lowest net farm income at $2189.61. Although the lowland rice- summer potato was the highest net farm income in all cropping pattern, pre monsoon potato- canola/ niger were the highest in benefit cost ratio and net farm income ratio. Potato-groundnut pattern was the highest net farm income in three potato I based patterns whereas it was the lowest in other profitability measures. Among all potato-based cropping pattern in study area, post monsoon potato (potato II)-fallow was the lowest in all profitability measures. The result of costs and returns of cropping pattern are presented in table (6.3).

Table 6.3 Gross income, total variable costs and gross margin of the potato-based cropping patterns per hectare

items unit=$/ha	potatoI-canola	potatoI-niger	potatoI-groundnut	potatoII-fallow	potatoIII-rice(L)	rice(up:) fallow
1.Gross income	6646.24	6643.49	7391.69	6020.63	8151.23	491.25
2.Total variable cost	3366.23	3332.27	3865.4	3831.02	4631.99	302.58
seed	1324.54	1321.45	1389.38	1296.75	1562.28	37.05
FYM	210.44	210.44	313.36	275.67	368.37	77.19
fertilizer	261.63	261.63	364.55	370.94	653.62	35.51
pesticides	534.01	534.01	534.01	563.87	308.43	0.00
water fee	-	-	-	-	6.18	-
labor	689.73	658.86	871.9	957.13	1030.64	87.99
land preparation	191.42	191.42	234.65	256.26	392.11	55.58
interest of loan	46.40	46.4	46.4	46.40	211.56	-
transportation cost	108.06	108.06	111.15	98.80	98.80	9.26
3.Net farm income	3280.01	3311.22	3526.29	2189.61	3519.24	188.67
4.Benefit:cost (1/2)	1.97	1.99	1.91	1.57	1.76	1.62
5.Net farm income ratio (3/1x100)	49.35	49.84	47.71	36.37	43.17	38.41

Source: Field survey, 2011.

1) Potato I = pre monsoon potato
2) Potato II = post monsoon potato
3) Potato III = summer potato
4) Rice(L) = lowland rice
5) Rice(up) = upland rice

6.4 Cost and return of potato-based cropping pattern per hectare for two years rotation.

The two years rotation is practiced on marginal upland soil under rain-fed condition. In first year, it is normally grown in March or April and harvested in July or August. Due to its high nutrient required, it is sowed as a first crop after the fallow period. After potato, the canola or niger is sown without fertilizer addition during July-August and harvested in November-December. Upland farmers grow upland rice in June-July and harvest in October-November. Therefore, they practice to grow potato-canola/niger/ groundnut in one year and upland rice as next year crop. This two years rotation is commonly practiced for upland farmers. Results of the study had shown that summer potato-lowland rice cropping pattern is the most profitable pattern in two years pattern.

Lowland cultivated areas between hill-slopes are mostly peaty soil. Therefore, farmers can grow potato-rice every year in successful. Due to this fact, potato-rice cropping pattern is the most profitable pattern of $7038.48/ha in calculating two years. Whereas the upland area practiced potato-canola/niger/groundnut and upland rice pattern in two years rotation to avoid the pest and disease circulation and to fulfill the household use for daily food demand. Among the two years rotation patterns in upland area, potato-groundnut and upland rice is the most profitable pattern of $3714.96/ha. The rest two pattern in potato with canola/niger and upland rice are profit of $ 3468.68 and $3499.89 per ha respectively.

Table 6.4 Gross income, total variable cost and net farm income of cropping pattern in two years rotation

item (unit= $/ha)	I	II	III	IV	V
1.Gross income	7137.49	7134.74	7882.94	7000.77	16302.46
2. Total variable cost	3668.81	3634.85	4167.98	4495.61	9263.98
seed	1361.59	1358.5	1426.43	1313.74	3124.56
FYM	287.63	287.63	390.55	352.86	736.74
fertilizer	297.14	297.14	400.06	529.95	1307.24
pesticides	534.01	534.01	534.01	563.87	616.86
water fee					12.36
labor	777.72	746.85	959.89	1215.71	2061.28
land preparation	247	247	290.23	390.57	784.22
interest of loan	46.4	46.4	46.4	46.40	423.12
transportation cost	117.32	117.32	120.41	117.33	197.6
3.Gross margin	3468.68	3499.89	3714.96	2505.17	7038.48
4. benefit:cost(1/2)	1.95	1.96	1.89	1.56	1.76
5.net farm income ratio(3/1*100)	48.60	49.05	47.13	35.78	43.17

Source: Field Survey, 2011

I. Pre monsoon potato-canola/upland rice
II. Pre monsoon potato-niger/upland rice
III. Pre monsoon potato-groundnut/upland rice
IV. Post monsoon potato/maize-pigeon pea
V. Summer potato-lowland rice/summer potato-lowland rice

6.5 Crop productivity condition within five years

According to the field survey, 80.6% of Heho potato growers believed which their productivity of crop conditions were stable inside five years ago. That is 65% of Myaechar potato growers. About 11.1% Heho potato growers and 21%of Myaechar potato growers, respectively, defined that it to be remained the same interval five years ago. Only 8.3% of Heho potato growers and 13.2% of Myaechar potato growers confronted decreasing crop productivity (Table 6.5).

Table 6.5 Crop productivity condition within five years

Crop production within five years	Heho		Myaechar	
	N	%	N	%
Stable	29	80.6	25	65.8
Increasing	3	8.3	5	13.2
Decreasing	4	11.1	8	21.0
Total	36	100	38	100

Source: Field survey, 2011.

6.6 Chapter summary

Cost and returns analyses were conducted to determine the profitability of existing crops and cropping patterns including two years rotation pattern. Net farm income per hectare from potato production is highest in summer potato at 3423.13 $. Compared between pre monsoon and post monsoon potato, pre monsoon potato is higher at 3143.41$ than post monsoon one at 2154.81$. Because fungicide was applied most frequently on post monsoon crops of which climatic conditions were ideal for late blight developed (Myint 2004). Post monsoon potato was non-seasonal crop and must use seed tuber for summer and pre monsoon potato. In facts, demand of this potato was raised.

Therefore, farmers had grown this season potato although production cost was higher than in other two. In six cropping pattern, potato-lowland rice was the highest profitability among six cropping patterns. Among the upland cropping pattern, potato-groundnut was highest net income. However, most of the respondents have used the groundnut for household use in edible oil. Upland rice-fallow was the lowest profitability pattern in the study area, nevertheless respondents still continue to cultivate their land apparently because rice is a source of staple food. Canola and niger were easy to planted that only broadcasting in seed and sometimes zero tillage after harvesting of potato. Therefore, potato-canola/ niger were the profitability crops as cash crops and potato-canola was the most cultivated cropping pattern in upland area.

Chapter 7
Constraints of potato production in the study area

The constraints of potato production and marketing in the study area were identified accounting the percentage and frequency from multiple responses to analyse the level of farmers' opinion in constraints of their potato production.

According to the farmers' survey designated that the major problem in potato production and marketing was the low price of the product in the study area. Due to this fact, the farmers, especially upland farmer, were not able to recover the cost incurred on potato cultivation. Other constrains in an ascending orders were high input price, inadequate fund, non available quality seed, disease attack, pest attack and limit of technology that show table(7.1) and figure(7.1). Ahmad et al. 2005) pointed out almost the same constraints in potato cultivation.

Table 7.1 Production and marketing constraints of potato cultivation

constraints	Multiple response		Percent of cases
	N	percentage	
High input price	60	19.5	81.1
Inadequate fund	51	16.6	68.9
Non available quality seed	41	13.4	55.4
Pest attack	16	5.2	21.6
Disease attack	29	9.4	39.2
Low price of product	65	21.2	87.8
Limit of technology	9	2.9	12.2

Source: Field survey, 2011.

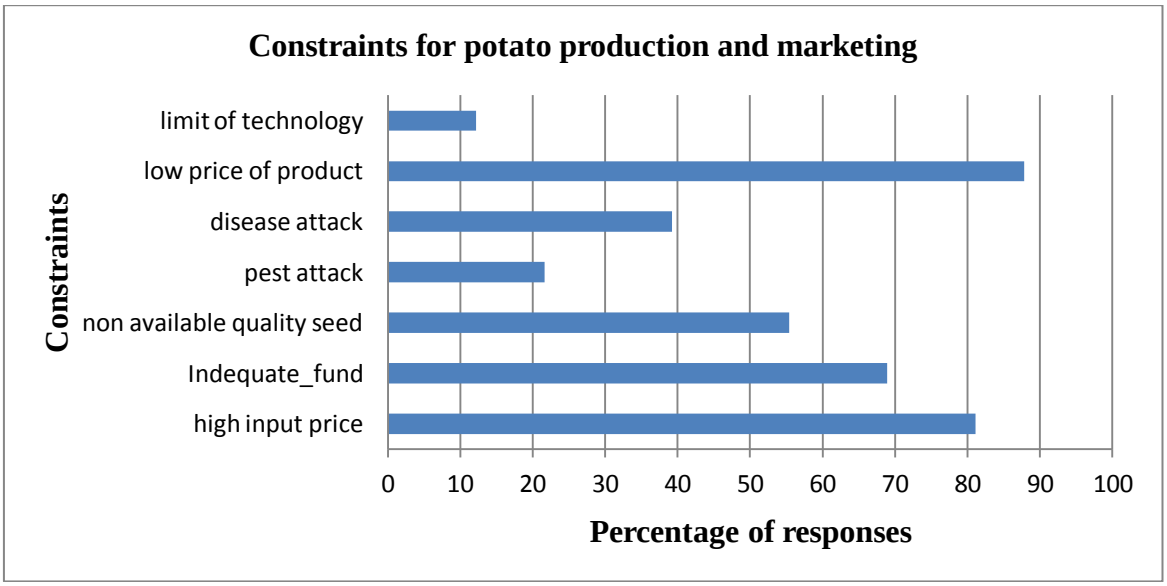


Figure 7.1 Production and marketing constraints of potato cultivation

7.1 Low price of product

According to the survey signified, about 87.8% of all respondents assumed that the major problem of potato production is the low price of commodity. The most potato cultivated areas in the study area are the upland soil at the slopping hill land and farmers can grow crops including potato in only rain-fed condition. On the other hand, potato production in the study area is very seasonal since about 83% (annual report,2011- Kalaw,MAS) of their production is harvested between July and August. Therefore, those farmers face low marketing price in this season crop production (monsoon potato). Due to this fact, farmers were not able to pick up the cost incurred on potato cultivation. (Yiwang 2004) identified most of the potato production in developing countries are seasonal production, easy to destroy due to fresh produce and high cost storage condition, market price instability are the major factor of the unpredictability to low price observed.

7.2 High input price

To successful potato production, farmers used the large amount of agro-input such as seed tuber, farmyard manure, fertilizer, fungicides and pesticides. (Yiwang 2004) reported that provides to farmers in agriculture, developed countries are a common practice but developing countries are little observed. Similarly, in Myanmar, allocation of agricultural inputs were radically examined mostly by Myanma Agriculture service is being carelessly alternated to the private sector, at the same time, supports on agricultural inputs are being discarded (Kyi 2004). Therefore, potato growers purchased their agricultural inputs in the market price from the private companies and then farmers gave some interest rate for a given period in some private sector. So that high input price is another considerable constraint of their potato production.

7.3 Inadequate fund

Potato cultivation is an input intensive farming practice generally requiring more funds to raise a successful. However, small and medium farmers lack need funds and have not enough financial resources to grow potato efficiently. The government accords in loans to the farmers depend on the crop variety through Myanmar Agricultural Development Bank. Although using this approach, this amount of loans cannot recover to farmers' production cost. Moreover, this loan can be obtained especially for rice growers. Therefore, potato growers find the production cost in loans from other afforded farmers or merchant at various interest rates. Due to this fact, farmers need more funds for their production per unit area.

In the study area, potato growers in lowland as summer potato growers cannot grow it all their own land because they cannot afford for huge inputs to production. The following table presented the source of credit of respondents. Only 20% of the respondents of Heho' village had got loan from government according to the rice lowland cultivated area. 44.4% and 39.5% of the respondents of two villages borrowed from others farmers or merchant with different interest rate arranging from 7% up to 15% per given time. The rest respondents were from the NGO. In Myaechar, over 52% of respondents had not received for their production.

Table 7.2 Source of credit and loan status of respondents

Source of credit	Heho'		Myarchar	
	frequency	percentage	frequency	percentage
Not received	5	13.9	20	52.6
GO	7	19.4	0	0
NGO	7	19.4	3	7.9
Both GO and NGO	1	2.8	0	0
Others(farmer)	16	44.4	15	39.5
	36	100	38	100

Source: Field survey, 2011.

7.4 Non available of good quality seed

Non-available of good quality seed was the next decisive problem in the study area. This constraint forced the potato-growing farmers to use their own seed tuber. However, farmers owned seed tuber was not in such a condition to give higher yield because of poor storage facilities. (Singh 2008) wrote that keeping seed tuber for sowing in a long period is identified in main point for inhibiting potato production throughout the world and seed production in vegetatively propagated crops like potato is beset with problems of low seed multiplication rate(1.6 per generation), a low proportion of seed-sized tubers in the produce, high production cost, and high rate of degeneration.

In the study area, all potato growers have used their own seed tuber or from other farmers seed tubers and there is no practice for the production of seed potato. Moreover, Up-to-date variety, they had used since 1915 was high infected level of seed and soil born disease (Myo 2007). In addition, it is also susceptible to late blight disease. CIP-24(CIP-720088) and Kufri Jyoti were introduced from Bhutan in 1992 as late blight resistant cultivars and grown in some areas. However, those varieties are not farmers' incentive due to severe tuber rotting during storage and poor fried quality. Otherwise, those varieties had no demand in marketing. (Myo 2007) reported that there is no seed production organization, particularly for Myanmar farmers to utilize TPS. For these reasons, lack of available quality seed is one of the constraints to successful potato production.

7.5 Disease and pest attack

Late blight, Early blight, Bacterial wilt and nematode root knot diseases are found in the study area. Among them, Potato late blight disease is the most crucial constraint to potato production in Myanmar (anon 1990). In addition, (Myint 1992) found that about 23.1% to 38.3% of yield loses in the Kalaw Township due to this disease affected. In the study area, potato is planted the whole year round due to the geographical location and the climatic condition. Therefore, the high incidence and severity of potato late blight occurs at all stages of development can be found year-round. Most of the growers applied fungicides to get the predictable yield in various rates and times as the growing seasons about every 5 or 7 days to keep their crops (Yi wang 2004). In fact, it can be raised up input cost and also decreased profit of their production. Besides, disease attack cause yield decline until not recover the production cost according to the rainfall. Although pest attack is not serious compare with disease attack, tuber moth, cut worm and 28-spotted beetle that make severe destruction of potato plant and yield. In fact, disease and pest attack are the constraints of the successful potato production.

7.6 Limit of technology

In the table 7.1, 94% of respondents in Heho have in training experience whereas only 5% of respondents in Myaechar. Because Myaechar village is located about 7 miles in distance from the office and the hill slide area. It is difficult to travel in rainy season for extension worker and other supporters. Moreover, existing training program is mostly related to rice cultivation practices as a staple food. In fact, no attention of pest and disease control program as good agriculture practices for potato production. In addition, most of the extension workers are non productive and in valuable due to the low salary and less of reactivated in technologies. Besides, education level of most farmers was weak to apply the advanced technologies and non incentive the improvement practices.

Table 7.3 Training experience of the respondents

Training experience	Heho		Myaechar	
	N	%	N	%
Yes	34	94	2	5
No	2	6	36	95
Total	36	100	38	100

Source: Field survey, 2011.

7.7 Chapter summary

To successful potato production need to confront and solve the many constraints. This study found that the constraints of potato production and marketing. There were low price of produce, high input price, inadequate fund, non available good quality seed, pest and disease attack and limit of technology. Low price of produce was the most important constraint because 83% of their potato production was produced in rainy season on upland hillside area as seasonal production. High input price and inadequate fund were second and third relative constraints. Non-available of good quality seed was the next decisive constraint. It drove the potato-growers to apply their seed tubers that are low quality due to degeneration. The other considerable constraints were pest and disease attack and limit of technology. The pest and disease attack cause the high input cost and reducing yield per unit area, so that profitability of production is decreased.

Chapter 8
Conclusions and Recommendations

This chapter comprises the conclusion and recommendation according to the identiying of the previous chapters.

8.1 Conclusions

Firstly, this study revealed the socio-economic conditions of the respondents on potato-based cropping system. There were two villages: one was Heho' which had lowland and upland cultivated area and the two was Myaechar which had only upland area. The majority of respondents in two villages were male. In ethnic groups, nearly half of farmers in Heho' were Burma and the whole farmers in Myaechar were Pao. The education level of respondents was primary school in superiority. The high proportion of respondents' age was 41-60 years old. The average numbers of family members was 4-6 and contributed family members was 1-3 in both areas. The average land holding size was 1.6 hectares in upland area of two villages and 1.5 hectares in lowland area of Heho'. The livestock ownership was mostly cow for bullock cart and tillage. All families depend on the farm income about 97% and a little percent of family members who work off-farm for additional income.

This study identified the crop management practices based on the different growing seasons of potato. The study found that the cost of land preparation, fertilizer applications, pesticides and seed tubers were greater amount in use of summer potato than in monsoon potato. In contrast, the cost of FYM, fungicides, weeding and labors were more in monsoon than in summer. Especially, fungicides and fungicide application cost in upland field were more than in lowland due to weather condition. Furthermore, potato growers had not practiced in seed potato production. Most farmers practiced double cropping system in a year. In some upland areas, mono cropping and intercropping system were generally practiced. Besides, mostly cultivated potato-based cropping system in upland area fallowed a two years rotation. There were six predominant cropping patterns in the study area. They are potato-canola, potato-niger, potato-groundnut, potato-fallow, upland rice-fallow in upland and lowland rice-potato in lowland.

The profitability comparison among the existing selected crops in the study area, all potato crops exhibited the highest profit per hectares. Results of the cost and return analysis by the potato growing season showed that summer potato per hectare was the highest gross margin and post monsoon potato was the lowest gross margin. Besides, the production cost of post monsoon potato was the highest due to climatic conditions in the growing season.

In addition, the profitability comparison among cropping patterns in the study area, lowland rice-potato (summer) exhibited the highest profit per hectare in the lowland. Potato-groundnut was the most profitable cropping pattern in upland area. However, the most cultivated pattern was potato-canola and then potato-niger. Farmers were grown groundnut for household use in eatable oil. Upland rice-fallow was the least profitable in all patterns whereas farmers were more grown this pattern than other because rice is their staple food. Similarly, post monsoon potato was second least profitable crop and farmers were grown this group to use seed tuber for pre monsoon potato.

This study pointed that the production and marketing constraints of the potato production in the ascending orders were 1) low price of products (seasonal production) 2) high input

price 3) inadequate fund 4) non available good quality seed, 5) disease and pest attack and (6) limit of technology.

The research concluded that potato is second crop most important food and cash crop after rice in Kalaw Township. Cultivation of potato crop was a costly farming practice with sufficient income if the reasonable price of the produce is conquering in the market. Nevertheless, the potato-based cropping system of the study area can provide about 97% of household income.

8.2 Recommendations

On the basis of the findings, following recommendations are made for increasing the yield and income of the potato growers.

- The potato growers were not able to recover the cost incurred on potato cultivation in every year due to low price in seasonal productivity. Therefore, it is required to make destinations for potato production according to demand for this region. These destinations should be accomplished by Myanma Agriculture Service.

- The varieties which are Up-to-date and Kufri jyoti introduced in more than 20 years occupied almost all of the potato growing areas in study area. It is subjected to degeneration. Therefore, the use of high-yielding varieties (HYV) of potato with resistant to late blight by farmers should be encouraged by putting up demonstration farms and by making the HYV potato readily available to farmers. Moreover, seed suppliers such as seed division of MAS, private company provide training on benefits and use of commercial new seed varieties.

- Potato cultivation is an input intensive farming practice commonly requiring more funds to raise a successful crop. However, farmers lack needed funds and have not sufficient financial resources to grow potato efficiently. The government should provide credit support to potato growers and private sectors should be given drives to support loans to the potato growers on easy terms and conditions.

8.3 Recommendations for further study

As this research established in the hilly region should be studied the deterioration of soil fertility and relatively crop productivity conditions from year to year. Potato production applied large amount of fungicides and pesticides to get predictable yield so that the sustainability of productivity and environment of potato production system should be studied.

The effective fertilizer and fungicide application practices should be studied in experimental research by the government sector. Moreover, the experiment of high yielded seed tuber storage capacity and true potato seed production should be done.

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Appendix-1

Questionnaire survey on "Assessment of potato-based cropping system in Southern Shan State of Myanmar"

Date ----------

I. General information

1. Name of farmer ----------
2. Ethnic group Pao/Shan/Danu/Palaung/Burma/other
3. Age ----------
4. Gender Male/female
5. Education just literary/ Monastery/ Primary/ Middle/ High/ graduated
6. Farming experience----------
7. About family member

No.	age	Male/female	relationship	education	employment	Participating in farm

II. Farm information

8. How many total cultivated areas do you have? (Owned/Rented)

no	Area(ac)	Type of land	Owner ship status					Distance from home
			Owned	Rented in	Rented out	Mortgaged in	Mortgaged out	

Note; Column (3) – homestead/ low land/ upland/forest land/ pasture land/fallow land/ orchard/ other

9. what kinds and how many of livestock do you have?

No.	Type of livestock	Number	Income/year	Estimated amount of Manure/year
	Buffalo			
	Cow			
	Pig			
	Poultry			
	other			

10. No. of cropping season per one year

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11. Sowing and harvesting time of crop grown

No.	Crop name	Months of year												Type of land
		J	F	M	A	M	J	JL	Au	S	O	N	D	

12. What are the perennial crops in your farm?

Crop grown	Grown area (ac)	number	Crop yield/yr	Income/yr (kyat)	Purpose of sowing
Banana					
Avocado					
Mango					
Pineapple					
Jackfruit					
others					

13.What are the source of water for your farm?

- Raifed

- Irrigation type (dams/village pond/well /other) and available period

III. Farming activities

14. land preparation and sowing

Operation	No.of person	No of day	Labour			Wage (kyat)	Food expend	Date of start
			FL	HL	EL			
Plowing Tractor/ buffalo/cow								
harrowing Tractor/ buffalo/cow								
planting Tractor/ buffalo/cow								

FL= family labor HL=hired labor El= exchange labor

15. Seed tuber and seed rate

No.	crop	variety		Quantity (kg or viss)/ac	Cost (kyat/kg or viss)/ac	Remark
		Local/HYV	Tuber/seed			
1						
2						
3						

16. Fertilizer application

Kind of fertilizer	Frequency of application	Time of application	Amount (kg/ac)	Method of application	Fertilizer cost (kyat)/ac	Labor cost/ac
Organic						
Manure						
Green manure						
Compost						
Inorganic						
Urea						
T super						
Potash						
compound						

Method of application = broadcasting, plowing, mulching and etc…

17. Pesticide application

crop	Name of pesticide	Frequency of application	Time of application	Amount (kg/ac) or li/ac	Method of application	Pesticide cost (kyat)/ac	Labor cost/ac

18. Herbicide application

crop	Name of herbicide	Frequency of application	Time of application	Amount (kg/ac) or li/ac	Method of application	herbicide cost (kyat)/ac	Labor cost/ac

19. Have there been vigorously affected of pest and disease problems?

Crop grown	Pest/disease/ insect	Infected year	frequency	remark

20. Weeding practices

crop	Day per sowing	Labor (FL/HL/EL)	Time of operation			Total man	Wage (kyat/day)	Total wages(kyat)
			1st	2st	3st			

21. Harvesting

Harvest portion	operation	No.of person	No. of day	Kind of labor			Wage (kyat/day)	total	Time of harvest
				FL	HL	EL			
	harvesting								
	Threshing								
	sorting								
	drying								
	Storing								

22. Allocation of sown crop and system in the village

Crop grown	Area(ac)	Yield gain(basket)		Total production(basket)			
		This year	Previous year	Home consumption (viss/basket)	Harvest share	Sale amount (basket)	Maintain as seed (viss/basket)

23. Farm implements

Farm equipment	ownership		remark
	Yes	No	
Harrow			
Plough			
Tractor			
Bullock cart			
Trolley			
Truck			
other			

24. what kinds and how many of livestock do you keep?

No.	Type of livestock	Number	Income/year	Estimated amount of Manure/year
	Buffalo			
	Cow			
	Pig			
	Poultry			
	other			

25. Production cost, yield ad return of the all crop in total field.

Sr.no	item	Crop-1	Crop-2	Crop-3
1	Land preparation costs			
2	Seed/seedling/ tuber			
3	Planting (ploughing and harrowing) cost			
4	Fertilizercost			
5	Labor costvof fertilizer application			
6	Pesticide cost			
7	Labor cost for pesticide application			
8	Weeding cost			
10	Harvesting cost			
11	Post harvesting cost			
12	Total cost			
13	Yield			
14	revenue			

26. cost-return structure of crops

Crop planted	Unit	Yield/ac (viss/basket)	Marketing price	Gross returns	Total production cost (kyat)	Gross profit

27. Household income from non-farm/off-farm activities

Kind of work, where, duration and amount of earned.

28. Do you have loans/ financial support?

Attention	Amount (kyat)	Interest rate (kyat)	Period of loans		Organization (GO, NGOs, other)
			borrowed	payment	

29. Do you any training experience?

Type of training			Supporting institution		Training experience	Response on support		
Fores try	Agri culture	enviro nment	GO	NGO		Satisfact-ory	fair	Unsatisfac - tory

30. Transportation accessibility to central market and farm

vehicle				Distance miles	Time taken(hr)	Response on convenience		
bus	truck	Cart	others			suitable	fair	unsuitable

V. The constraints on existing cropping system

32. Do you think that the current cropping system will sustain the production?

33. Has crop production changed within the last five years?

( ) stable ( ) increasing ( ) decreasing. Why is it?

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34. How do you think the current crop producton systems and management practiced in farm.

If good, why ----------

If bad, why ----------

35. Do you face following constriants in the potato-based cropping system?

(a) inadequate fund
(b) non-availability of good quality seed(c) high input price
(d) low input product
(e) limit of technology
(f) disease attack
(d) pest attack

Appendix-2

Table. costs and returns of selected crops per ha in study area

items	pre-monsoon	post-monsoon	summer	lowland	upland	canola	niger	groundnut	maize	pigeon	lentil
unit=$/ha	potato	potato	potato	rice	rice					pea	
1.Gross income	6325.94	6020.63	7090.28	1060.95	491.25	320.3	317.6	1065.75	589.43	685.425	540.31
2. Total variable cost	3182.53	3865.82	3667.15	964.84	302.58	183.7	149.7	682.87	412.19	458.49	314.93
seed	1296.75	1296.75	1512.88	49.40	37.05	27.79	24.7	92.63	18.53	7.72	49.4
FYM	210.44	275.67	198.56	169.81	77.19	-	-	102.92	-	77.19	-
fertilizer	261.63	370.94	503.88	149.74	35.51	-	-	102.92	71.01	123.5	37.05
pesticides	534.01	563.87	246.68	61.75	0.00	-	-	-	-	-	-
water fee	-	-	6.18	-	-	-	-	-	-	-	-
labor	589.39	957.13	657.05	373.59	87.99	100.34	69.47	282.51	202.23	157.46	154.38
land preparation	145.11	256.26	293.31	98.80	55.58	46.31	46.31	89.54	101.89	83.36	64.84
interest of loan	46.40	46.40	211.56	-	-	-	-	-	-	-	-
transportation cost	98.80	98.80	37.05	61.75	9.26	9.26	9.26	12.35	18.53	9.26	9.26
3.Gross margin	3143.41	2154.81	3423.13	96.11	188.67	136.6	167.8	382.88	177.24	226.935	225.38

Source: Field Survey, 2011.

Table 4.1 Rainy days, quantity of rainfall and Temperature of Kalaw Township by monthly in Ten Years Period (2001-2010)

Month	Rainfall		Temperature	
	days	Quantity(mm)	Maximum (˚C)	Minimum (˚C)
January	-	4.06	26.19	4.25
February	-	11.68	27.86	5.49
March	1	18.03	30.96	10.56
April	4	62.74	32.46	15.17
May	13	202.95	30.65	17.78
June	14	129.54	28.75	19.18
July	15	129.29	27.50	19.09
August	16	150.37	27.30	18.83
September	14	148.08	27.69	18.08
October	11	115.57	27.30	16.97
November	3	37.85	26.61	10.44
December	1	11.94	25.27	6.59
Average	9	85.17	28.21	13.53

Source: Annual report of Myanma Agriculture Service, Kalaw Township, March-2011.