The ‘Pulses, People, Planet and Profit’ (P4) Project

Report: Assessment on DRR/environment (protection)/CSA of mung bean production in Myanmar

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INTRODUCTION

Pulses are important food crops that can play a major role in addressing global food security, nutrition and environmental challenges. In recognition of the contributions that pulses can make to human well-being and to the environment, 2016 was declared as the "International Year of Pulses" by United Nations General Assembly. Traditionally a variety of pulses were cultivated as a small scale production mainly for home consumption. With the introduction of improved varieties of pulses and the "Open market economy" in Myanmar in 1990s, the commercial production of pulses has been taken place. Due to the high export demand and economic return, farmers in Yangon and Magway Regions have been engaging with mung bean (Pae-di-sein, in local language) production for several decades.

1.1 Food security and nutrition:

Pulses are important food crops that can play a major role in addressing global food security. They are inexpensive sources of plant-based proteins, vitamins and minerals for the people worldwide. They have a low fat content, contain zero cholesterol, and are a significant source of dietary fiber. Mung bean is a high source of protein, fiber, antioxidants and phytonutrients. In most parts of the world they are less popular than other bean varieties, like chickpeas or black grams; mung beans have some huge health benefits. They are a high source of nutrients including: manganese, potassium, magnesium, folate, copper, zinc and various B vitamins. Because of their high nutrient density, mung beans are considered useful in defending against several chronic, age-related diseases, including heart disease, cancer, diabetes and obesity. Mung beans produce an edible sprout that's crisp and nutty tasting. Mung bean sprouts are low in calories, have fiber and B vitamins, and deliver a boost of vitamins C and K.

However, Myanmar people in many regions do not recognize or appreciate the value of nutritional diet of pulses, even though they produce them in large amounts and yearly. People in some areas do not have pulses in their traditional cuisine. For example, although mung bean, black gram, chickpea and pigeon pea are largely produced in many regions of Myanmar the locals do not use much for their diet and the produce is targeted mainly for export. Myanmar has recorded to have nutritional problems of malnutrition in its several regions and states, micronutrient deficiencies and diet-related diseases. Pulses are a nutrient-rich food that can help fight malnutrition in both rural and urban areas.

1.2 Climate change adaptation and mitigation potential

In the general cropping systems of Myanmar, particularly in central and lower Myanmar, farmers practice multiple cropping (double crop, rotational crop, mix crop, intercrop, and etc.) including pulses. These systems enhance soil fertility, improve yields, and contribute to a more sustainable production.

Pulses have been recognized as a very low water requirement, and can be grown in very poor soils. They are assumed to be tolerant, to some extent, to climate variability, such as drought and rains. Therefore, farmers usually grow pulses for a climate change adaptation strategy when the weather is not favorable to the cash crops like sesame, peanut and maize.

After the monsoon rice harvest, pulses, like mung bean, black gram, chickpea, are usually cultivated as a second crop with the residual soil moisture. With root nodules for the nitrogen fixing capacity from the air, the pulses improve the soil fertility and structure. Due to increase nitrogen in the soil, farmers can reduce the amount of nitrogen applied to their crops, helping the climate change mitigation potential. Myanmar farmers use pulses as cover crops, residue mulching, composting and crop rotation. All these practices are integral to soil-carbon sequestration, an important climate change mitigation process.

1.3 Pulses production in Myanmar

With the “open market policy” in early 1990s in Myanmar, the pulses businesses were booming for export markets. The sown area of pulses increased to 0.56 million hectares in 1961-62, 0.72 million hectares in 1988-89, and sharply to 4.41 million hectares in 2009-10. Currently, pulses stand as the second most important crop in Myanmar after rice and other cereals, occupying an annual production area of 45, 34,000 hectares in the year 2015. It covered 21 % of total crop sown areas of the country with an annual production of 59,74,363 mt. Pulses are widely cultivated across the country, mainly in Ayeyarwaddy, Magwe, Pegu, Mandalay, Sagaing and Yangon Regions. The major pulses are mung bean, black gram, pigeon pea, chickpea, soybean, butter bean, kidney bean, cowpea, Lab lab bean, Suntani and Suntapya. The large amounts of exportable pulses are mung bean, black gram, pigeon pea, chickpea, soybean and cowpea.

In general, pulses are cultivated in two seasons: (i) monsoon season (May- July), and (ii) post-monsoon season (October-December). Mung bean, pigeon pea and soybean are grown in monsoon season, while black gram, chickpea, cowpea are during post-monsoon season. Mung bean is also grown in post-monsoon season after the rice harvest in lower part of Myanmar.

1.4 P4 Project

ICCO Cooperation and the Da Na Facility, in collaboration with East West Seed and Network Activities Group, have launched a 30-month UK Department for International Development (DFID) - funded project, namely the P4 project, to increase the incomes of 10,000 smallholder mung bean farmers, 20% of whom are landless female farm laborers. The ‘Pulses, People, Planet and Profit’ (P4) project will work with smallholder mung bean farmers and laborers in four Townships in the Yangon and Magway Regions. The project aims to:

(a) Improve the enabling environment for the mung bean value chain in Myanmar by proposing policy and regulatory reforms;

(b) Increase the volume of mung beans purchased by premium market buyers from farmers’ groups by enhancing access to support services on Good Agricultural Practices (GAP), Climate Smart Agriculture (CSA) and collective marketing;

(c) Increase productivity and quality of produce by enhancing access to support services and good quality mung bean seeds; and

(d) Highlight the need for enhanced investment in research and development and in extension services.

With these project aims, a survey assessment of mung bean cultivation was carried out in Thonegwa and Khayan Townships of Yangon Region and Magway and Minbu Townships of Magway Region.

The specific objectives of the survey research are:

(a) To study the cropping systems of mung bean areas representative for the largest production of Myanmar,
(b) To find out the main challenges of mung bean farmers facing with regard to the production, and how these should be addressed
(c) To recommend the application of DRR, environmental protection and CSA practices for the mung bean farmers
(d) To recommend the proper methods of production, such as varieties used, input use of fertilizers and pesticides through the farmers' participatory workshops

METHODOLOGY

2.1 Data collection

The survey sites were selected in the large productive mung bean areas in Myanmar; namely Thonegwa and Khayan Townships (Yangon Region) and Magway and Minbu Townships (Magway Region). For the primary data, Focus Group Discussion (FGD) and household survey were carried out while the secondary data were collected from the concerned departments, such as Department of Agriculture (DOA) and Department of Agricultural Land Management, Statistics (DAMLS) and General Administration Department (GAD) of respective townships.

FGD was conducted once in each township to understand the general view of mung bean and other crops production, land use, socio-economy at their village level. For the FGD, key questions were developed and suitable participants were invited; the numbers were about 15 which included village heads/ leaders, male farmers as well as female farmers. It provided an insight into how the group thinks about the issues mainly related with mung bean production. It also showed opinion and ideas, and some variation in a particular community in terms of beliefs and their experiences and practices. Some of these findings were used to employ in designing the household level questionnaires.

The sampling of household was a purposive sampling method with a priority to mung bean farmers. Seven villages were selected from each Region based on their distance and large sown area of mung bean. Twenty sample household farmers were selected from each seven villages of each region: total sample household numbers were 140 in each region. Emphasis was given to include large, middle and small holder's farmers depending on their land holding. Women headed households and women were encouraged to participate as respondents creating a gender balance. The household survey data includes family size, education, land holdings, land use, economic return from their crops, crop production practices of mung bean, impact of extreme climates, farmers' coping strategies, and etc. These data showed a general picture of mung bean production at a farm level. In Khayan and Thonegwa Townships, paddy production was briefly recorded, which may have some impacts on the second crop of mung bean production, particularly time of sowing of mung bean. (The questionnaires were described in attachments).

2.2 Schedules of field survey

27-03-2018: Training for enumerators (at Khayan Project office)
28-03-2018: Focus Group Discussion with farmers (at Khayan and Thonegwa), (FGD included village heads/ leaders, male farmers as well as female farmers)
1st week of April, 2018: Household survey Khayan and Thonegwa Townships by NAG team
9-04-2018: Training for the enumerators (at Minbu Project office)
10 -04-2018: Focus Group Discussion with farmers (at Magway and Minbu), (FGD included village heads/ leaders, male farmers as well as female farmers)
3rd week of April: Household survey in Magway and Minbu Township by NAG team
30-05-2018: Paper presentation on "Climate Smart Agriculture (CSA) Research on Mung Bean Production in Myanmar" in the workshop of "Learning Event on Pulses and Oil Seeds, and Seeds Sector related Policy, issues and Practices on (Trading and Market, Seed issues, P4 Climate Smart Agriculture Research), at Myanmar Floriculturist Association Hall, People Park, Yangon.
May – June, 2018: Data analysis and reporting

3.RESULT AND DISCUSSION

3.1 Brief description of the study areas

(1) Khayan Township

Khayan Township is located in Yangon Southern District, Yangon Region, between north latitude 16°54´ 12"and east longitude of 96°13´35". The area of the Khayan Township is 236.75 square miles with the town area of 6.98 square mile. Most of the Township area is a flat plain and only a few areas are low lands. Since the township is very close to the Gulf of Martaban, some villages near the sea sometimes suffer from landslides and floods in monsoon season. Khayan creek which flows from east to west across the township is 29 miles long. The creek can be used as a water way in raining season and not applicable in dry season when it dries up. Khayan Township is situated at 12.196 feet above sea level, and Ta Man Gyi village is at the highest level while Kywe Da Lin village is at the lowest level. It has a hot and humid climate, with the maximum temperature of 40.5°C and the minimum temperature of 12.0 °C (2013).

History of Disasters: As heavy and torrential rains sometimes occur in monsoon season, the areas along the Khayan creek are flooded. There was no record of fire, storm and earthquake in Khayan Township. The Cyclone Nargis in May 2008 affected some areas in Khayan Township and the losses were recorded as 18, 486 million Kyats for the cost of infrastructure destructions and damages. It was also recorded that there were landslides / bank erosions in 1996 and 1997 which devastated some villages of Khayan Township.

(2) Thonegwa Township

Thonegwa Township is situated between north latitude of 16° 41´ and 16° 52´ and east longitude of 96°23´ and 96°46´in Yangon Region. It has an area of 322.58 square miles with the length of 27.5 miles in east-west and 15.5 miles in north-south directions. The area of the town is 2.5 square mile. The Township is situated at 14 feet above sea level; Kan Myint village is at the highest level while Min Ywar village is at the lowest level. Thonegwa Township has a hot and humid weather, and the maximum temperature is 42.5°C and the minimum temperature is 15.1°C (2016).

History of Disasters: As the area of Thonegwa Township is adjacent to the Andaman Sea, the tsunami tides and floods sometimes occur. The cyclone Nargis which fell in May 2008 did not severely affect Thonegwa area and the loss was recorded as 582 million Kyats.

(3) Minbu (Saku) Township

Minbu (Saku) Township is located between the north latitudes of 19° 53´ and 20 ° 19´ and the east longitude of 94° 28´ and 95° 00´, in Minbu District, Magway Region. The township area is 642.71 square mile, with the length 46 miles from east to west and 42 miles from north to south. The urban area of Minbu (Saku) is 4.17 square miles. Since itis situated in central hot and dry zone area of Myanmar, it has less rainfall. It has a maximum temperature of 44.7°C and a minimum temperature of 19.8°C (2013).

History of Disasters: There was no disaster recorded in Minbu (Saku) Township.

(4) Magway Township

Magway Township is located between north latitude of 19°45´ and 20°21´ and east longitude of 94°54´ and 96°18´ in Magway District, Magway Region in Central Myanmar. The township has an area of 682.22 square mile with the length of is 27 miles from east to west and 40 miles from north to south. The area of the town is 7.84 square mile. Magway Township has hot and dry climate with a maximum temperature of 46.5°C and a minimum temperature of 8.2°C (2016).

History of Disasters: As Magway Township is in the Dry zone area, the township is prone to drought and occurrence of fire. The danger level of the river Ayeyarwaddy in Magway is 1700 cm. The disaster history of Magway was six times of fire with the total cost of disaster was 64.6 million Kyats.

3.2 Analysis of responses to questionnaires

3.2.1 Characteristics of sample mung bean farmer-respondents

Table 1 showed the characteristics of respondents involved in mung bean production activities such as, gender, age group and education levels. Among the respondent farmers, the participation of female farmers was in the range of 20% to 62% of which more female respondents were found in Magway Region. The highest numbers of respondent farmers were found in the group “between 41 – 50 years” and “51 – 60 years” of age, ranging from 24% to 38% of respondent. It was followed by the age group of “31 – 40” and “more than 60 years” of age. The fewest number fell in the group of under 30 years of age.

In the study area, educational status of farmers was classified as four levels, namely monastic, primary school, middle school, high school and graduate levels. Monastery level people are capable of reading and writing but never attended the government school. The results showed that respondents with primary level education were the highest (ranging from 37% to 56% of respondents) while the graduate levels were the lowest number (ranging from 3% to 9% of respondents) (Table 1).

As most farms are small in size, farm work is carried out by the family members, except in the harvesting time when manual laborers were required for hand picking of pods. For pulses cultivation the work of tilling soils and broadcasting seeds are carried out by males. Females are engaged in picking pods, removing the husks and sun-drying the seeds. For spraying folia fertilizers and pesticides were commonly done by hired laborers /applicators, both male and female.

Table 1: Gender and age groups of respondents involved in the paddy and pulses activities

Township	No. of Village	No. of Respon-dents	Male (female) %	Age group (years)					Education level				
				< 30	31 – 40	41 – 50	51 – 60	> 60	Mo-nastic	Pri-mary	Mi d-dle	High	Gra - duate
Khayan	4	80	78 (22)	6	20	24	30	20	16	37	19	19	9
Thonegwa	3	60	80 (20)	2	17	25	37	19	20	39	24	10	7
Minbu	4	80	55 (45)	4	22	38	29	7	3	56	26	11	4
Magway	3	60	38 (62)	6	29	27	27	11	10	44	27	16	3

3.2.2 Land holdings of sample household

The land type of mung bean cultivation in two regions of study areas were found to be different, namely Le Land (low land) and Ya Land (upland) in Yangon and Magway Regions, respectively. The results revealed that the average land holding of each respondent farmer in Khayan and Thonegwa Townships were 11 and 10 acres with a maximum area of 50 ac and 40 ac, respectively (Table 2). Mung bean was grown in all study villages as a second crop after the rice harvest (double cropping system). Mung bean area coverage in the study villages generally remained unchanged in successive years (e.g., previous year of 2017 and current year of 2018).

In Magway Region, several upland crops were cultivated, such as sesame, peanut, pigeon pea, cotton and mung bean, black gram and etc. The average land holding of Minbu Township was 11 ac (maximum area of 40 ac) while that of Magway was 7 ac (maximum area of 20 ac in). The average Mung bean sown area changed a little year after year because individual farmer decided to select crops mainly depending upon crop prices and rainfall pattern. It was noted that in Minbu Township, 27% of respondent farmers reduced the area while 14% increased the area comparing with previous year. Similarly, in Magway Township, 26% of respondent farmers reduced the area while 9% increased mung bean area in the current year. In Khayan /Thonegwa areas, seed rates were 12 Pyis with a maximum use of 18 Pyis per acre. It was found that the seed rates per acre were fewer in Minbu and Magway area because of the reduced use of mung bean seeds for mix or intercropping with other crops. The average yield ranged from 11 to 15 baskets per acre and the maximum yield of 30 baskets were observed among all study townships.

Table 2: Status of land holding and mung bean cultivation in study area in 2017-18

Township	HH 's Total Land holding Av. area (Max.) (ac.)	Mung bean Area (ac.) Av. area (Max.) (ac.)	Change in Mung bean area Same/ increase/ decrease (Area (ac.))	Seed Rate (Pyi) Average (Max.)	Yield/ac (bsk) Average (Max.)
Khayan	11 (50)	11 (50)	No change	12 (16)	11 (25)
Thonegwa	10 (40)	10 (40)	No change	12 (18)	15 (25)
Minbu (Saku)	Ya =11 40 (max.) Kaing=2.8 6.6 (Max.)	Mung bean 4.0 (15 max.)	This Yr.4.7 (max.15) No change: 59%, Reduced: 27%, Increased: 14%	5 pyi, 16 (Max.)	14 (30)
Magway	Ya= 7 (max.20)	4 (13 Max)	No change: 65%, Reduced: 26%, Increased: 9%	4 (12 Max.)	8 (20)

3.2.3 Cultural Management Practices of mung bean production

3.2.3.1 Mung bean varieties used

The mung bean variety of most widely cultivated in Khayan and Thonegwa area was Pedishwewar (golden mung bean), which was introduced by the Myanmar Agriculture Service in the early 1990s. Currently farmers in these townships commonly used improved varieties released from Department of Agricultural Research (DAR), Yezin, such as Yezin - 9, Yezin 11 and Yezin 14. Some farmers in Minbu and Magway Townships used improved varieties, Pedishwewar, and Myakyaemon while many farmers grew local varieties. Farmers think that Pedishwewar has been grown since a long time ago and degraded. The other improved varieties released from DOA were not sufficient for farmers. Therefore, the access of good quality improved varieties is also a constraint for farmers. Farmers keep their own harvest for the main seed source and some from exchange with co-farmers; only a few farmers received through the DOA and private companies.

3.2.3.2 Cropping patterns and crop calendars

Land use types in Khayan and Thonegwa Townships and Minbu and Magway Townships were presented in Attachment 1 and Attachment 2. Paddy land (Le) were recorded as 115,966 acres, and 144,403 ac. in Khayan and Thonegwa Township, respectively. In both townships, there were no upland areas (Ya) and only two main crops, paddy and mung

bean were cultivated as a double cropping system. No other crops were cultivated with a considerable acreage. In 2016-17, paddy sown area in monsoon season was 112,282 ac while mung bean area was 101,002 ac in Khayan Township (Attachment 3). Similarly, in Thonegwa Township, monsoon paddy was 150,265 ac and post monsoon mung bean was 128,749 ac in 2016-17 (Attachment 4). Nearly all areas of paddy fields were double cropped with mung bean.

Regarding with cropping patterns in Khayan and Thonegwa Townships, mung bean has been grown in post- monsoon season after the monsoon rice harvest. It is cultivated in a large commercial scale as a mono-cropping system. In Khayan and Thonegwa Townships monsoon paddy is grown during the beginning of monsoon season and harvested in September – October, in general. Soon after the rice harvest, the lands are prepared and mung bean seeds are broadcast before the soil moisture declines. The sowing method is broadcasting the seeds. The optimum Mung bean sowing time is mid- November. Farmers think that the sowing time after mid- November gives less yields. Mung bean is cultivated in rain fed condition; the residual soil moisture content is an influencing factor to produce a good yield. If the paddy harvest is later than normal, the sowing time of mung bean is late. Most farmers use the short duration paddy varieties to do the early harvest.

In Minbu Township, there were 36,207 ac of paddy area (Le), 99,387 ac of upland (Ya) and11,913 ac of alluvial (Kaing) lands. Likewise, paddy land, upland and Kaing lands of Magway Township were 4,225 ac, 187,779 ac and 5,646 respectively. In both townships, mung bean is grown in monsoon season and the sowing method is mainly by row-planting. Other crops, such as groundnut, sesame, sunflower, seed corn, and pigeon pea were also grown during early monsoon to late monsoon season (Attachment 5 and Attachment 6). In both Townships, farmers of upland (Ya) lands generally follow a practice of multi-cropping pattern. Since Since sesame, groundnut and cotton have more reliable market price, these crops are more preferable to mung bean for the farmers. Attachment 7 and Attachment 8 presents the production of several crops cultivated in Minbu and Magway Township, respectively. In 2016-17, the mung bean sown area of Minbu Township was recorded as 74,670 ac while that of Magway Township was 52,151 ac.

The majority of farmers grow sesame and groundnut in the pre-monsoon/ early monsoon season (April – June). Mung bean is sown as a second crop or a single crop in mid – monsoon or late monsoon (August – September) and harvested in December. Farmers usually grow mung bean in mixed / intercropping with cotton, sesame, pigeon pea and etc. Cotton and groundnut are also widely grown in post-monsoon season (October – November) where the soil moisture content is enough or irrigation is possible.

The existing cropping calendar of both study areas were shown in Fig. 1 and Fig. 2.

Figure 1: Cropping calendar for rice-mung bean cropping system, Khayan and Thonegwa, Yangon Region

CROP	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR
Paddy												
		Plowing		Broadcasting /Transplanting			Harvesting		Threshing			
Mung bean												
								Plowing / Broadcasting		Fertilizing / pesticide application		Harvesting

Figure 2: Cropping calendar for several crops in Minbu and Magway Townships, Magway Region

CROP	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR
Sesame												
Mung bean												
Groundnut												
Sesame + Pigeon pea												
Cotton												

3.2.3.3 Fertilizers, pesticides and GAP application

It was noted that the respondent farmers usually apply urea, compound and foliar fertilizers. Due to the fewer number of cattle in Khayan and Thonegwa area, farmers' practice was more use of chemical fertilizers and less use of organic / natural fertilizer. The average % of Khayan / Thonegwa respondents who used the compound, folia, urea and FYM were 85%, 36%, 36% and 6% respectively, while those of Minbu and Magway farmers were 61%, 18%, 25%, and 64%, respectively (Table 3). Comparing of two regions, Khayan /Thonegwa farmers used more chemical fertilizers and fewer use of FYM. The reverse was true for Minbu/ Magway farmers.

The large numbers of respondents of Minbu /Magway Townships (avg. 64 %) used organic fertilizers, such as chicken dung, cow dung and crop residues (Farm Yard Manures /FYM) to replace the expensive chemical fertilizers. On the other hand, in Khayan / Thonegwa Townships the average 6% of respondents used FYM in mung bean cultivation. Based on the results of FGDs and household surveys, farmers in Khayan / Thonegwa townships noticed that their fields were degraded and less productive than about ten years ago. It agrees with the general concept that, use of large amount of chemical fertilizers for a long

time damages the soil structure and soil productivity. On the other hand, organic or natural fertilizers like cow dung improve soil fertility. Therefore, it can be assumed that the soil condition of Khayan / Thonegwa areas will become less productive due to the less use of organic fertilizers.

The recommendation or advice related with use of fertilizers, farmers received mainly "from farmers to farmers". There were very few extension workers from DOA, private companies and local and international NGOs who gave the advice of proper use of fertilizers to farmers. The technology of "Good Agricultural Practices (GAP)" of mung bean production was introduced in 2017 to these areas with the support of DOA and Network Activities Group (NAG), a local NGO. The farmers have not widely adopted the technology but they accepted that by following this technology the mung bean quality will be improved and meet with the export requirement. The dissemination of the GAP should be promoted by the concerned departments and local NGOs. The average respondent farmers who followed GAP were 27% in Khayan / Thonegwa Townships while those in Minbu and Magway Townships were 13% (Table 3).

Table 3: Use of fertilizers and GAP for mung bean production (Respondent farmers %)

Township	Use of chemical fertilizer				Adoption of GAP
	Compound	Folia	Urea	FYM	
Khayan	86	37	30	8	29
Thonegwa	83	34	41	4	25
Average % of respondent farmers of Khayan and Thonegwa Townships	85	36	36	6	27
Minbu	60	23	15	48	18
Magway	62	12	35	80	8
Average % of respondent farmers of Minbu and Magway Townships	61	18	25	64	13

3.2.3.4 Constraints in mung bean production

The constraints of mung bean production mentioned by the respondents, such as biotic and abiotic factors and labor issues were presented in Table 4. Farmers in both regions perceived that the weather was the most important limiting factor of their production. The average % of respondent farmers who found the weather related problems in Khayan / Thonegwa and in Minbu / Magway Townships were 81% and 92%, respectively.

Besides, average 65% of respondent farmers in Khayan /Thonegwa Township and 25% of Minbu / Magway mentioned the "high input" as a constraint of production. It is consistent

with the finding that Khayan /Thonegwa farmers used much more input than did the Minbu / Magway farmers.

Regarding with soil fertility, farmers in Khayan/ Thonegwa fourteen percent of respondents in Khayan Township and 8% in Thonegwa Township expressed “the poor soil quality”. No farmers in Minbu and Magway Townships said about the soil degradation problem of their lands.

Furthermore, average 24% of Khayan /Thonegwa farmers and 66% of Minbu / Magway farmers described “labor issues” as a constraint. It was consistent with the finding that , the “scarcity of labor” was described by 33% of Khayan /Thonegwa farmers and 82% of Minbu / Magway farmers.

The Khayan /Thonegwa farmers applied “family labour” by the average of 52% and “hired labour” by 16% for their production. It was found that much more use of “family labour” and “hired labour” of Minbu / Magway farmers, by 70% and 47%, respectively. These results showed that the labor problem was more prominent in Minbu / Magway area which may be related with their production system of several crop varieties during a crop season.

Regarding with the training support, the GAP was found to be the top priority farmers wanted to access in both regions. Farmers in Khayan / Thonegwa Townships wanted GAP by 60%, “Proper use of fertilizers” by 16%, “Proper use of IPM and Post harvest technology” by 14%, “Use of pure and good quality seeds” by 7% and “Proper soil management” by 4% in the descending order. Similarly, in Minbu /Magway Townships GAP stood first priority (71%) followed by “Use of pure and good quality seeds” (13%). Six percent of farmers showed interest in “Use of pure and good quality seeds” and “Proper soil management”, while 5% of respondents in “Proper use of IPM and Post harvest technology”. In comparison, the results showed that more respondent farmers in Khayan /Thonegwa Townships wanted to access training on IPM than the farmers in Minbu and Magway Townships. It may be related with the fact that Khayan /Thonegwa farmers had more experiences with pest and disease occurrence than the Minbu / Magway farmers. Farmers have been practising mono-cropping system of mung bean in a commercial scale for long consecutive years in Khayan /Thongewa area, which encourages more occurrence of pest and disease.

Table 4: Constraints encountered by respondent farmers

Township	Biotic and abiotic problems					Labor issues			Trainings farmers want to get				
	Wea-ther	Pest/ dis-ease	High input	labor	Poor soil	Scare of labor	Fam-ily labor used	Hired labor used	GAP	IPM / PH	Pure seed	Use of fert i.-	Soil man-age-ment
Khayan	81	41	58	18	14	35	55	10	61	10	6	16	6
Thongewa	80	46	71	29	8	31	48	21	58	17	8	15	2
Average %	81	44	65	24	11	33	52	16	60	14	7	16	4
Minbu	91	66	20	78	0	88	67	61	67	6	10	9	8
Magway	92	42	30	53	0	75	73	33	75	4	16	2	4
Average %	92	54	25	66	0	82	**70**	**47**	71	5	13	6	6

3.2.4 Farmers' perception of weather condition and climate impact on mung bean production

Farmers' perceptions on weather condition and climate impact on mung bean production were described in Table 5. For the Khayan / Thonegwa farmers, the departure of monsoon rains had more influence on their production since they cultivate mung bean in post monsoon season (October – November). The average 75% farmers felt that monsoon departure in 2017 was late which had a huge negative impact on their production. Under this condition, the fields were wet and farmers had to wait to till the fields and the sowing time of mung bean was about three or four weeks later than optimum time. Besides, the young plants were sometimes damaged by unusual /unseasonal rains in post-monsoon season.

Since Minbu / Magway farmers cultivate mung bean in the mid- rainy season or late rainy season (July – August – September), the distribution of rains has a greater impact than the monsoon arrival and departure. The farmers responded as normal condition of monsoon arrival and departure, by 18% and 27%, respectively. When the rain falls at flowering time, the yield is seriously affected and when it occurs at the time of pod mature and harvest, the quality of seeds, color and moisture, will be damaged.

Concerning with the climate change impact, mung bean farmers in both regions commonly have been experiencing of yield decline affected by climate variability, particularly unusual or unseasonal rains. Average 41% of Khayan / Thonegwa farmers and 88% of Minbu / Magway said that the yield was noticeably reduced because of rains in current year. Similarly, the occurrence of noticeable yield reduction during last three years was responded by 62% of Khayan / Thonegwa farmers and 60% of Minbu / Magway farmers.

It was found that over 90% respondent farmers agreed that the pest occurrence and weather conditions were highly related: moist and cloudy weather for 3 - 4 successive days, favors the infestation of pest and diseases. In such condition farmers usually apply pesticides to their fields even if they do not see the pests infested in their fields.

For the pesticide application, the survey results showed that there were no farmers who applied less than 3 times during a crop cycle in Khayan / Thonegwa Township; average 90% respondents did more than 5 times of application. In the case of Minbu / Magway farmers, 33% applied less than three times while 22% more than five times. Based on these findings, it can be assumed that Khayan / Thonegwa farmers applied more pesticides than did the Minbu / Magway farmers. This result may be related with the cropping patterns of mung bean cultivation. In Khayan / Thonegwa Township, mung bean is a commercial/ cash crop and cultivated as mono-cropping, no other crops at the time of mung bean growing season. Besides, the same cropping pattern (mung bean after rice) has been practiced for several decades. These facts are highly favorable to pest and disease infestation. On a contrary, Minbu / Magway farmers follow a multiple cropping system – they grow mung bean as a complementary crop: mix-crop or intercrop or crop rotation system with sesame, peanut, cotton, pigeon pea, etc. Such systems well suppress the pest and disease occurrence. Thus, Khayan / Thonegwa farmers applied more frequency of pesticides spraying than Minbu / Magway farmers.

Table 5: Respondent-farmers' perception of weather condition and climate impact on mung bean production

Township	2017 - Monsoon arrival			2017 - Monsoon departure			Noticeable yield reduction in current year (2018)	Noticeable yield reduction during the past three years	Relation with Pest and Weather	Pesticide spray frequency		
	Ear-ly	La t-e	Nor-mal	Early	Late	Nor-mal				< 3	3-5	>5
Khayan	6	23	71	1	80	19	49	61	97	0	13	87
Thonegwa	8	12	80	0	71	29	32	63	95	0	55	93
Average of Khayan-Thonegwa	7	18	75	1	75	24	41	62	96	0	34	90
Minbu	55	23	20	31	36	29	88	61	93	0	54	38
Magway	72	13	15	30	45	25	87	58	92	65	29	6
Average of Min. – Mag.	64	18	18	32	41	27	88	60	93	33	42	22

3.2.5 Socio-economic condition of respondent farmers

Table 6 presents the socio-economic condition of respondent farmers (estimated total annual income from crop production per household) in study areas. Generally, the majority of households' incomes come from the annual total crop production. Monsoon rice and post-monsoon mung bean were the main crops for Khayan / Thonegwa farmers while sesame, peanut, mung bean, cotton, pigeon pea, and etc., grown in monsoon and post monsoon were the main income sources of Minbu / Magway farmers. The estimated total annual income were classified into six categories: (1) less than 10 Lakh and (2) between 11 – 20 Lakh (poor income level) ; (3) between 21 – 30 Lakh and (4) between 31 – 40 Lakh (medium income level); (5) between 41 – 50 and (6) above 50 Lakh (high income level).

It was observed that Minbu / Magway farmers, ranging from 4% to 33% of respondents, received the "poor level income" while the Khayan /Thonegwa farmers who fell in this category were 0 % to 6% of the range. More respondents with high level of more than 51 Lakh were found as in 57% and 64% in Khayan and Thonegwa Townships, respectively. Minbu and Magway farmers in this category were 11% and 9%, respectively. These results

explained that Khayan/ Thonegwa farmers have income from rice and mung bean, which provided higher revenue than the various upland crops in Minbu/ Magway areas.

With the economy, industry and infrastructure development in Myanmar, young people from rural areas moved to urban areas as migrant workers. The rural – urban migration has been a projecting issue in rural areas in recent years. In all study areas, the percentage of households with one or two family members working outside (home or abroad) was observed in a range of 20 to 29%.

The average highest production cost of mung bean per acre was estimated to be 244,000 Kyats in Khayan Township and the lowest amount (161,000 Kyats) was responded by Magway farmers. The same value of maximum production costs of 30,000 Kyats was estimated in all study townships. As for the profits (net income) from mung bean crop, Thonegwa farmers earned the highest amount of 229,000 Kyat /ac while Magway farmers the lowest amount of 73,000 Kyats/ ac.

Table 6: Socio-economic condition of respondent farmers in study areas

Township	% of respondents with income from crop production (Kyats in Lakh) (,00000)							Production cost of mung bean/ ac		Profit Kyats/ ac
	< 10	11-20	21 - 30	31 - 40	41 - 50	>51	Migra-tion	Average	Max.	
Khayan	4	6	11	8	14	57	22	244,000	300,000	125,000
Thonegwa	0	1	2	14	19	64	20	237,000	300,000	229,000
Minbu	4	21	29	21	14	11	29	183,000	300,000	120,000
Magway	17	33	15	18	8	9	29	161,000	300,000	73,000

Note: 1 lakh in Myanmar kyats = 100,000

3.2.6 Agricultural assets of respondent farmers in study areas

The agricultural assets of respondent farmers of fourteen study villages in four townships were described in Table 7. The results show that the average land holding and maximum land holding of individual farmers were different among the villages as well as the townships. The largest size of land holding of individual farmers was found in Oo Pho Lone village of Khayan Township. The average land holding varied from 7.7 acre in Yae Paw Kan villageto 16 ac in Oo Pho Lone village. The maximum area of land holding was the lowest in Kan Nyi Naung village with 16 ac and highest acreage was observed in Oo Pho Lone village with 50 ac.

In Thonegwa Township, Yae Nwe village farmers had the smallest size of average land holding (8.5 ac) while Thae Kone Farmers had the largest area (10.9 ac); the maximum acreage of land holdings varied from 19 ac in Yae Nwe and 40 ac in Ka tone Paw Ahtet village. Among the study villages in Thonegwa Township, the smallest size of average land holding and maximum land holding of individual farmers were found in Yae Nwe village.

In Minbu (Saku) and Magway Townships, farmers possess two different types of land, namely Ya and Kaing (alluvial land). For the water access, the Ya lands are rain fed while Kaing lands are generally irrigated. The highest land holding of Ya land (13.7 ac) and maximum Ya land area of 40 ac were observed in Mon Taung village in Minbu Township. Farmers of Lake Kan village in Magway Township had the largest area of Ya land (8.5 ac) and the largest area of maximum land holding (20 ac) of individual farmer.

In both Townships, the size of land holding of Kaing lands were smaller than Ya land. The average largest area of Kaing land (4.2 ac) and maximum land holding (15 ac) of Kaing land were observed in Mon Taung village of Magway Township.

Concerning with cultivated area, Khayan and Thonegwa farmers cultivated almost all areas with rice in monsoon season and mung bean in post-monsoon season. Generally, the area coverage of rice and mung bean were more or less the same and remained constant. On the contrary, in Minbu and Magway area, mung bean cultivation was only a portion of the total land and it varied year after year; the areas were generally declining in recent years. Farmers generally selected the crops based on the weather, investment capacity, possible price of the crops, and etc. Comparing with other crops like sesame and peanut, mung bean prices were highly fluctuated and unreliable these years. Thus, farmers of Minbu and Magway gave mung bean the less priority.

The highest mung bean acreage (6 ac) and the maximum land holding of individual farmer (15 ac) were observed in Mon Taung village of Minbu Township in 2018. It was reduced from the area of 7 ac with maximum area of 20 ac in previous year (2017). Similarly, a few area reductions of average land holdings in current year were found in two villages, Lake Kan and Thae Kyi Kone, of Magway Township.

The ownership of agricultural machinery, namely tractor and power tiller, and draught cattle by the respondent farmers were also presented in Table 7. The average percentage of respondents of four villages in Khayan Township who owned tractor, power tiller, and cattle were 8%, 48% and 33%, respectively; those in Thonegwa Township were 7%, 51% and 22%.

The average percentage of respondents of Minbu Township with tractor was found to be 5% and there were no farmers who owned power tiller. Likewise, Magway farmers mentioned no ownership of tractor and power tiller. Instead, 93 % of Minbu farmers and 62% of Magway farmers owned draught cattle. In comparison, it was observed that, Khayan/ Thonegwa farmers owned more farm machinery than draught cattle and the reverse was true for MInbu/Magway farmers. According to the FGD, it was noted that the application of farm machinery depends on the suitability with soil type: tractor and power tiller are suitable with low land fields (Le) while Ya land are not suitable with them.

It was documented that majority of households has one or two motor bikes, complementary with the fact that and rural access roads have been upgraded and improved in almost all

study villages. The survey results showed that all study villages had motor bikes, ranging from 50% to 95% of respondent farmers.

Table 7: Agricultural assets of respondent farmers of study villages

Township	Village (Village Tract)	Mung bean cultivation				Ownership (Respondent %)			
		average land holding (Max. acre)	Mung bean area average (Max.)	Seed Rate (Pyi)	Yld (bsk)	Tractor	Power tiller	Cattle	Mo-tor bike
Khayan	Yae Paw Kan (Yae Paw kan)	7.7 (18)	7.7 (18)	14.3 (16)	14.0 (25)	10	45	30	75
	Kan Nyi Naung (Kan Nyi Naung)	8.3 (16)	8.3 (16)	10.2 (16)	11.6 (20)	10	40	35	80
	Oo Pho Lone (Nyaung Pin Kwin)	16 (50)	16 (50)	12 (16)	8 (15)	5	47	37	84
	KanKone (KyarKan)	12.4 (35)	12.4 (35)	10 (16)	10 (18)	5	60	30	95
Average of Khayan Township						8	48	33	85
Thonegwa	Katone Paw Ahtet (Katone Paw Ahtet)	10.5 (40)	10.5 (40)	11 (16)	18 (25)	0	26	37	84
	Thae Kone (Azan Daw Zoon)	10.9 (30)	10.9 (30)	11 (16)	11 (15)	15	45	25	95

	YaeNwe (Yae New)	8.5 (19)	8.5 (19)	14.8 (18)	15 (20)	5	80	5	95
Average of Thonegwa Township						7	51	22	95
Minbu (Saku)	Thee Kone (Thee Kone)	Ya = 11 (20) Kaing = 3.3 (6.6)	This year = 6.6 (14) Last year = 7.4 (15)	5 (6)	17 (25)	0	0	100	89
	Htein Taw (Htein Taw)	Ya = 6.7 (23) Kaing = 1.3 (2)	This year = 3 (8) Last year = 3 (8)	4 (8)	8 (15)	0	0	75	55
	Mon Taung (Mon Taung)	Ya =13.7 (40) Kaing = 4.2 (15)	This year = 6 (15) Last year = 7 (20)	6 (10)	19 (30)	19	0	95	90
	Sin Lan Kyi (Yae Twin kone)	Ya = 12 (22) Kaing = 4 (4)	This year = 3 (15) Last year = 3 (15)	6 (16)	13 (25)	5	0	100	65
Average of Minbu Township						5	0	93	75
Magway	Lake Kan (NyaungKan)	Ya = 8.5 (20)	This year = 3.6 (13) Last year = 4.4 (13)	5 (12)	7 (15)	0	0	65	50
	Thae Kyi Kone (Inn Taing)	Ya = 5 (12)	This year = 2.9 (12)	3 (5)	7 (15)	0	0	62	62

			Last year = 3.4 (12)						
	Alae Chaung (Htone Pauk Taw)	Ya =7.7 (15) Kaing = 6 (12)	This year = 5 (12) Last year = 5 (12)	5 (8)	9 (20)	0	0	58	89
Average of Magway Township						0	0	62	67

3.3 General discussion

3.3.1 Status of existing mung bean production

3.3.1.1 Economic and institutional Factors

With the change of government's economic policy after 1989, the restrictions on private sector have been relaxed. To boost the production of pulses is one of the main objectives the Ministry of Agriculture and Irrigation. It encouraged the farmers to use more fertilizers, pesticides, better seeds and farming techniques, particularly in growing mung bean and black gram which are high in demand to earn more foreign exchange. As Thonegwa and Khayan Townships have suitable physical conditions to grow mung bean, these two townships have been recognized as "special mung bean zones" in 2008-09. DOA provided quality seeds, chemical fertilizers and pesticides at reasonable prices. Although such assistance was terminated in 2005, farmers continued to expand mung bean areas. The sown area remained constant and high despite of the increase of production cost and instability of mung bean prices.

A comparison of the production status of mung bean between the year 2000-01 and 2011-12 was shown in Table 8. It can be clearly seen that the area coverage as well as yields per hectare were increased in both study township of Yangon Region.

Table 8: Mung bean production in study areas of Yangon Region

Township	**2000-01**			**2011-12**		
	Sown area (ha)	**Yield/ha**	**Production (bsk)**	**Sown area (ha)**	**Yield/ha**	**Production (bsk)**
Thonegwa	37,909.8	28.1	1065,265	50,552.2	42.23	2134,819
Khayan	30,408.5	22.2	675,981.6	39,336.7	40.01	1573,862

The largest mung bean area was cultivated in Thonegwa Township in Yangon Region. The village tracts with large mung bean sown area in 2011-12 were Pyin Ma Kan (4647 ha), Naung Ni (4,078 ha), Pa Le (3,887 ha),Ka Don Baw Ale (3,771 ha),Tone Kyi (3,468 ha),Thike Too Kan (3,450 ha), Ta Man Gyi (3,037 ha) and these villages are located in the middle and western parts of the township. The village tracts with small area of mung bean

are located in the eastern part close to the Gulf of Mattaban, tidal water intrudes into the cropland, thus having alkaline soils unfavorable for growing pulses. All the village tracts in this township also depend on the extent of physical restraints to grow pulses.
The spatial distributions of mung bean cultivation in South Yangon District, Yangon Region in 2011-12 were described in Fig.3.

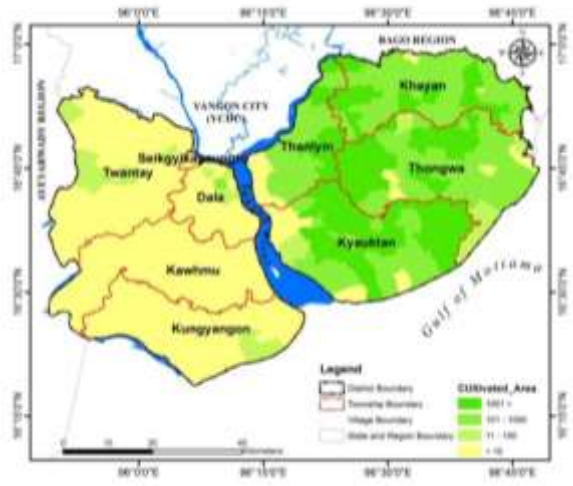

Fig.3 Spatial distribution of pulses cultivation in South Yangon District, Yangon Region (2011-12)

Source: Settlement and Land Records Department, South Yangon District, Yangon Region

3.3.1.2 Agro-climatic suitability

Khayan - Thonegwa has the largest mung bean growing area producing good quality seeds in Yangon Region. By the end of the 1990s, Thonegwa became the largest producer of mung bean in Myanmar. The major cropping pattern in these areas is double cropping of mung bean after rice. Pedishwewah of Khayan and Thonegwa are high in quality and it demands higher price than the products of Ayeyarwady, Bago, Magway, Mandalay, and Sagaing Regions.

In climatic factors, temperature is high enough for the requirement of the crop, and receives sufficient sunshine as the crop is grown in the post-monsoon period with little or no cloud cover. The occasional light rains favor the crop vegetative stage. Based on the minimum temperature, rainfall and soil moisture storage, agro-climate suitability of mung bean in study areas was considered. For Khayan and Thonegwa Townships, temperatures of four months from November to February were included in consideration. Generally, the daytime highest temperature from November to February is between 25 ˚C and 36 ˚C which are suitable for the pulses crop. In the ripening period, usually in February, the maximum temperatures are between 34˚C to 36˚C, the best conditions for the full maturity of mung bean seeds.
During the early development stages, mung bean needs a little rain for the emergence of the plants to the full ground cover. Normally the rainfall is low in these months, favoring to the healthy plant growth, flowering and fruiting. However, unseasonal and unusual rains occurred in some years due to the remnants of typhoons that originated in the South China Sea, and the crop can be destroyed. However, heavy rain retards the optimum growth and decreases the yield or even destroys the entire crop. In the ripening stage, no-rain condition is more favorable for good yield and less destruction by pests.

3.3.1.3 Crop price and market

According to the FGD and household surveys, many farmers said the fluctuation and instability of mung bean price is their main constraint. The prices vary from time to time (varying day to day and month to month); from the early harvest to the end of harvest. Since only about 10% of the production is consumed in home country, the price highly fluctuates depending on the export demand. Mung bean is mainly traded to India, Singapore, Switzerland, Philippine, Indonesia, Malaysia, Bangladesh, UAE, China and Thailand. India is a major buyer of Myanmar pulses and fair average quality (FAQ-Fair Average Quality) has more demand by India market, others are Middle East countries, European market (S Q -Quality product). Thus, the quality of mung bean plays an important role for competition in the global market.

Besides, traders and companies control the price-fixing, usually a very low price in harvest season. The small holders with limited capital have to sell out their crop soon after the harvest, increasing the supply volume, which makes the price decline. The traders purchase pulses in the harvest season and sell out with high price when farmers have no pulses for sale. Therefore, the larger share of profit goes to the companies than to the pulses growers. The range of approximate mung bean prices within a year and fluctuations between years were recorded as shown in Table 9.

Table 9: Fluctuation of pulses prices from 2000 to 2014 in Yangon Region

Sr.	Townships / Year	2000 (kyats/ Basket)	2005 (kyats/ Basket)	2010 (kyats/ Basket)	2011 (kyats/ Basket)	2012 (kyats/ Basket)	2013 (kyats/ Basket)	2014 (kyat/ Basket)
1	Thonegwa/ Khayan	4500 to 5200	24,000 to 27,000	32,000 to 48,000	25,000 to 36,000	18,000 to 25,000	20,000 to 35,000	45,000 To 58,000

3.3.1.4 Assistance from Government and NGOs

The DOA extension officials and local NGOs occasionally hold education talks, sharing the good farming techniques, such as Good Agricultural Practices (GAP) of mung bean. GAP includes the use of good quality seeds, effective use of agrochemicals, soil and water management practices and so on. In the past the good quality seeds of improved varieties, such as Pedishwewah, Yezin 9 and Yezin 11, and etc. were used to be distributed to farmers. Since several years ago, farmers have poor access of these seeds and they have to keep their own seeds themselves. In order to buy more pulses, there were a few companies shared some cultivation techniques; sold tractors and power tillers on deferred payment basis.

The Myanmar Agricultural Development Bank (MADB) disburses loans in every growing season to pulses growers at the rate of Kyats 50,000 per acre and the interstate rate is 0.72%. This amount of loan is only about one fifth of the actual cost so that most farmers need to get other sources of credits with high interest rates. There are a few cases of lending money from local NGOs, and cooperatives with reasonable interest rates to pulses

growers. However, most farmers rely on the credits from the informal sources of friends, relatives and local money lenders.

Regarding with GAP, in Magway Township, Network Activities Group (NAG) has been introducing a 'Farmer to Farmer Sesame Programme' for about four years. It focuses on Good Agricultural Practice (GAP) for improving sesame produce quality (chemical free products), collective selling/ buying and enhancement of value chains. With support of NAG, the programme is mainly led by Farmer Development Association (FDA) members. It was observed that Department of Agriculture (DOA) representatives and private sector export companies directly liaised with the local farmers – answering questions, clarifying post harvest techniques and assisting them in the adoption of GAP practices etc.

Based on the success of sesame production, the GAP approach for mung bean is also an ongoing process in all study areas, starting from 2007 and 2018. This program includes the development of collective selling or buying and adoption of GAP practices, improving quality seeds access from credible government and private sources, pest control and market access.

Agriculture Department granted a certificate of Good Agricultural Practices (GAP) to mung bean farmers of Khayan and Thonegwa Townships. Their crop production methods are designated to be in line with GAP and efforts are being made to disseminate GAP guidelines to the growers in other regions and states. By following the GAP, the products will meet the criteria set by other buyers' countries and mung bean export market can be expanded from regional market to international market such as Japan and European countries.

3.3.1.5 Use of high input technologies

Since a market-oriented economy was introduced in Myanmar, the country's exports of agricultural products were gradually opened to the private sectors – trade, import and distribution of agricultural inputs were liberalized. This led the farmers to boost their production especially on pulses, cotton and vegetables. Among these crops, pulses were the most popular crop due to its short duration, low cost of production, high rate of return and increasing market demand. At the same time, yield-increasing measures and quality improvement of pulses through agricultural intensification, such as high inputs use of agrochemicals and crop management technologies have become an important issue.

The use of pesticides rapidly increased and it became an indispensable input among pulses growers to minimize yield losses caused by pest and disease infestation. Farmers use pesticides as a risk minimizing tool without knowing the true cost to society and the environment. Except for a few agricultural education talks, there have been no sufficient trainings for the sound and effective use of pesticides in pulses production. Farmers are not well aware of the adverse effects of heavy pesticide use, unsafe application techniques, the impact on human health of pulses growers, the village communities and the environment. Dissemination of information and necessary supports to address this issue are still lacking.

To promote the sustainable conservation of natural ecosystem and safer environment, the application of Integrated Pest management (IPM) is urgently needed. Among the pest control measures**,** the cultural management practices, such as crop rotation, timing of planting and harvesting, use of farm yard manure or organic composts, and proper soil management should be practiced. The choice of disease- and pest- resistant crop varieties and safer pesticides are also important environmentally and ecologically friendly practices.

3.3.1.6 Climate change impact on mung bean production

Like many other countries in the world, climate change impact is one of the major challenges for crop production in Myanmar. Under the climate change scenario, rains and cyclones occur with more frequency and intensity in recent years. Due to the irregular and unseasonal rainfalls, drought and heavy rains often happen during the crop seasons, creating extremely low yields to the crops. Generally, mung bean farmers in both study regions have encountered more serious impacts of rains than droughts. When heavy rains come during the time of early crop establishment and flowering, it damages the crops, leading to a significantly reduced production.

It was recorded that in Khayan and Thonegwa Townships heavy rains fell in November and December in 2012; mung bean fields were water-logged and yields were noticeably decreased. Again, about a week of almost incessant rains in July and August in 2014 caused widespread flooding in several townships of Yangon Region, destroying the paddy fields. Farmers replanted the paddy and the paddy harvest time became late. Consequently, sowing time of mung bean was later than the normal, resulting in poor yields. Furthermore, because of the continuous rains in post monsoon, in November 2017, sowing time of mung bean reached to December; the crops did not grow well and yields were highly affected. Most farmers of in Khayan and Thonegwa Townships said that the yield of mung bean in 2018 (harvested in March) was the worst year of production they had ever encountered.

In the case of Minbu and Magway area, since mung bean is cultivated during the monsoon season, rains can affect any time during the crop cycle. When it comes at the proper stage of vegetative growth, it favors the yield. However, intense rains or drizzling long days can damage the crop at any stage. More irregular rains fell in Myanmar in previous years; the rains were highly fluctuated in time and space, particularly in central dry zone, including Minbu and Magway Townships. When rains occur during the flowering time, the yields are affected; if it rains during the pod maturing and harvest time, the qualities of the seeds such as color, moisture, etc., are damaged and the market price becomes low.
Rainfall data (monthly rainfall and rainy days) of the four study townships were described in Attachment 9 to Attachment 15.

3.3.2 Climate Smart Agriculture (CSA) for mung bean production

As for CSA practices to follow, the suitable climate change adaptation technologies should be applied, with the support and cooperation of the concerned government departments, local and international NGOs local stakeholders and technicians. Short-lived paddy varieties and good quality pulses varieties and resistant varieties to pest and diseases should be introduced in these areas by the Department of Agriculture. To save the time of land preparation, zero tillage or relay cropping system of mung bean can be initiated. The zero tillage technology of chick pea and black gram production after the rice harvest has been successful in many parts of the country; some related research should be undertaken in mung bean areas.

In Yangon regions, the water management systems should be upgraded, such as better drainage facilities, repair of existing sluice gates and embankments and etc. Poor drainage system causes widespread flooding in many areas every year. Land should be managed to

be well-drained at individual farm; and the embankments and slice gates should be repaired to keep the flood-prone area to be well-drained with the support of Irrigation Department.

Besides, proper soil and water management technologies should be promoted for improvement of soil fertility and soil structure. It has been well documented that the use of organic fertilizers and composts favors the better crop establishment and resilience to the climate change impacts. With the development of farm mechanizations in Khayan and Thonegwa areas, it comes up with more use of power tillers, less use of draught cattle and cow dung manure. It leads to the land degradation problem and disturbs the long term sustainability of ecosystem and economy of the local communities. It is, therefore, an urgent need to initiate a soil fertility improvement program, such as making composts, use of organic fertilizers, and etc. in these areas.

For the Minbu and Magway Townships, droughts as well as the rains are limiting factors for the successful mung bean production. The supplementary irrigation with tube wells may be a potential solution for drought. The proper soil fertility management needs to be initiated in mung bean production to encourage the crop resilience to drought and flood. In both study areas, GAP approach should be incorporated into the CSA system. Mung bean GAP includes use of good quality seeds, use of pest and disease resistant varieties, proper soil and water management practices. For the timely sowing use of agriculture farm machinery is necessary. However, most farmers cannot afford to buy their own and have to hire tractor and power tillers. Farmers have to wait to till their land due to the insufficient numbers of machines, resulting in delay sowing. Provision of sufficient numbers of farm machineries will encourage the farmers to get more return.

3.3.3 Disaster Risk Reduction in study areas

Myanmar is exposed to multiple natural hazards which include cyclone, storm surge, floods, landslide, earthquake, tsunami, drought, fire and forest fire. Furthermore, Myanmar ranks as one of the most vulnerable countries in the world to climate change. Since the impacts of natural disasters are expected to increase in future it is important to take the systematic DRR management measures. The Government developed the Myanmar Action Plan on Disaster Risk Reduction (MAPDRR) in 2017. Myanmar is committed to disaster risk reduction and it has systems and procedures at National, State/Region, District, Township, Wards and Village Tracts levels for disaster management.

Like many other regions of Myanmar, the study areas require the DRR management plans to be implemented. As evidence of natural disasters, the four villages in Khayan Township, namely Yay Kyaw, Boka Lay, KanKyaung and Sin Kyun were swept away due to coastal erosions in 2016 -17. All affected villages were relocated to a safer place soon after the disaster. Currently, about 5200 acres of alluvial land have emerged at original location of the villages. As a natural disaster management activity, the regional government is planning redistribute their lands to the locals. Moreover, to conserve and restore the environment affected by natural disasters, about 2300 acres of alluvial lands in Khayan Township were allocated as external mangrove forest by the Ministry of Natural Resources and Environmental Conservation.

Beside the erosion of banks and shores, rainfall-induced flooding is a recurring phenomenon; farmers in Khayan and Thonegwa farmers often encountered yield losses.

The warnings for flooding, storms, heavy rains should be disseminated in proper time so that farmers can avoid the crop losses in some ways.

Mung bean is a highly susceptible crop to pests and diseases so that farmers practice the injudicious use of pesticides application to avoid the crop damage. It can create a potential disaster risk – dangers caused by farming industries, such as air and water pollution which will affect to the village communities and surrounding environment. IPM technology should be incorporated into the DRR management programs to provide health, education, social and livelihood programs in order to make better living conditions for these communities. The programs of risk information and awareness and risk mitigation, particularly for use of agrochemicals, should be promoted in these townships.

In the study areas of Minbu and Magway Townships, many places are at risk from drought, earthquakes and fires. A big fire broke out in Pike Thin village in 2007 and about 90% of houses were destroyed. The victims were relocated to a nearby place. For the rehabilitation process, with the support of the Settlement and Land Record Department, the grants / certificates of ownership of the settlement were issued for all households of the new village. The village also received aids from governmental department and NGOs, such as provision of good quality seeds and agriculture techniques and GAP for sesame, cotton, groundnut from DOA, dairy cows from Animal Husbandry Department, and so on. The village was conferred to be a “Sample village” (San-pya -ywa in local language) in 2016 and it accessed the electricity in 2017. It also obtained the village development program of “Emerald Green Project” with large amount of funds (300 Lakh Kyats).

CONCLUSION

Myanmar stands as a leading country of largest pulses production among the ASEAN nations. Agriculture technology development and socio- economy status of Myanmar farmers, however, are comparatively lower than other countries. The underlying causes may be the long time constraints farmers have been facing. The prominent ones are high input costs and fluctuation of market prices. The situation is compounded by adverse weather which highly affected affects the yield and seed quality. The collaboration and cooperation among all stakeholders along the value chain are vital for addressing the issues and constraints facing by mung bean farmers these days. Based on the FGD and household surveys in study villages, it is well observed that farmers have been producing mung bean and enjoying a considerable profit for about two decades, although they have several constraints. More family income enhances the educational level of household members and there are I graduate farmers in villages. Village infrastructures and communication facilities these days such as houses, village roads and bridges were witnessed for the improvement. On the other hand, in spite of these infrastructure development, their environment (land, air, water, etc.) is degrading due to the unsustainable production system. Farmers apply injudicious use of pesticides to boost their production, which will surely pollute the environment, damage the air and water quality and adverse impacts on human health at present and worse in immediate future, if the counter measures are not taken place. It clearly manifested that the P4 team should work with these recommendations, in terms of technical advice to key farmers and service providers and in terms of policy recommendations to policy makers and private sector players. To fill the gaps, P4 project team will work with in terms of tools for monitoring DRR/ environmental protection/ CSA efforts within the project such as training and practicing GAP, choosing resilient seeds, etc.

Recommendation for the P4 Project

Based on the results of the survey research, the following are several entry points for the P4 Project to boost the productivity and production of the mung bean farmers in study areas.

(1) To overcome the constraints currently faced by farmers: The major production constraints are biotic stresses, such as pod borer, aphids, armyworm, powdery mildew and rust are the major pests and diseases affecting production, particularly in Yangon area. To introduce an IPM program in these areas, the P4 Project team should start working with Plant Protection Division of DOA. The project team can take a lead to set up demonstration plots, trainings of IPM practices, awareness raising for health education and environment related with use of agrochemicals, to the local mung bean farmers**.**

As socio-economic constraints, farmers' access to inputs is generally limited, because of low purchasing power and accessibility to markets. The farmers in Magway Region give first priority to other cash crops for allocating inputs and the less priority to mung bean. As a result, pulses are grown on poor soils with low inputs. Although Myanmar is a large pulses producer in the world, farmers treat pulses as secondary crops and the government also gives less importance to pulses compared to the staple crops of cereals.

(2) Improved varieties: There is lack of policy support on mung bean seed system so far. Availability of quality seed of improved varieties is one of the major constraints in increasing the production. Improved varieties of short-duration and high-yielding are required to enhance the productivity and production of mung bean in Myanmar. Matching the crop maturity duration to the available cropping systems, including soil moisture availability, is a major strategy to avoid drought stress. Therefore, crop improvement programs should focus on the development high-yielding, short-duration cultivars which can escape the terminal drought. These short duration varieties provide opportunities for inclusion of the particular variety in their cropping systems. In addition, a drought-tolerant variety will provide sustenance to the livelihoods of farmers who are highly vulnerable to shocks of crop failure.

On the other hand, even though the potential economic benefits of these crop improvement programs are attractive, farmers may not benefit from it if the appropriate institutional arrangements are not well in place for multiplication and distribution of seeds of these improved varieties. The accessibility of smallholder farmers to quality seed of improved pulses varieties is constrained by inadequate demands creation and limited supply. This situation is compounded by unfavourable and inadequate policy support of the national seed system, such as inadequate institutional and organizational arrangements, and deficiencies in production and supply infrastructure and farmers' socio-economic situation.

The numerous constraints which limit the performance of seed systems in Myanmar include limited access of smallholder farmer to seed of improved varieties; limited supplies of quality seeds (breeder, foundation and certified); lack of co-ordination and collaboration among national seed production organizations and policy making institutions (e.g., DAR and Seed Division and Extension Division of DOA, and etc.). In this area, the P4 Team will help to realize these programs effective, for example, networking among the stakeholders.

(3) Improved crop management practices: There are several research areas the P4 Team should work out. Examples are - input supply (micro-nutrients and fertilizer application), use of Rhizobium for seed treatment, introduction of line sowing method instead of broadcasting method in Yangon Region, shallow tube well irrigation, and etc.

In Yangon Region, mung bean is grown under moisture stress conditions. Yields are necessarily limited by the amount of water available to support growth. Research evidence showed that supplemental irrigation during critical stages can result in substantial improvement in mung bean yield. There is a great potential for enhancing mung bean yields through providing irrigations in rain fed farming, particularly in Yangon area.

(4) Mechanization: With ever increasing labor cost, manual harvesting has become an expensive operation for mung bean crop and farmers are increasingly opting for mechanical harvesting where it is feasible.
The current mung bean cultivars should be suited to mechanical harvesting (e.g., suitable plant height, erect growth habit). A few farmers started to use a harvester invented with a Kubota engine in some village. It was also noted that some farmers tested to apply weedicides to enhance the leave shedding and early flowing of second flush so that they could harvest only one time.

For enhancing the productivity and production, there are several “future challenges” mung bean farmers will have to encounter under the changing nature of climate and cropping systems in the study areas.

(1) Yangon area

Climate change impact: In Yangon Region, mung bean is cultivated in alluvial soil (Le lands after rice) with residual soil moisture. Therefore, the rainfall pattern was a critical issue for the mung bean time of sowing for farmers. Late sowing creates a considerable reduced yield. To apply CSA strategy, the following gaps need to be filled.

- Mechanization: Increasing mechanization offers opportunities of timely sowing under the climate variability as well as challenges (e.g. costs of machinery purchase, decline cattle population, decline of organic matter replenishment). After rice harvest, rice straws were commonly burned down so that land preparation is to be done as fast as possible. Because of rice harvest mostly done with combine harvester, the field needs to burn the straw residues or to plough them in with tractors. Only a small number the households who owns a tractor and /or a roller can integrate the straw into the soil. Other farmers hired tractors from companies and other private owners and many have to wait to get a tractor, because of the limited number of tractors.
- The more mechanization / use of farm machinery in land preparation in Yangon Region, the less Farm Yard Manure (FYM) applied to the field. Farmers more rely on mineral fertilisers and they need advice on the type and rate of fertilisers used to complement nutrients supplied as FYM. The soil degradation will become a big challenge for farmers in near future.
- In Yangon Region, all farmers use broadcasting method for mung bean growing while the Magway Region farmers are normally doing line sowing method. Line sowing method has several advantages over the broadcasting method. For the better crop management practices, such as weeding, inter-cultivation, effective application of pesticides, drainage, and reduction in seed cost, etc., line sowing method should be initiated in Yangon area.

- Mungbean in Yangon area is mono- cropping after rice; two main crops, very few crop diversities. Plant disease and pest occurrence likely to increase to a threat level to the environment. It was recorded that the pesticide application is more in Yangon Region compared with Magway Region.
- Crop Management: At the sowing time, mung bean seeds should be mixed with fungicides and or Furadan placed in rows before planting seeds. The survey results showed that most farmers do not follow this practice. Pesticide application was recommended by DOA for four times of application: 10 days after sowing, 21 days after sowing, the flowering time, and seeding time. However, farmers usually applied pesticides about eight to ten times.
- IPM packages in rice production were successfully introduced to farmers by DOA the extension personnel and Plant Protection Division. Similarly, IPM packages in pulses production should be implemented to mung bean farmers as a low-cost and environmentally- friendly measure to control pests. To effectively disseminate the above-mentioned IPM technologies, education and extension programs of the Department of Agriculture (DOA) should devote more time to hands-on technology demonstrations, experimental plots of pest-resistant varieties, field visits and etc. More extension programs and technical support to mung bean farmers will help increase the quality of their farm management practices and reduce the health risks from overusing and /or mishandling of pesticides. P4 Project should help to realize these programs in collaboration with DOA staffs.

The following are the recommendations for the related government agencies –

- To provide more trainings to mung bean farmers and hired workers on proper pesticide usage, provide public health education to mung bean farmers on pesticide handling and safety practices
- To monitor the pesticide importing companies, dealers and retailers for the proper and registered pesticides

(2) Magway area

- Main crops of Magway area are sesame, peanut, cotton and pulses, including mung bean, cultivated in upland/Ya land. Crop diversity in Magway area is much more than in Yangon area, however, it is too little cereals to balance legumes and sesame/peanut.
- Time of sowing of Magway Region is in monsoon season (June to August). The harvest time often meets with post monsoon rains and the quality of mung bean is reduced. The sown areas have been declining in Magway Region in recent years. In 2017 it was estimated only one-fourth of mung bean area retained in the study villages. The main reasons were, comparing with other crops, mung bean requires high cost of labor (especially for pod collection), unreliable market price and yield loss by fluctuated rainfalls.
- Magway Region farmers mostly use cattle for land preparation; only when they need to be hurry they hire machine, particularly a tractor. These days because of more fluctuated rains, farmers need to grow their crops fast and machines are necessary –

many farmers use cow and machine together. Normally crop residues are not used for making compost. Sesame/ peanut / pulses residues are mostly burned. The P4 team should help to encourage the use organic matter/ compost.

- The P4 Team supported Sesame seed production by establishing a network of stakeholders in value chain. Similarly, it will be a great help if the P4 Team can do the same process in mung bean seed production. Comparing with Yangon Region, farmers in Magway Region has poorer access for mung bean seeds and market.

In order to boost the mung bean production, the following are recommendation the concerned departments (e.g. MOALI - DOA, DAR, DOM; Ministry of Commerce, and etc.) should undertake -

- Help to stabilize the market and prices of the mung bean
- To provide sufficient farm machines in time of land preparation
- To provide quality seeds, effective and good quality fertilizer and pesticides
- Introduce IPM / proper control measures for the pest and disease management
- To share more knowledge and better techniques for successful growing of mung bean
- To keep the flood-prone area to be well-drained (particularly in Yangon Region)
- To find ways and means to solve salinity problem in the areas prone to tidal invasion (particularly in Yangon Region)
- To disburse sufficient long-term loan (3-4 years) to farmers

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Attachment 1: Land use type in Khayan Township, Yangon Region

	Land use type	**Area (acre)**
	Total net Sown area	115,966
	A. Le (Paddy area)	110,461
	B. Ya (upland)	-
	C. Alluvial land	-
	D. Orchard	1,071
	E. Dani (Nypa)	41
	fallow land area	1,337
	A. Le (Paddy area)	1,337
	B. Ya (up land)	
	C. Alluvial land	-
	D. Orchard	-
	E. Dani (Nypa)	-
	Pasture land area	6,569
	Industrial land	79
	Urban and others	6,172
	Rural area	4,791
	Other land	39,157
	Reserved and non-reserved forest area	-
	Virgin land area	5,963
	Uncultivable land area	21,172
	TOTAL	151,518

Source: DOA office, Khayan Township, Yangon Region, 2017

Attachment 2: Land use type in Thonegwa Township, Yangon Region (2017)

	Land use type	**Area (acre)**
	Total net Sown area	145,943
	A. Le (Paddy area)	144,403
	B. Ya (up land)	-
	C. Alluvial land	-
	D. Orchard	951
	E. Dani (Nypa)	589
	Total fallow land area	2,778
	a. Le (Paddy area)	2,778
	b. Ya (up land)	
	c. Alluvial land	-
	d. Orchard	-
	e. Dani (Nypa)	-
	Pasture land area	2,946
	Industrial land	50
	Urban and others	969
	Rural area	4,791
	Other land	39,157
	Reserved and non-reserved forest area	-
	Virgin land area	9,815
	Uncultivable land area	47,913
	TOTAL	206,449

Source: DOA office, Thongwa Township, Yangon Region, 2017

Attachment 3: Crop production of ten major crops in Khayan Township, Yangon Region

	Crop	Season	Planned area (ac) for 2016-17	2016-2017			
				Sown (ac)	Harvested (ac)	Yield (bsk/ac)	Production (basket)
	Paddy Total	Summer	406	10		73.65	30,197
		Monsoon	112,317	12,282	112,282	71.49	7,907,932
	Groundnut	Monsoon					
		Winter	127	21		50.55	6,116
	Sesame	Monsoon	-			-	-
		Winter	-			-	-
	Sunflower						
	Black gram		-				
	Mung bean	Monsoon					
		winter	101,002	01,002	101,002	15.28	1,542,868
	Pigeon pea	-	-			-	-
	Cotton	-	-			-	-
	Sugarcane						
	Corn						

Source: DOA office, Khayan Township, Yangon Region, 2017

Attachment 4: Crop production of ten major crops in Thonegwa Township, Yangon Region

	Crop	Season	Planned area (ac) for 2016-17	2016-2017			
				Sown (ac)	Harvested (ac)	Yield (bsk/ac)	Production (basket)
	Paddy Total	Summer					
		Monsoon	150,168	150265	150,265	70.59	10,608,113
	Groundnut	Monsoon					
		Winter	119	41	41	50.24	2,059
	Sesame	Monsoon					
		winter	100	3	3	9.33	28
	Sunflower		1,534	24	24	4.96	119
	Black gram			1,358	1,358	9.37	12,731
	Mung bean	Monsoon					
		Winter	13,078	128,749	128,749	15.43	1,986,684
	Pigeon pea		-	-	-	-	-
	Cotton		-	-	-	-	-
	Sugarcane		-	-	-	-	-
	Corn		-	-	-	-	-

Source: DOA office, Thonegwa Township, Yangon Region, 2017

Attachment 5: Land use in Minbu (Saku) Township, Magway Region

	Land use type	**Area (acre)**
	Total net Sown area	147,674
	A. Le (Paddy area)	36,207
	B. Ya (up land)	99,387
	C. Alluvial land (Kaing)	11,913
	D. Orchard	167
	E. TaungYa	-
	Total fellow land area	-
	Pasture land area	-
	Industrial land	-
	Urban and others	103,559
	Reserved and non-reserved forest area	78,356
	Virgin land area	81,745
	Myayyein	-
	Uncultivable land area	-
TOTAL		411,334

Source: DOA office. Minbu (Saku) Township, Magway Region, 2017

Attachment 6: Land use type in Magway Township, Magway Region

	Land use type	**Area (acre)**
	Total net Sown area	198,656
	F. Le (Paddy area)	4,225
	G. Ya (up land)	187,779
	H. Alluvial land (Kaing)	5,646
	I. Orchard	6
	J. Dani (Nypa)	-
	Total fallow land area	109
	B. Le (Paddy area)	40
	F. Ya (up land)	69
	G. Alluvial land (Kaing)	-
	H. Orchard	-
	I. Dani (Nypa)	-
	Pasture land area	162
	Industrial land	2,562
	Urban and others	46,184
	Reserved and non-reserved forest area	5,519
	Virgin land area	174
	Uncultivable land area	171,239
	TOTAL	436,623

Source: DOA office. Magway Township, Magway Region, 2017

Attachment 7: Crop production of ten major crops in Minbu Township, Magway Region

	Crop	Season	Planned area (ac) for 2016-17	2016-2017			
				Sown (ac)	Harvested (ac)	Yield (bsk/ac)	Production (basket)
	Paddy Total	Summer	-	520	-	-	
		Monsoon	-	38,084	38,084	93.19	3,549,120
	Groundnut	Monsoon	-	5,794	5,794	52.55	304,475
		winter	-	8,063	8,063	60.14	484,103
	Sesame	Monsoon	-	74,670	74,407	10.10	771,049
		winter	-	1,423	1,423	13.73	19,538
	Sunflower		-	17,193	17,193	29.51	1,097,783
	Black gram		-	753	753	18.48	13,915
	Mung bean	Monsoon	-	74,670	54,456	16.20	882,187
		winter	-	-	-	-	-
	Pigeon pea		-	10,653	10,653	17.95	191,221
	cotton	Monsoon	-	32,261	32,261	603.23	19,460,874
	Sugarcane		-	6	6	13.52	81
	Seed corn		-	6,435	6,435	59.67	383,982

Source: DOA office. Minbu (Saku) Township, Magway Region, 2017

Attachment 8: Crop production of ten major crops in Magway Township, Magway Region

	Crop	Season	Planned area (ac) for 2016-17	2016-2017			
				Sown	Harvest	Yield	Production (basket)
	Paddy Total			146	-	-	-
		Monsoon	5,416	2,526	2,526	83.14	210,018
	Groundnut	Monsoon	47,699	70,396	70,396	57.60	4,052,012
		Winter	1,892	1,585	1,585	82.34	130,509
	Sesame	Monsoon	181,932	184,354	181,545	13.50	2,465,470
		Winter	4,866	1,055	1,055	13.85	14,612
	Sunflower		15,835	`1,551	1,551	24.63	38,196
	Black gram		100	683	683	19.25	13,148
	Mung bean	Monsoon	60,944	52,151	52,151	14.49	755,661
		winter	2,961	1,408	1,408	15.57	22,176
	Pigeon pea		33,752	28,616	28,616	17.46	499,669
	cotton	Monsoon	24,050	12,252	12,241	612.42	7,496,670
	Sugarcane		-	-	-	-	-
	Corn		-	-	-	-	-

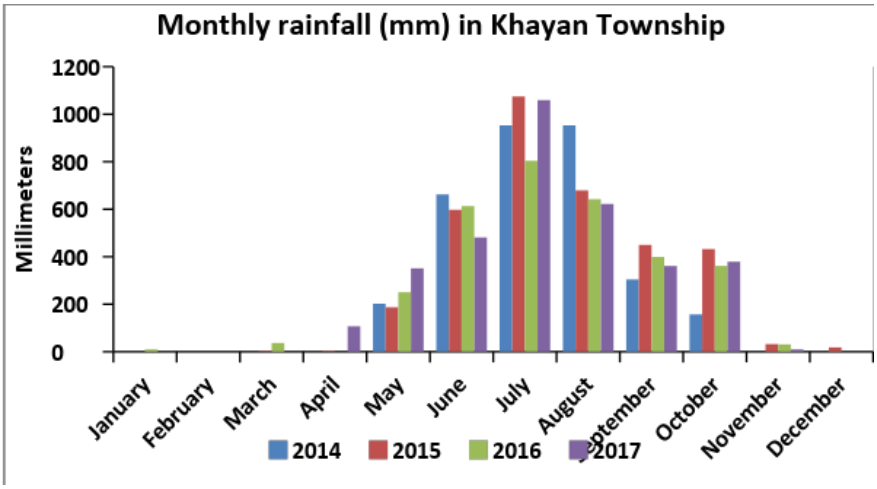
Source: DOA office. Magway Township, Magway Region, 2017

Attachment 9: Monthly rainfall data in Kayan Township (2014 – 2017)

Sr.	Month/ Year	2014		2015		2016		2017	
		Rainy days	RF mm	Rainy days	RF mm	Rainy days	RF mm	Rainy days	RF mm
1	January	0	0.0	0	-	1	9.9	0	-
2	February	0	0.0	0	-	0	-	0	-
3	March	0	0.0	1	3.0	3	36.8	0	-
4	April	0	0.0	1	3.0	0	-	2	106.9
5	May	13	202.2	6	186.9	9	250.4	13	351.0
6	June	19	661.9	25	597.9	24	612.9	26	481.1
7	July	29	952.8	28	1,074.4	27	804.2	29	1,058.9
8	August	28	952.8	28	679.7	26	642.6	30	622.0
9	September	18	304.3	23	449.8	22	399.0	21	360.9
10	October	**14**	157.0	13	432.1	18	361.2	15	379.0
11	November	0	0.0	3	32.0	5	30.7	2	10.2
12	December	0	0.0	1	18.0	0	-	0	-
	Total	**121.0**	**3230.9**	**129.0**	**3,477.0**	**135.0**	**3,147.8**	**138.0**	**3,370.1**

Source: GAD office. Khayan Township, Yangon Region, 2017

Attachment 10: Monthly rainfall (mm) in Khayan Township (2104 – 2107)



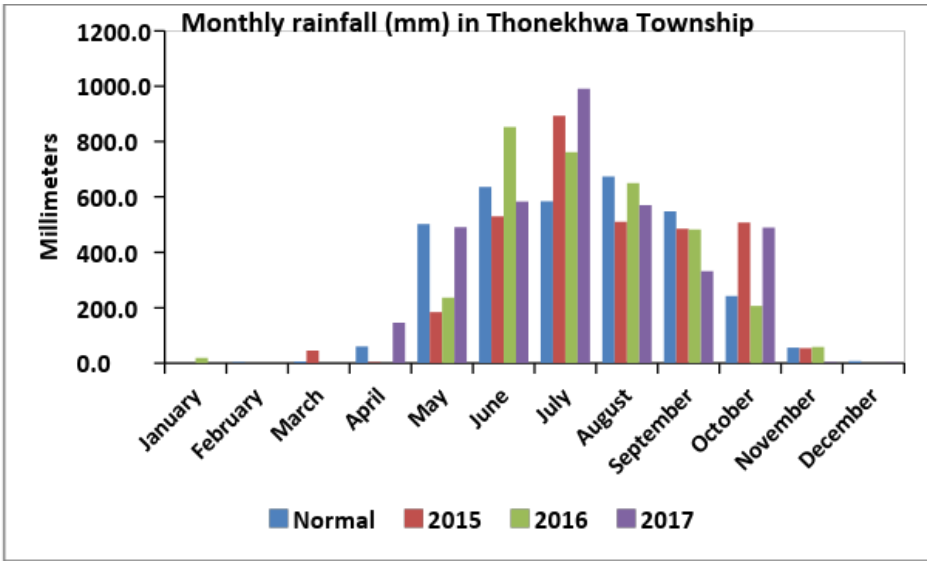
Source: GAD office. Kayan Township, Yangon Region, 2017

Attachment 11: Monthly rainy data in Thonegwa Township (2015 – 2017)

Sr.	Month/ Year	Normal/ Average for ten years		2015		2016		2017	
		Rainy day	RF (mm)	Rainy days	RF (mm)	Rainy days	RF (mm)	Rainy days	RF (mm)
1	January	-	0.3	-	0.0	1	19.1	0	-
2	February	1	3.6	-	0.0	-	0.0	0	-
3	March	1	6.4	2	45.5	-	0.0	0	-
4	April	2	60.2	1	3.0	-	0.0	2	146.1
5	May	18	502.7	9	184.2	8	236.5	12	491.2
6	June	25	636.5	25	529.3	26	852.9	24	583.4
7	July	23	584.2	26	892.6	27	762.0	28	990.3
8	August	25	674.4	26	510.5	26	650.0	28	570.5
9	September	20	548.4	23	485.9	24	482.6	19	332.0
10	October	10	242.3	14	508.3	20	206.5	20	489.0
11	November	2	55.9	3	54.1	4	58.4	1	4.1
12	December	1	7.6	-	0.0	-	0.0	1	2.0
	TOTAL	**128**	**3322.3**	**129**	**3213.4**	**136**	**3268.0**	**134.**	**3,608.6**

Source: GAD office. Thongwa Township, Yangon Region, 2017

Attachment 12: Monthly rainfall (mm) in Thonegwa Township (2015 – 2017)



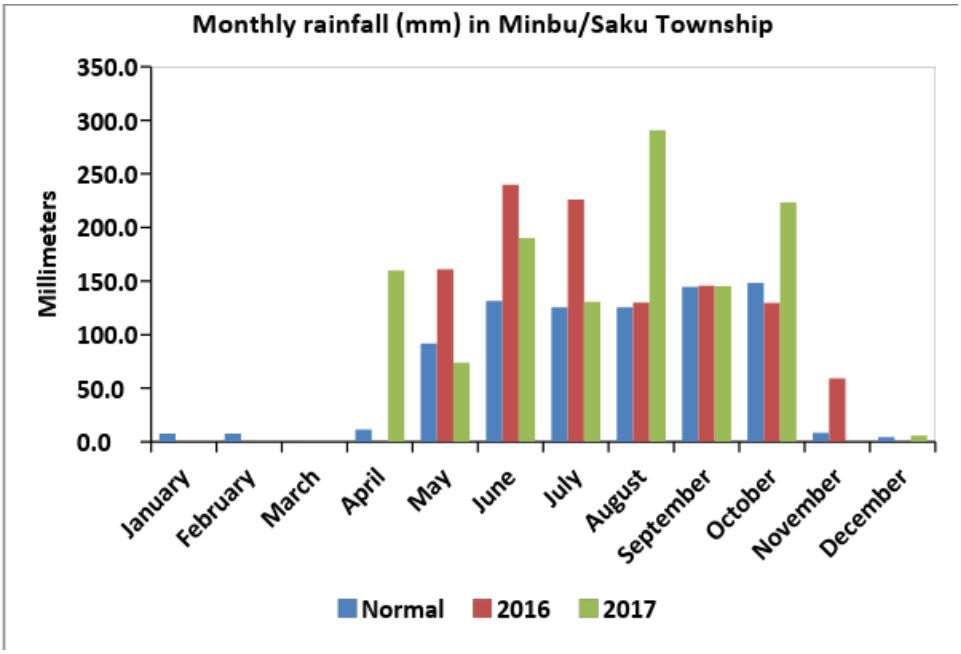
Source: GAD office. Thonegwa Township, Yangon Region, 2017

Attachment 13: Monthly rainfall data in Minbu/Saku Township (2016 – 2017)

Sr	Month/ Year	Normal		2016		2017	
		Rainy day	RF (mm)	Rainy day	RF (mm)	Rainy day	RF (mm)
1	January	1	7.6	0	-	0	-
2	February	0	7.6	0	-	0	-
3	March	0	0.5	0	-	0	-
4	April	1	11.4	0	-	3	160.0
5	May	6	91.7	7	161.0	4	73.9
6	June	12	131.6	12	240.0	15	190.0
7	July	11	125.5	12	226.1	11	130.6
8	August	10	125.5	12	129.8	16	290.8
9	September	10	144.5	13	145.5	14	145.3
10	October	9	148.1	11	129.5	13	223.3
11	November	1	8.4	5	59.2	0	-
12	December	1	4.3	0	-	1	5.8
	TOTAL	**62**	**806.7**	**72**	**1,091.2**	**77**	**1,219.7**

Source: GAD office. Minbu (Saku) Township, Magway Region, 2017

Attachment 14: Monthly rainfall (mm) in Minbu/Saku Township



Source: GAD office. Minbu (Saku) Township, Magway Region, 2017

Attachment 15: Weather data of Magway Township, Magway Region

Sr	Year	Rainfall		Temperature	
		Rainy days	Rainfall (mm)	Maximum °C	Minimum °C
1	2010	68	1098	45.5	8.5
2	2011	87	1052	42.2	10.5
3	2012	73	759	43.5	10.4
4	2013	77	1011	44.0	10.5
5	2014	55	604	43.0	13.1
6	2015	62	1170	44.2	10.1
7	2016	77	1271	46.5	8.2

Source: GAD office. Magway Township, Magway Region, 2017

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