Research article

New Science Tools for Spatial Distribution of Yield and Management Practices of Major Pulse in Selected Area in Myanmar

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Received 31 December 2017 Accepted 5 May 2018 (*Corresponding Author)

Abstract Pulses are one of the major agricultural exports in Myanmar. About 70 percent of all pulses are normally grown immediately after monsoon rice in middle and lower region. Farmers are not achieving the optimum yield due to inappropriate crop management and insufficient technological solutions although modern varieties are cultivated extensively. The introduction of applying new science tools such as GPS, GIS and drone image can develop timely and accurate estimation of crop areas and forecasting its production. It may also provide governments, planners, and decision makers with essential information to make a successful plan of appropriate technologies in regard to import/export. The study was conducted at Kyee Inn Village, Pyinmana Township, middle Myanmar from December 2016 to May 2017 to expose mapping for spatial distribution of yield and management practices. Drone flying had done by using DJI Phantom 4 drone and Litchi software. Drone photos were consolidated and prepared for digitizing and analyzing with pix 4D software and ArcGIS. Seventy farmers were selected as sample respondents for collecting ground truth information of yield and management practices based on pulses cultivated area. The study revealed that the major pulse grown in target area was black gram with yields ranging from 0.16 to 2.29 MT/hectare. The majority of respondents were found to have low level adoption of Good Agriculture Practices (GAP) of black gram recommended by Agricultural Department. It is urgently needed to upgrade full adoption of improved recommended package of practices by supporting training institutions to train the farmers and recommend technological solutions for the increase of productivity. Thus, new science tools such as GPS, GIS and drone image must be applied in agricultural system for increasing crop productivity as well as improving livelihood of the farmers.

Keywordsp pulses, new science tools, mapping, yield, management practices

INTRODUCTION

Pulses are one of the major agricultural exports in Myanmar. The major pulses exported are black gram, green gram, pigeon pea, kidney bean and cow pea. Pulses are grown on 4.20 - 4.30 million hectares of area with an annual production of 5.04 -5.16 million tons (GAIN, 2017). About 70 percent of all pulses are normally grown immediately after the harvest of monsoon rice in middle and lower region. Farmers are not achieving the optimum yield due to inappropriate crop management and insufficient technological solutions although modern varieties are cultivated extensively (Phway Su Aye et al., 2013).

Spatial data incorporating with socioeconomic information relating to pulses cultivation is possible to perform appropriate technological solutions for constraints of their cultivation. Currently, nationwide pulses production area has been obtained with statistically-based ground surveys but there has been seldom precise information on spatial distribution of yield, management practices and constraints of major pulses. Indeed statistical data are costly, time-consuming and do not provide sufficient detailed information to determine either the extent or the geographical distribution of major crops.

The introduction of applying new science tools such as Global Positioning System (GPS), Geographical information systems (GIS) and drone image can develop timely and accurate estimation of crop areas and forecasting its production (Wyland, 2009). Geographical information systems (GIS) technology in combination with ground surveys can relate spatial distribution of crop yield and management practices that would determine the extent of major crop production and constraints to their cultivation (Sreedevi et al., 2009). Moreover, it may provide governments, planners, and decision makers with essential information to successfully plan and deploy appropriate technologies in the most effective manner in regard to import/export.

OBJECTIVES

The objective of this research was to expose mapping for spatial distribution of yield and management practices of major pulse in selected area using new science tools.

METHODOLOGY

Study area: The research was conducted at Kyee Inn Village, Pyinmana Township, middle region of Myanmar, which lies between north latitudes 19°42'30" and 19°43'40" and east longitudes 96°13'30" and 19°15'30" from December 2016 to May 2017 (Fig 1.). Total study area is 483ha and pulses are grown just after the harvest of monsoon rice as double cropping (Table 1).

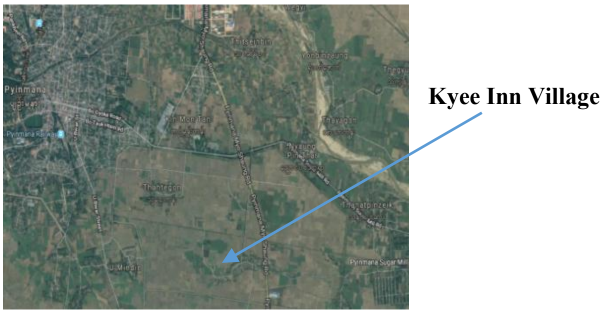

Fig. 1 Study area at Kyee Inn Village, Pyinmana Township, Myanmar

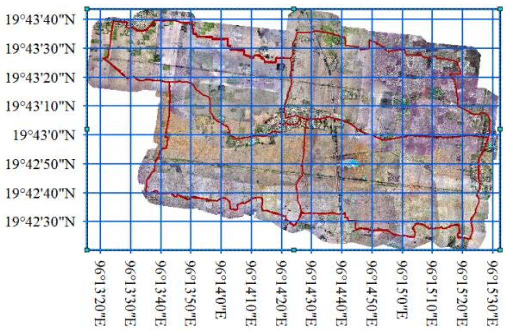

Fig. 2 Sample plots taken in study area using grid sampling system

Table 1 Total cultivable area and major pulses growing area in study area, 2016

Block No.	Cultivable area (ha)	Major pulse Area (ha)	Percent (%)
1698	120	107	89.17
1699	100	84	84.00
1708	114	100	87.72
1709	149	137	91.95
Total	**483**	**428**	**88.61**

Source: DoALMS Pyinmana Township

Data collection: Using 300m × 300m grid sampling system, total numbers of 104 grid squares were taken in the study area (Fig 2.). Grid squares located outside of the study area were removed and left 78 grid squares which had been cultivated with pulses. One plot from each grid squares was randomly selected as a sample plot and surveyed in the field for ground truth data. Seventy farmers occupied in sample plots were selected as sample respondents and interviewed with the help of well-structured questionnaire. The data collected were demographic characteristics of the respondents, yield and cultivation of major pulses practiced by the respondents, source of seed availability and constraints of management practices related to major pulses cultivation in the study area.

Field basemap hardcopy used as the base layer for digitizing and required secondary data were gathered from Department of Agricultural Land Management and Statistics (DoALMS), Pyinmana Township, Union of Myanmar.

Drone Flying: Drone flying had done by using DJI Phantom 4 drone and Litchi software at an altitude of 120 meters above the ground. Drone photos were consolidated and prepared for digitizing and analyzing with pix 4D software to provide digital base map of the study area. Thematic mapping for spatial distribution of yield and management practices were provided using ArcGIS Desktop [software] from Environmental Systems Research Institute (ESRI).

RESULTS AND DISCUSSION

Cultivation Conditions of Major Pulses in the Study Area

Major pulse grown in the study area was black gram (*Vigna mungo* (L.). Figure 3 shows total sown area possessed by sample respondents ranging from 0.2 to 11.0ha. Most of sample respondents (72%) were experienced with pulses cultivation in 4-10 years, 26% in 11-20 years and only 2% in 21-30 years respectively (Fig 4.).

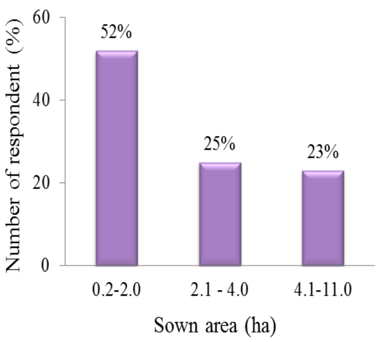

Fig. 3 Sown area possessed by sample respondents in study area

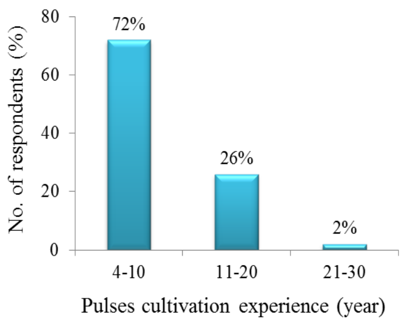

Fig. 4 Pulses cultivation experience of sample respondents in study area

Cultivation Practiced by Sample Respondents in the Study Area

Seed source and variety used: Figure 5 reveals that most of the sample respondents in study area applied their own seed or dealer seed for sowing. Only 5% of them applied quality seed from research station. They usually practiced by storing their own seed or exchanging with dealer seed at the time of crop harvest. This clearly indicates that the necessity of quality seed multiplication program should be undertaken with cooperative farmers by Department of Agriculture (DOA).

The black gram varieties commonly sown by sample respondents were Yezin-6 (Sepae), Yezin-5 (Paenat) and Yezin-2 (Matpae Yoeyoe) (Fig 6.). Among them, Yezin-5 is more longer duration (100-110 days) than Yezin-6 (90-95 days) and Yezin-2 (70-75 days).

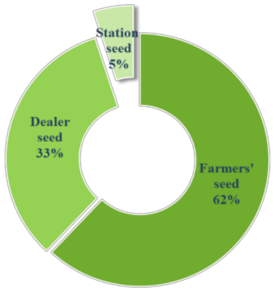

Fig. 5 Seed source of sample respondents in study area

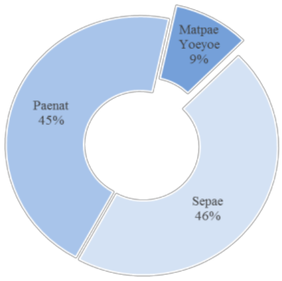

Fig. 6 Black gram varieties sown by sample respondents in study area

Time of sowing and method of sowing: In the study area, 4%, 59% and 37% of sample respondents sowed black gram in October, November and December, respectively. The optimum time of sowing for black gram recommended by Department of Agricultural Research (DAR) is during mid-October to end of November. It was found that some of the farmers in study area could not sow black gram timely. The reason given by the farmers was late harvest of monsoon rice possibly relating with late onset of monsoon or irregular rain during harvesting of monsoon rice in that area.

All of the sample respondents in study area used broadcasting practice in seed sowing. Although Department of Agriculture (DOA) endorses line sowing method for pulses cultivation, all of the farmers in study area did not adopt that practice. The constraints for adoption of practice as expressed by a majority of farmers were labor shortage and insufficient mechanical implements for line sowing.

Applying basal fertilizer and seed treatment: The majority of sample respondents (94%) did not apply fertilizer as basal application during land preparation. Because of the high cost of fertilizers, they usually apply basal fertilizer for monsoon rice and rarely for black gram. Moreover 96% of them did not treat the seed with pesticide and fungicide at the time of sowing. Perhaps they may not familiarized with the practice of seed treatment.

Seeding rate and plant population at vegetative growth stage: It was noticed that 59% of sample respondents practiced the optimum seeding rate (60kg/ha) recommended by DOA whereas less seeding rate by 10% and 31% applied more than the optimum rate. Furthermore, it was observed that 59% of sample respondents achieved normal plant population while 4%, sparse and 37%, dense at vegetative growth stage. Probably normal plant population may be concerning not only with seeding rate but also adequate amount of residual soil moisture at sowing time.

Spatial Distribution of Yield and Management Practices

According to spatial distribution of grid squares, it was found that black gram variety applied in most of the sample plots was Yezin-5 in western part and Yezin-6 in eastern part of study area. Moreover the trend in spatial distribution of yield also revealed that yield per hectare in western part was lower than that in eastern part of study area (Fig 7.). It may be in agreement with the potential yield of black gram variety, 1.6-2.0 ton/ha for Yezin-5 and 2.5-3.3 ton/ha for Yezin-6, reported by Department of Agricultural Research (DAR, 2016).

Generally, it was clear in Fig 7 that the yield of Yezin-2 and Yezin-6 variety in most of the sample plots were not considerably affected by time of sowing although a few days later than recommended sowing time. In contrary, the yield was diminished by late sowing time in the sample plots applied with Yezin-5. It indicates that crop duration of the variety should be considered if the sowing time will be late because of the dependence on residual soil moisture for crop's success.

Spatial distribution of management practices such as weed management, spraying frequency of foliar fertilizer and pesticide were shown in Fig 7. It was found that weed management practices are not applied in sample plots at the middle of study area. About 2-12 spraying frequency for the whole season was applied in half of the sample plots (54%) and the rest applied till to 15.

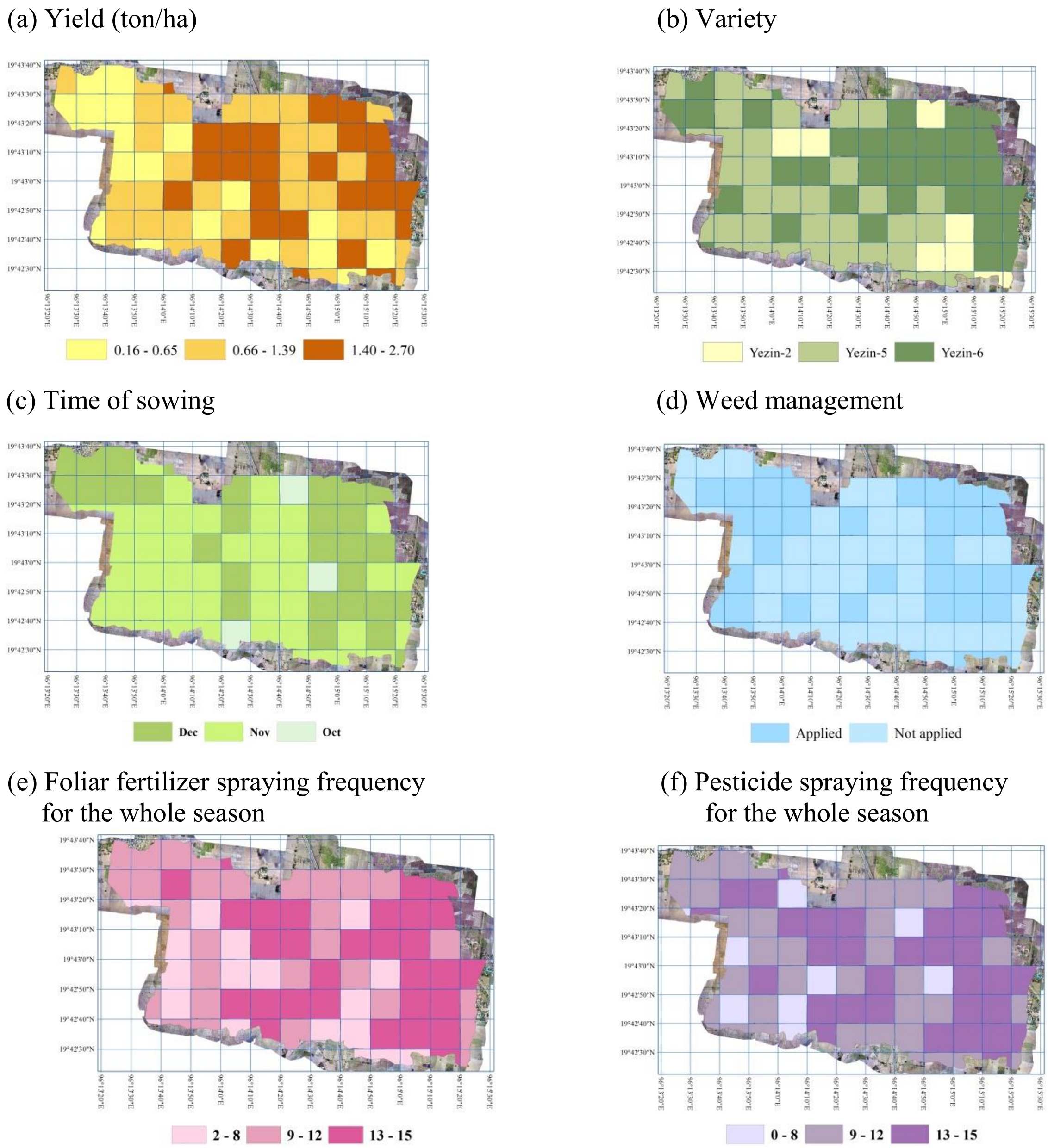

Fig. 7 Spatial distribution of yield and management practices based on sample plots randomly in each grid squares in study area

Regarding to foliar fertilizer and pesticide spraying frequency mapping, it was noticed that higher spraying frequency were applied in the sample plots at the middle and eastern part of the study area. The reason said by the sample respondents was that higher spraying frequency was required to increase black gram yield starting from 15 days after emergence to 15 days before harvest.

Constraints for Good Agriculture Practices of Black Gram

The data regarding the constraints for Good Agriculture Practices (GAP) of black gram perceived by sample respondents were stated in Table 2.

Table 2 Constraints for good agriculture practices of black gram

Good Agriculture Practices (GAP)	Constraints
- To apply good quality seed for sowing	- Insufficient supply of quality seed
- To sow timely with recommended sowing time	- Late harvest of monsoon rice
- To apply line sowing method	- Labor shortage and insufficient mechanical implements for line sowing
- To apply fertilizer as basal	- High cost of fertilizers
- To apply seed treatment with pesticide and fungicide	- Not familiarized with the practice

CONCLUSIONS

Use of drone image along with GIS helps quick and accurate analysis on huge data. According to the results, mapping allows to identify easily the correlation between spatial distribution of yield and management practices of black gram in the study area. Since a thematic map has a table of contents that allows adding layers of information to a basemap of the study area. The majority of respondents were found to have low level adoption of Good Agriculture Practices (GAP) of black gram recommended by Agricultural Departments. It is urgently needed to upgrade full adoption of improved recommended package of practices by supporting training institutions for training of the farmers and advising technological solutions for the increase of pulses productivity. It was clear that another study can be extended across the country as the present study. The use of new science tools are cost effective and time saving, thus it must be applied in agricultural system for increasing crop productivity as well as improving livelihood of the farmers.

ACKNOWLEDGEMENTS

The authors would like to thank the generous financial and technical training support of Japan International Cooperation Agency (JICA) Project for Capacity Development of Yezin Agricultural University. We also gratefully acknowledge Chief Advisor Professor Tanaka Koji, Dr. Yamamoto Yosi, Dr. Kazuo Watanabe and Mr. Nihsimoto Goro for their generous technical and intellectual support and valuable involvement in this study. We are also appreciative to the authorized persons from Department of Agricultura (DOA) and Department of Agricultural Land Management and Statistics (DoALMS) for data provision.

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