EVALUATION OF FERTILIZER MANAGEMENT ON DIFFERENT MAIZE DIFFERENT VARIETIES IN SOUTHERN SHAN STATE

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A thesis submitted to the post-graduate committee of the Yezin Agricultural University as a partial fulfillment of the requirements for the degree of Master of Agricultural Science (Agronomy)

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The thesis attached hereto, entitled **"Evaluation of Fertilizer Management on Different Maize Varieties in Southern Shan State"** was prepared under the direction of the chairperson of the candidate supervisory committee and has been approved by all members of that committee as a partial fulfillment of the requirements for the degree of "**Master of Agricultural Science (Agronomy).**

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This thesis represents the original work of the author expect where otherwise stated. It has not been submitted previously for a degree at any other university.

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ABSTRACT

The study was carried out with four objectives (1) to explore the current cultural practices and constraints in maize production, (2) to observe the highest fertilizer response on growth performance of grain maize varieties, (3) to determine the effect of fertilizer management practices in response on yield and yield components and (4) to assess farmer perception on varieties and fertilizer management practices. Survey was conducted in Kalaw Township of four villages by interviewing 120 farmers with simple random sampling method using well structured survey questionnaires from December 2016 to January 2017.The sample farmers did not follow GAP (Good agricultural practices) of maize formulated by DOA. More than half of the sample farmers (65%) are primary education level. Thus, it is hard to understand the new technology especially good agricultural practices (GAP). Maize yield are decreasing because sample farmers are growing with traditional methods. Therefore, government and private sector should participate in maize GAP training for farmers. The field experiment was conducted at Aung Ban Research Station under Department of Agricultural Research by using split plots design with three replications. Five maize varieties were used as tested varietyunder four levels of fertilizer management practices. SAPA fertilizer application practice gave the highest grain yield, yield components and agronomic parameters than the others.It may be probably due to higher fertilizer application rate together with micronutrients especially more potassium application with S, Ca and Mg than other practices. Among the varieties, NK 621 variety gave the maximum yield, yield components such as number of kernels per row, thousand seed weight and agronomic characters such as SPAD value, ear weight and ear diameter. "In combination effect of SAPA fertilizer and SA282 variety gave the maximum yield but the yield of SA 282 was not significantly different with NK 621. The farmer participatory selection showed the highest score for SAPA fertilizer management and NK 621 and SA 282. Therefore, these two varieties were found as the best performing in grain yield and good potential for the future in Southern Shan State.

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CHAPTER I

INTRODUCTION

Agriculture plays an important role in economic growth, enhancing food security, poverty reduction and rural development. However majority of smallholder farmers relies on traditional methods of production and this has lowered the level of productivity. For instance Over 70% of the maize production in the majority of developing countries is from smallholders who use traditional methods. These farmers generally obtain very low crop yields because the local varieties used by farmers have low potential yield, most of the maize is grown under rain-fed conditions and irrigation is used only in limited areas, little or no fertilizers are used and pest control is not adequate (Muzari et al. 2012).

Maize (*Zea mays* L.) production in Asia countries is being increasingly important as the demand for both national needs and export is expending quickly. Maize is the second most important cereal crop in Myanmar, which is used as human consumption, animal feed for livestock farming and as one of the major agricultural products for export. Hence more production of maize is needed through expansion of cultivable area and increased production per unit area. In Myanmar, the average yield of maize in 2014-2015 was 3.75t ha^{-1}, the total sown area was 459000ha and produced 1.71 MT and the export was 1.3562 MT (MOAI 2015).

Good Agriculture Practices (GAP) have encouraged to farmer that address environmental, economic and social sustainability for on-farm processes and to be better results in safe and quality food and non-food agriculture products. The GAP package consisted with land preparation, plant density with number of seeds per hole, time and frequency of weeding and pest and diseases control. Adoption of GAP creates the chances for farmers to have higher profits in grain yield and food safety. Increase in productivity can be achieved by better agronomic management such as proper planting and weeding which increase the efficiency with which available nutrients, water and labor.

Poor management of fertilizer has major key role to play in obtaining low yield productivity, so in order to achieve optimum crop productivity management of nutrients through careful application of organic sources, bio-fertilizers and micro-nutrients are required (Ghaffari et al. 2011). In addition, the fertilizer management is one of the most important factors that influence the growth and yield of maize crop.

Maize is considered as most exhaustive crop after sugar cane and requires both micro and macro nutrients to obtain high growth and yield potentials. In fact, organic nutrients not only provide plant with nutrients but also improve and or sustain the soil health. The micronutrients content in organic manure may be sufficient enough to meet the crop production requirement but problem of low soil fertility is one of the obstacles to maintain and sustain agricultural production and productivity Kumar (2011).

Fertilizer application and management play an important role in increasing the maize yield and their contribution is 40-45 percent. . In spite of the increase in land areas under maize production yield is still low. Some of the major causes of low maize yield are declining soil fertility and insufficient use of fertilizers resulting in severe nutrient depletion of soils (Bruesh et al. 1997).

Nitrogen (N) is important nutrient to maximize crop growth, thus it is often applied to agricultural crops if available (Tilman et al. 2011). Although N fertilizer application can improve maize yields, if overused, it can also have negative environmental impacts such as groundwater pollution through nitrate leaching or increased global warming resulted to N_2O emissions (Burney et al. 2010). N increases vegetative growth and the photosynthetic capacity of the plant. Nitrogen determines the number of leaves the plants produces and the number of seeds percob, and therefore determines yield potential. About two‑thirds of the N absorbed by the plant ends up in the kernels at maturity. If the plants is deficient in nitrogen common symptoms are: leaves become pale greener yellow, premature yellowing starts at the tip and moves along the middle of leaf, and lower leaves appear burnt. Additionally, ears are small and protein content is low, and kernels at the tip of the cob are not filled.

Potassium (K), one of these three primary nutrients, is absorbed by plants in larger quantities than any other element; expect N (Krauss 1997). K plays a vital role as macronutrient in plant growth and sustainable crop production (Bukhsh 2010).Maize is also a demanding crop for P and is quite sensitive to low P availability, especially in the early growth stages. Fertilizer P should be applied at sowing, as most of the P is taken up early in the life of plants, particularly as it is required for healthy root development. Mycorrhizae are a symbiotic relationship between fungi and roots of plants and can improve the uptake. P deficiency symptoms are: stunted growth, dark green or reddish-purple leaves, particularly at the leaf tips in the young plant, and delayed flowering and ripening. In P-deficient maize, ears are small, often twisted and have undeveloped kernels.

Maize takes up potassium (K) in a relatively large amount. About 86% of K taken up has accumulated by silking and only 19% of this K is contained in the ear and shank portion. Maize takes up to 38% of the total K for the whole growing season, during 38 to 52 days after sowing (Rehmanetal. 2008). Modern maize cultivars respond to K application differently due to difference in its uptake, translocation, accumulation, growth and utilization (Minjianet al. 2007). It may have biological demand for K with uptake of up to 5.2 and 3.7 kg K ha^{-1} day^{-1}, respectively during peak time (White 2000). The first sign of K deficiency is reduction in growth rate. Plants become stunted and usually leaf color becomes dark the green. The symptoms of K deficiency are poor root growth and stalk breakages, as well as yellowing and drying along the tips and edges of lowest leaves. Ears show poorly filled tips and loose chaffy kernels of nutrients.

Many modern hybrid variety selections have been developed through modern breeding program from varieties institute around the world. Maize is the most important crop in the area and a participatory crop improvement project for maize was initiated using participatory varietal selection (PVS) and participatory plant breeding (PPB) techniques (Witcombe et al. 1996). PVS attempts to exploit the variation found in released varieties, or varieties in advanced stages of testing, by providing them to farmers to test in their own fields. Because it relies on already existing varieties the impacts of PVS can be rapidly obtained. To increase maize production, research should take into consideration the farmers' circumstances and preferences and develop maize varieties and crop management packages meet farmers demands. Incorporation of farmers' preferences in selection of maize varieties in breeding process would increase likelihood of adoption of the varieties. Whereas maize breeding cannot incorporate all the desired attributes, the key attributes should be included in particular varieties and many varieties should be bred focusing the demands of different groups of farmers. Research costs can be reduced and adoption rates increased if the farmers are allowed to participate in variety testing and selection (Yadawet al. 2006).

Therefore, the present study was under taken with the following objectives:

- to explore the current cultural practices and constraints in maize production,

- to observe the highest fertilizer response on growth performance of grain maize production,
- to determine the effect of fertilizer management practices in response on yield and yield component of maize, .and
- to assess farmer perception on varieties and fertilizer management practices .

CHAPTER II
LITERATURE REVIEW

2.1 Maize Crop Production and Its Importance

Maize, a crop of worldwide economic importance, provides approximately 30% of the food calories to more than 4.5 billion people in 94 developing countries. The demand for maize is expected to double worldwide by 2050. Maize also used for human consumption directly and indirectly and its one of the energy foods for livestock. Processing maize can also produce a wide range of products such as maize flour and maize meal. IITA (2012) stated that worldwide production of maize is 785 million tons, with the largest producer, the United States producing 42%. Africa produces 6.5% and the largest African producer is Nigeria with nearly 8 million tons, followed by South Africa. Maize (*Zea mays* L.) also known as corn, is one of the most important cereal crop of the world and is often known as the King of cereal crops (Amin 2011) . Decreasing soil fertility is a result of imbalance between nutrient inputs and nutrient removals through harvesting, erosion, and leaching (Zingoreet al.2005). The depletion rates of specific nutrients depend on a number of factors including management, soil type, and climate (Zingoreet al.2007).

2.2 Maize Cultural Practices

2.2.1 Effect of land preparation on maize production

The conventional and conservation tillage methods significantly influenced yield and yield components of crops. Conventional tillage method resulted with significantly higher yield compared to no tillage (Rashidiet al. 2010). Land preparation methods greatly influence growth and yield parameters of maize and soil properties. The choice of a method depends on the vegetation cover and the manner in which the soil surface is to be exposed for sowing of seeds is dependent on the density of weeds.

Tillage may be described as the practice of modifying the state of the soil in order to provide conditions favourable to crop growth (Culpin, 1981). Inappropriate land use and poor soil management exacerbate soil degradation, adversely affect the environment, and jeopardize the soil's productivity (Jagadammaet al. 2008). Different tillage systems may modify soil physical properties depending on factors such as cropping history, soil type, climatic conditions, and previous tillage system

(Ferreraset al. 2000). Tillage practices influence soil physical, chemical and biological characteristics, which in turn may alter plant growth and yield (Rashidi2007).

No tillage practices accumulate soil surface organic matter and improve soil biochemical properties, the ploughing and harrowing rather facilitate root penetration, seed sowing and organic matter incorporation into the soil and improve soil structure (Rashidiet al. 2010). Land preparation on commercial farms is done by tractor drawn implements where early ploughing prior to the onset of the rain is followed by one or two harrowing, but this practice is changing due to the high cost of operating machinery and the difficulty in obtaining spare parts to experiment with reduced and zero tillage (Raemaekers 2001). Aikins and Afuakwa(2012) found that traditionally different land preparation methods are employed in the production of different crops including maize.

2.2.2 Effect of weed control on maize production

Maize is cultivated as rainfed crop in subtropical mid hills ecosystem. Although yield potential of maize varieties is high but it has so far could not been realized upto its potential due to several constraints. Sharma et al.2010 stated that weed infestation causes yield losses varying from 28-100% depending upon the intensity, nature and duration. The losses caused by weeds exceed the losses from any other category of agricultural pests .Weeds compete with the crop plants for sunlight, moisture and nutrients (Kumar et al.2013) and deprive the crops from vital resources. Weeds not only decrease crop yield but also harbour insect-pest and diseases and in some cases, they serve as an alternate host for these pest. In organic farming, the weed problems are further high mainly due to application of organic manure, mulches, biomass which exacerbates the weed multiplication and growth. Therefore, it was necessary to devise organic system of weed control comprising of cultural, mechanical, biological and physical practices to manage weeds without synthetic herbicides and chemicals which promote weed suppression, rather than weed elimination.

Aggarwalet al. (1992) found that good weed management does not only involve timely weeding of individual fields and crops during the critical stages of crop growth, it also involves keeping the whole field clean and ensuring that a minimum of weed seed is allowed to come to maturity. The smallholder farmers have to rely on improved hand tools and occasionally animal-drawn implements because other alternatives such as herbicides and heavy machinery are too expensive. Weeding frequency is usually at the discretion of the farmer and may not be economically feasible if yield largely depends on weeds removal at the critical stages of crop development (Adenawoolaet al. 2005). Cumberland et al. (1971) stated that “critical stage” was between 4 and 6 weeks after emergence, and competition at this stage had a major effect on potential yield. Others have found that the critical period fell between 4 and 8 weeks after emergence, with the starting time of the period showing more variation than the end time (Hall et al. 1992). It has been observed that if weeds are not controlled, there is a critical crop–weed competition period with grain losses reaching between 35 and 70% (Ford 1994).

2.2.3 Effect of planting depth on maize

Maize thrives well on mean temperature of 22ºC but cultivation is not possible when day temperature is less than 19ºC and night temperature during the first 3 months falls below 21ºC. Temperature above 35ºC for several days destroys pollen and reduces yields. Germination occurs within 4-6 days after planting when the soil temperature is 20ºC. Maize can be grown without additional irrigation in areas receiving about 600 mm of well distributed rainfall

Temperature and moisture affect seed emergence of maize when the seeds are planted deeply in the soil. Alessi and Power 1971 found that emergence was delayed by one day for each 2.6 cm increase in depth of planting. The appropriate planting depth varies with soil and weather conditions. Barker and Swan 1966 stated that with an average air temperature of 10 °C, the soil temperature at the 5-cm depth was also very near 10 °C. Below 10 °C it was cooler; above 10 °C it was warmer. At shallow depths, the soil may be much warmer than air temperature during periods of intense heating, but on cloudy days, soil temperature at the planting depth closely approximates air temperature.

Planting depth significantly influenced time of emergence .If the Time of seedling emergence decrease with increasing planting depth. Alessiand Power (1771) observed that when seeds are gown at higher depth the shoot apex of newly germinated seeds may not able to push up the soil to come out into the surface and the water applied may not acquire wet the soil that can also cause variation in emergence. Boctes and Girardin, (1994) stated that if farmers can plant maize shallower (at least 5 cm) their crops will be healthier, more reliable and better able to produce higher yields.

2.2.4 Effect of plant density on maize production

Maize yield was significantly affected by plant density Sarlangue (2007) only in proper plant density, plants can achieve highest yield. Monneveuxet al. (2005) stated that optimum Plant density, controlling water, fertilizer and chemical inputs is essential for improving the growth variables responsible for high yield. High density planting, while important to increased yields, can also lead to greater competition for resources and morphological changes in the plant and caused lodging.

Optimum plant density ensure the plants to grow properly both in their aerial and underground parts through different utilization of solar radiation and nutrients. Higher plant density than optimum level, resulted in severe competition among plants for light above ground or for nutrients below the ground, consequently the plant growth slows down and the grain yield decreases. Tahmasbi and Mohasel (2009) showed that increase plant density significantly cause to grain yield growth and highest grain yield was recorded from 85000 Plantha^{-1} with 11.13tha^{-1}.

Saadat et al. (2010) indicated that the highest number of rows per ear and number of grains per ear was found 40000 Plantha^{-1}. Pepoand Sarvari(2013) stated that maize is a plant with individual productivity; therefore plant density determines yield significantly. Optimal plant density can be affected by the genetic properties and vegetation time of the given hybrid, just as by the conditions of the production area, by the crop year and the extent of water and nutrient supply. Fanadzo et al. (2010) mentioned that the application of 45 cm row distance resulted in 11% higher grain yield than in case of the setting of 90 cm rows. Increasing plant density from 40 000 to 60 000 plants ha^{-1}resulted in 30% higher grain yield.

Recent increases in maize grain yield can be attributed to genetic advances and to improved agronomic practices, including optimizing plant population (Ciampitti and Vyn (2011). Van Roekel and Coulter 2011) found that plant population has a strong influence on maize grain yield, but this relationship is highly variable (Assefa et al. 2016) and can be affected by factors such as rainfall, tillage system, fertilization, and soil type. The optimum plant population depends on several crucial factors, including soil fertility, soil water-holding capacity, and hybrid maturity group (Sangoi et al. 2002).

2.2.5 Nitrogen and its importance

Nitrogen is the most important and curcial major nutrient and it is very important for maize and other cereal crops. In condition where there is lack of nitrogen in soil, plant maturity can be delayed and also it minimize yield of crop to high extent. Nitrogen (N) is one of the macro nutrients needed for crop production; however it is most mobile and votatile and the most exhausted nutrients due to its ability (Mucheru-Munaet al. 2014). Without N fertilizers, an estimated one third of our current agricultural production would be lost despite government's efforts to promote its use (Fufa andHassen 2006).

According to Mucheru-Munaet al. 2014, nitrogen management in agroecosystems has been extensively studied due to its importance in improving crop yield and quality. Lungu and Dynoodt (2008) stated that one of the ways of addressing nitrogen limitation is use of inorganic fertilizers. In the absence of site-specific recommendations, Nitrogen management poses a serious challenge in the high lands (Shanahan et al.2008).

The most important role of N in the plant is its presence in the structure of protein and nucleic acids, which are the most important building and information substances of every cell. N is the key elements in increasing productivity and increase of agricultural food production world-wide. Chen et al. 2004 observed that a large amount of fertilizer N loss in the environment can cause a serious environmental problem such as groundwater contamination. Mahmoud et al. (2009) stated that the increase of N uptake appeared to be more obvious when compost was mixed with the mineral N fertilizer as compared to the 100% compost or 100% N mineral fertilizer alone on improving soil physical properties or to a higher mineralization of composts which is due to mineral N inputs.

Mohammadian (2010) stated that yield reduction in corn due to nitrogen deficiency is higher than of other elements deficiency. Mekdad et al. 2015 found that increase in yield as a result of increasing nitrogen fertilizer levels may be due to the importance of nitrogen as one of the macronutrient elements for plant nutrition and its role in increasing vegetative growth through enhancing leaf initiation, increment chlorophyll concentration in leaves which may reflected in improving photosynthesis process. Improved cultural practices can play an important role in augmenting yield of maize crop. For an optimal yield, the nitrogen supply must be available according to the needs of the plant.

2.2.6 Time of Nitrogen application

Time of N application at appropriate crop growth stage is also another main focus to enhance N use efficiency and increase maize productivity. All applied N is not absorbed by the crop since leaching is one of the main challenges for N loss in high rainfall areas. Jamal et al. 2006 reported that at higher doses of applied N remain unavailable to a crop due to N loss through leaching. This leaching loss may be determined by a quantity of N applied, inappropriate time of application, soil permeability, and quantity of rainfall drops in the area Fageria and Baligar 2005. However, an optimum and efficient time of N application can increase the recovery of applied N up to 58–70% and hence increase yield and grain quality of the crop Haile et al. 2012.

Split application of nitrogen is an important nutrient management practice used for increasing nutrient use efficiency. Different form of nitrogen losses can be reduced if nitrogen is applied in splits. Data revealed that nitrogen application in splits showed significant effect on plant height during both experimental years. According to Wasaya et al. 2012, numerically taller plants were found when nitrogen applied in three splits at different growth stages viz. one-third at sowing + one-third at V5 + one-third at tasseling and shorter plants were observed when nitrogen was applied in two splits i.e. half at V5 and half at tasseling

2.2.7 Effect of Nitrogen on yield and yield component of maize

Plants absorb nitrogen as either ammonium ions, or as nitrate ions, however nitrate is the predominant form (Taiz and Zeiger 2010). However, soil N supply is often limited (Vigneau et al. 2011), which forces farmers to increase the amount of N fertilizers in order to achieve better crop yield. Khaliq et al. (2008) observed that the application of N delays the silking of maize crops. Increases in N rates significantly delays the duration of the vegetative and reproductive period that results in high grains yields (Namvar and SeyedSharifi2011).

Hammad et al. (2011) recorded that maximum number of seeds ear^{-1} was produced when one-third N at V2, one-third N at V16 and one-third N at R1 stage was applied while the application of one-third N at seed bed preparation, one-third N at V12 stage and one-third N at R2 stage gave minimum number of seeds ear^{-1}. Previous studies, shows that split application of fertilizer at different growth stages had significant effect on maize fodder yield. Split application of nitrogen significantly enhanced all plant traits except emergence. Higher plant height, stem girth were in three split application of 140 kg N ha^{-1} through fertilization at planting, V4 and V6 stage (Hassan et al. 2010).

Hammons (2009) observed that the maximum N uptake by maize occus during the month prior to tasseling and silking. Reddy et al. (2012) observed that application of 180 kg N ha^{-1} was found to be optimum for getting higher yields of maize under zero tillage conditions in rice fallows on sandy clay loam soil. According to the Bundy et al. (2011), from their long term N experiments on silt loam soil and the data combined over 50 years, the seed yields increased linearly by about 150 kg ha^{-1} year^{-1} in the medium (140 kg N ha-1) and high (240 kg N ha^{-1}) long term N treatments while yields in the control long term treatment have remained relatively constant over time. Similar result are also stated that by Meena et al. (2013) on clay loam soil.

2.2.8 Phosphorus and its importance

Phosphorus is essential in the plant for photosynthesis, respiration and energy transfer. Phosphorus use efficiency in maize fields is critically important, since this nutrient constitutes one of the most limiting factors to production (Coelho et al. 2009). For many cropping systems, application of P from organic and inorganic sources is essential to sustain high crop yield (Jones 2003). Enhanced early-season P nutrition in maize increased the dry matter partitioning to the grain at later development stages (Plenetet al. 2000).Phosphrous play an active role in the plant metabolism process starting from cell wall development to respiration, photosynthesis, chlorophyll formation, enzyme activity and nitrogen fixation (Das 2000). Rashid and Iqbal (2012) reported that yield of maize fodder increased with increasing rate of phosphorus up to 53 kg ha^{-1}.Quality traits (P concentration, dry matter, crude protein, crude fibre, ash content) improved with the application of 57 kg phosphorus ha^{-1}. Gazola et al. (2013) observed that in the case of phosphorus, a simple practice such as liming would be effective in reducing its problem of high soil adsorption and slow release fertilizer would not be required for this nutrient. In maize cultivation, Valderrama et al. (2011) reported that increasing doses influenced the phosphorus content in the plant, fitting the quadratic equation and peaking at the application of 127 kg ha^{-1} de P_2O_5. Silva el al. (2014) observed linear increase in grain productivity up to the 120 kg ha^{-1} P_2O_5 dose.

2.2.9 Effect of phosphorus on yield and yield component of maize

Maize requires adequate supply of nutrients particularly nitrogen, phosphorus and potassium for good growth and high yield. Nitrogen and phosphorus are very essential for good vegetative growth and grain development in maize production.

Maximum grain yield at highest level of P may be due to proper nutrient availability during seed filling duration and resulted in the development of reproductive part especially in seed formation when large quantity of phosphorus is found. Jones (2011) who indicated that grain yield increased with increase in N and P rates. Amoruwaet al. (1987) found that thousand grains weight increased with increasing nitrogen and phosphrous rate because of greater contribution of N and P by producing healthy grains well filled grains and bigger grains while minimum grains weight was obtained at lower levels (0, 0) N:P kg·ha^{-1}. Mukuralindaet al. (2010) on their study on P uptake and maize response to organic and inorganic fertilizer inputs in Rubona, Southern Province of Rwanda showed that the combination of green manure with TSP at a rate of 50 kg ha^{-1}significantly increased maize yield from 24 to 508 % when compared to the control. Equally, the same study showed higher P uptake (15.6-18.6 kg ha^{-1}) than the control (5 kg P ha^{-1}).

2.2.10 Potassium and its importance

Potassium plays a vital role as macronutrient in plant growth and sustainable crop production (Bukhsh 2010). Potassium is regarded as one of the major nutrient element which affects the yield and quality of grain and fruits. Its activates enzymes, severe as an osmoticum to maintain tissues turgor pressure, regulates the opening and closing of stomata and balances the charge of anions Potassium has an impact on the uptake of other cationic species and they may affect the crop yield and crop quality (Mengel 2007).K interacts with almost essential macronutrients, the secondary nutrients and the micronutrients Clelik andKatkat, 2007 showed that when the chlorosis symptoms occurred, K contents of the plants were found high these chlorotic plant samples.

2.2.11 Effect of Potassium in Yield and Yield component of Maize

The positive effects of K on maize growth yield and quality parameters are now well established in the literature. The growth and yield components of maize like plant height, number of seed ear^{-1}, ear length, thousand seeds weight and seed yield are significantly increased by K application (Bukhsh et al. 2012). FAO (2000) stated that 75 kg K_2O ha^{-1} was required for producing 5 t ha^{-1} seed of maize. Sharif and Hussain 1993 found that potash applied at the rate of 0, 40, 80, 120, 160 or 200 kg ha-1 to maize produce greatest seed yield and thousand seeds weight at 120 kg K ha^{-1}, greatest dry matter yieldat 80 kg K ha^{-1} an the net return from applying 40 kg K ha^{-1} Applying K, at the rate of 150-169 kg K ha^{-1}, increase yield and net profit, seed yield increased by 10.8 kg for each kg K applied (Zhang et al. 2000). The increase in yield up to 200 kg ha-1 was significant at each K level and significant reduction yield occurred at K level of 250 kg ha-1(Bukhsh et al. 2009).

2.2.12 Important of Micronutrients on Maize

The importance Ca and Mg soils cannot be understated for their role in plant nutrition is crucial since they constitute plants protoplasm (Szulcet al. 2008). In Pakistan, one of the main causes of low production of maize is lack of proper fertilizer management, especially micronutrients and method of application which plays a crucial role in growth and yield of maize (Asiehet al.2012). Farmers usually applied macronutrient to the maize crop and neglect micro fertilizers. Methods of fertilizer application also have great effect on the growth and yield of maize crops (Ahmad et al. 2013). Sulfur (S) is often the third limiting nutrient in soils after N and phosphorus (P) (Randhawa and Arora, 2000), yet it is seldom included in the fertilizers commonly available. Micronutrient deficiencies occur not only due to low contents of these elements in the soil but also nutrient mining by growing plants (Brady and Weil, 2002).

2.2.13 Effect of organic manure on maize production

The application of N.P.K fertilizer to the soil actually boosts the performance of maize. However, its persistence use destroys soil reaction and impedes the activities of soil micro organisms there by making the soil acidic and toxic to maize (Omisore 2001). Most importantly, the chemical fertilizer is not affordable to local farmers and so the use of organic manure is of great advantage, because it contains many nutrient required by plant for optimal performance and also helps in improving soil texture and structure. Wisdom et al. 2012 stated that on the comparative study of the effect of organic manure (cowdung) and inorganic fertilizer (NPK) on the growth of maize. Tanimu et al. 2013 also reported that the effect of cowdung and NPK fertilizer showed the development of maize crop and higher growth and grain yield.

2.2.14 Effect of drying method and storage on maize production

Vachanthet al. 2010 reported that 90% worldwide postharvest losses are due to insects, and mite infestation; and therefore the need to control them. The produce can be contaminated with insect bodies and frass, and toxic chemicals like quinines (Kabiret al. 2011).The storage of maize is an important step in preserving food security and increasing rural incomes.

In field drying

The method of leaving the crop standing in the field drying is popular in areas where maturity of the crop coincides with the beginning of a dry season. However, a crop left unharvested is exposed to attack by insects, birds, rodents , wild animals, strong winds and occasional rain showers, which can damage and reduce the crops. These factor are particularly important with the new, improved high- yelding crop varieties, which are more suitable to damage from the environment than the traditional varieties.For instance, a hybrid maize cob has less leaf cover than the cob of traditional maize varieties and is therefore more open to attack by insects and birds.

In-platform drying

Threshing of grain is mostly preceded by further drying in homesteads. The maize cobs may be hung on racks or placed on purposely constructed platforms .This method has many advantages compared to the infield drying but the percentage of grain loss is relatively high.

On-ground drying

The grains are typically spread-out on the ground floor to allow drying. The grains which may be on the bare floor could absorb moisture, be contaminated with dirt and foreign materials, and also be exposed to rains, insects, pests, livestock and birds. In recent times, people are commonly drying maize on plastic sheets or mats. This practice of ground floor drying is discouraged because of the following reasons;

- Have to keep watch all the time to keep the grains from rain and etc.

- Grains can be washed away when there is a sudden down pour or be brought under shelter at night or when about to rain.
- There is higher risk of contamination from dusts, soil, stones, animal droppings, fungal, and insect infestation.
- Losses from birds, poultry and domestic animals, and quantitative losses are very high.
- The method is time consuming, and can be labor intensive when harvest is huge. Unfortunately, this method is the most practiced by farmers.

Storage in airtight containers

This method was significantly different from open storage, for example hanging cobs over the fireplace and storage in gunny bags. Airtight storage provides excellent insect control and prevents the grain from re-absorbing moisture from humid outside air the farmers' methods of storing seeds in the open experienced significantly higher moisture content increase than in closed storage. This moisture increase may reduce the longevity of seeds since it is generally known that every 1% increase in seed moisture content reduces the storage period by Harrington 1972.

2.3 Important of farmer participatory variety selection

The agricultural sector is largely characterized by small-scale subsistence farming and low productivity. Farmer access to quality seed of better adapted varietie is of utmost importance for increasing productivity (Bishawet al. 2008).Selection of individual farmers was made on meeting with the key informants familiar about the crops to determine the adaptability and the growth performance of all maize technologies through the entire growing period. Varietal evaluation and decisions were only by researchers; however, this didnot lead to the expected speed of variety release, or their dissemination afterwards. In addition, in developing new materials and extending them to farmers, classical plant breeding faces two major obstacles. First, new varieties can be disappointing to farmers where undesirable traits go undetected during the breeding process. Secondly, breeders necessarily discard many crosses and varieties during the selection process because of traits considered undesirable; however, these traits may actually be of interest to farmers. Large numbers of information on farmers' perspectives of plant and grain trait preferences to these criteria will be helpful to the variety selection process. Weltzien et al. 2003 stated that participatory plant breeding/selection has shown success in identifying more number of preferred varieties by farmers in shorter time (than the conventional system), in accelerating their dissemination and increasing cultivar diversity.

CHAPTER III
RESEARCH METHODOLO Y

3.1 Study Area

Farmers from Kalaw townships to explore their practices and constraints in maize production.

3.2 Data Source and Data Collection

This study was conducted at Kalaw Townships, which is located at 20° 6'N latitude, 96° E longitude and altitude 1320m. The climate of Kalaw Township is with an average temperature of 24° C. The region receives an average rainfall of (400.4mm) per annum. Kalaw Township has large agricultural land (40,569 ha) and contributes (22.5%) of total land. Rice growing area is nearly half of the total cultivated areas. Most of the rural people are farmers and depend on rice production.

3.1 Distribution of Sample Farmers in the Study area

Township	Village Tract	Village	No. of respondents
Kalaw	Nan Tine	Nan Tine	30
	Nan Tine	HinnKharKhone	30
	Hae Ho	Sa Kar Inn	30
	Hae Ho	HsaungBae	30

3.3 Data Collection and Sampling Method

This survey was conducted in the period of November - December 2017. Simple random sampling method was used to select the sample farmer for the study. Firstly, Kalaw Township was selected as the study area based on the 65% of maize production in Southern Shan state, Myannmar. Afterward, four villages from Nan tine tract of Kalaw Township, Shan State were randomly selected and interviewed with well structured questionnaires.

Demographic and socio-economic characteristics of maize production of sample farmers such as age, education level as well as farm experience, family size and farm assets were collected. And also cultural practices of maize production such as maize production area, varieties used, seed rate, organic manure, weed control, thinning, earthening, drying methods and storage method.

The secondary data was obtained from Department of Agriculture (DOA).

3.4 Data Analysis Method

Data entry was done by using the Microsoft Excel program. These data was analyzed Excel Software.

3.5 Descriptive Analysis

Descriptive analysis as a part of the numerical methodology such as mean, minimum, maximum and percentage was used to describe or summarize the demographic and socio-economic characteristics, yield, inputs used in maize production of sample farmers.

3.6 Experimental Site

The field experiment was conducted at Aungban Research Station with 20˚40' N latitude, 96˚ 38' E longitude with the elevation of 4219 feets above sea level. The experiment of Aungban was started from April to September of 2017.

3.7 Experimental Design and Treatment

Split-plot design was used in the field experiments that arrange randomized complete block design (RCB) with three replications. Method of fertilizer application was assigned as “main plots” and maize verity was assigned as “sub plots”. Firstly, land was prepared by two times of ploughing and two times of harrowing. Composite soil was collected from the experimental site before starting the experiment and was analyze for various properties at Department of Agriculture in Taungyi.

The subplot size was 5 m × 5 m (25 m^2). The distance maintained between two replications and two plots will be 0.5 m. Yezin 11, CP 888, NK621, SA 282 and NK625 verities were be used as a tested cultivar. Row spacing and plant spacing were 75cm and 25 cm. The area of plots was 60 m × 50 m (3000 m^2).

Treatment

The treatments were as follows;

Main plot factor (Different fertilizer management practices)

F_1 – Control

F_2 - Farmer practice of fertilizer management practice

F_3 - GAP fertilizer management practice

F_4 - SAPA guideline fertilizer management practice

Where,

F1 = Cow dung manure without inorganic fertilizer

F2 = Urea (123.5 kg/ha) + Compound fertilizer (123.5 kg/ha)

F3 = Urea (185.3 kg/ha) + P_2 O_5 (123.5 kg/ha) + MOP (123.5 kg/ha)

F4 = Urea (290 kg/ha) + P_2 O_5 (123.5 kg/ha) + MOP (123.5 kg/ha) + micronutrient (313.61 kg/ha)

All treatment were applied of cow dung manure (2178.52 kg/ha) at basal fertilizer application.

Table 3.2. Different fertilizer management practices of Time and rate on fertilizer application on maize

Fertilizer Management Practices	Time and rate of fertilizer application (kg/ha)				
	Basal	20-23 DAS	40 DAS	60 DAS	Total
Control					
Cow dung manure	519.63				519.63
Farmer					
Cow dung manure	519.63				519.63
Urea		61.75	61.75		123.5
Compound	123.5				123.5
GAP					
Cow dung manure	519.63				519.63
Urea	123.5	61.75	61.75		185.3
P_2O_5	123.5				123.5
MOP	123.5				123.5
SAPA					
Cow dung manure	519.63				519.63
Urea	124	49.4	42	24.7	290
P_2O_5	123.5				123.5
MOP	123.5				123.5
$CaNO_3$		148.2			148.2
$MgSO_4$		98.8			98.8
Korn-Karli B			24.7	41.99	66.61

Sub plot factor (Different varieties)

V1 - Yezin 11 (Released from DAR)

V2 - NK 625 (Released from Awba Co.)

V3 - CP 888 (Released from CP Co.)

V4 - SA 282 (Released from Seed Asia Co.)

V5- NK 621 (Introduced from Awba Co.)

3.8 Soil Sampling and Analysis

Soil samples were taken from 0-15 cm depth of 10 random places in experimental area. The parameters like available N, P, K, soil texture and pH. The soil samplewere analyzed before experimental set-up at Soil and Water Utilization Division, Department of Agriculture, Taungyi. The physicochemical properties of experimental soil are shown in Table 3.3.

3.3 The physicochemical properties of the soil samples before experiment

Sr.	Description	Amount	Remark
1.	Moisture %	4.26	
2.	Soil pH	5.31	Moderately Acid
3.	Organic Carbon %	0.8	
4.	Total N%	0.38	Medium
	Exchangeable Cation mg/kg		
5.	Ca^{++}	91.19	Low
	Mg^{++}	30.39	Medium
6.	Available Nutrients		
	K_2O (mg/kg)	181.7	Medium
	P (mg/ kg)	10.99	Medium

3.9 Data Collection

During the experimental period, plant height and SPAD value were collected by two weeks intervals starting from 14 DAS to56 DAS (Days after sowing).

3.9.1 Agronomic Character

During the experimental period, plant height and chlorophyll content (SPAD value) were collected by two weeks intervals starting from 14 DAS to 56 DAS (Days after sowing). Plant characters such as days to 50% tasseling, days to 50% silking, ear diameter, ear length, ear weight and seed weight ear $^{-1}$ were measured from randomly selected ten ears and the average values were recorded at harvest. Five plants were randomly selected from each plot and plant height was measured at two weeks interval. Plant Height was measured from the ground level to the uppermost fully expended leaf before tasseling. For SPAD value, non-destructively with the protable SPAD meter (M-502) or chlorophyll meter was used. It measured the youngest fully expanded leaf before silking.

3.9.2 Yield and yield components

The number of rows ear^{-1}, number of seeds row^{-1}, number of ears plant-^{1,} thousand seeds weight and yield components were recorded from randomly selected 5 sample plants of each plot at harvesting. Plants from m^2 of each plot were used as harvest area yield and converted to ton ha^{-1}.

$$\text{Yield} = \frac{\text{(100-Moisture\%)} \times \text{Field weigh (kg)} \times \text{Shelling \%} \times 10000}{85 \times \text{Harvested area } (\text{m}^2) \times 1000}$$

(CIMMYT 1985)

Where,

Ton ha-1	=	seed yield converted into tons per hectare
85	=	adjusted factor of seed moisture to 15 %
10,000 sq meter	=	conversion factor to an area of one hectare of a plot
1000	=	kg per ton

Shelling %

$$\text{shelling (\%)} = \frac{\text{Seed dry weight}}{\text{Ear dry weight}} \times 100$$

Harvest Index (HI)

$$\text{Harvest Index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

(Donald, 1962)

3.9.3 Statistical analysis

Analysis of variance (ANOVA) was done for the statistical significance and LeastSignificant Difference test (LSD) was used to compare the treatment mean at 5% level byusing stastix(version .8)

CHAPTER IV
RESULTS AND DISCUSSION

Current Cultural Practices of Maize Cultivation

4.1 Demographic characteristics of sample farmers

Table 4.1 shows that the sample farmers were average age of 42 years in the range of 20-70 years. The sample farmer has farming experience of 22 years in the range of 2-55 years. The average family size was 5 among them 2 were male and 2 persons were female, respectively.

Table 4.2 shows grouping of total area and cultivated area in study area by sample farmers. One third (28.33%) of sample farmers felt 20-30 year age group , 31.66 % of sample farmers felt 31-40 year age of group, 20.83% of sample farmers felt 41-50 year of age group and 19.18% of sample farmers felt 50-60 year of age group. Eighty nine percent of sample farmers were 20- 40 year age of group. This result shows that farmers in the study area were in the age of active and experience in farming and more interest in agriculture.

In study area, 49 % of sample farmers cultivated had less than 1ha of maize in their own land. Fifty nine percent of sample farmers cultivated 1-2 ha of maize in their own land.

In this study, education level of household heads was categorized into six groups: (1) “illiterate” referred they could not know how to write and how to read, (2) “ Monastery education” referred informal schooling although they could read and write, (3) “ Primary level” referred formal schooling up to 5 years, (4) “ Middle school level” intended formal schooling up to 9 years, (5) High school level” intended formal schooling up to 11 years and “Graduate” referred to those who received degree from college or university.

There were 95% of male headed household and 5% of female headed household in this study. Thirty nine percent of sample farmers had attained monastery education level and 26% of sample framers attained primary education, eleven percent of sample farmers had attained secondary education level, three percent and two percent of sample farmers attained high and graduated education level while nineteen percent were illiterate. More than half of sample farmers (65 %) are primary levels.

Therefore, it is hard to understand the new technology especially good agricultural practices (GAP).

Table 4.4 shows the farming assets of sample farmers in study area. Almost all farmers processed sprayers, sixty eight percent of sample farmers processed plough, sixty six percent processed harrows, three percent of sample farmers owned inter-cultivator and seven percent of water pump. In case of the farm machinery, six percent of sample farmers owned tractor, four percent of them possessed gone dawn, seventy three percent of sample farmers owned bullock cart.

In the study area, communication asset owned by sample farmer were observed in Table 5. Communication assets such as nine percent of sample farmers, fifty four percent sample farmers and sixty seven percent sample farmers owned radio, TV, mobile phone. Eighty one percent of sample farmer owned motorbike for transportation of their farm products.

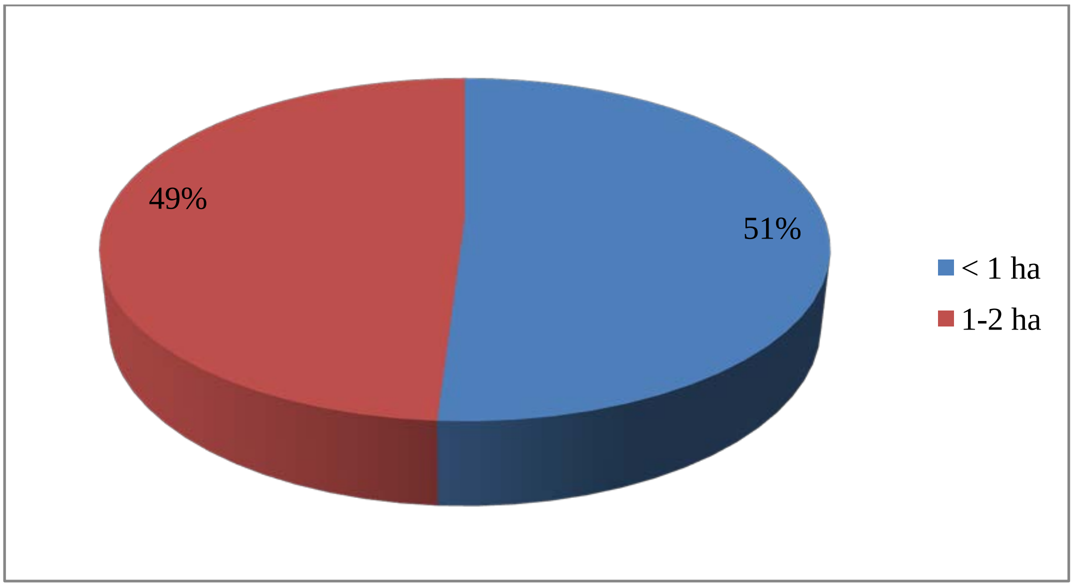
Livestock rearing was one of the livelihood activities of sample farmers. Sixty five percent of sample farmer rear cattle and seventeen percent them possessed buffaloes for the purposes of land preparation and transpiration of farm products. However twenty three percent of sample farmer owned by pig and fourteen percent of sample farmer owned by chicken. Therefore, pig and chicken were kept by sample households for consumption and other additional income.

4.1 Demographic characteristics of sample farmers in study area, 2017

Items	Average	Maximum	Minimum
Age of household head (years)	42.3	70.0	20.0
Farming experience of household head (years)	22.5	55.0	2.0
Total family size	4.5	9.0	2.0

4.2 Grouping of age in study area by sample farmers, 2017

Items	Sample farmer (n=120)	
	No. of sample farmers	Percent
Group of age		
20-30 years	34	28.33%
31-40 years	38	31.66%
41-50 years	25	20.83%
50-66 years	23	19.18%



4.1 Maize cultivated land size by sample farmers in study area

4.3 Percentage of gender and education of household head in study area, 2017

Items	Respondent (n=120)	
	Number	**Percent**
Sex		
Male	114	95
Female	6	5
Education level		
Illiterate	23	19
Monastery	47	39
Primary	31	26
Middle	13	11
High	4	3
Graduate	2	2

4.4 Farming assets of sample farmers in study area, 2017

Items	Respondent (n=120)	
	Number	**Percent**
Sprayer	119	99
Plough	81	68
Harrow	79	66
Water Pump	8	7
Tractor	7	6
Gone dawn	5	4
Cart	73	61
Inter-cultivator	4	3

4.5 Percentage of livestock asset of sample farmers in study area, 2017

Items	Respondent (n=120)	
	Frequency	**Percent**
Cattle	78	65
Buffaloes	20	17
Pig	28	23
Chicken	17	14

4.6 Percentage of communication asset of sample farmers in study area, 2017

Items	Sample farmers (n=120)	
	No.	**Percent**
Motor bike	97	81
Mobile phone	80	67
TV	65	54
Skynet	11	9
Radio	11	9

4.2 Farmers' Cultural Practices in Maize Production

4.2.1 Land preparation by sample farmer in study area

In land preparation, the sample farmers ploughed at the average of 2 times and harrowed 1 times. Land preparation methods greatly influence growth and yield parameters of maize and soil properties. Therefore, the land preparation should be practice in maize production.

4.2.1.2 Seed rate

In study area, the sample farmers used average seed rate of 10.7 kg/ha and the maximum and minimum seed rate were 17.12 kg/ha and 6.42 kg ha, respectively. The seed rate for maize production of sample farmer adjusted depending on soil condition and rodent damage. "The farmer said that when the field is level and free from bird or rodent damage, they reduced the seed rate. If the soil surface is uneven or bumpy and bird and rodent damage is in serious, they used more seed for compensation".

4.7 Land preparation of sample farmer in study area

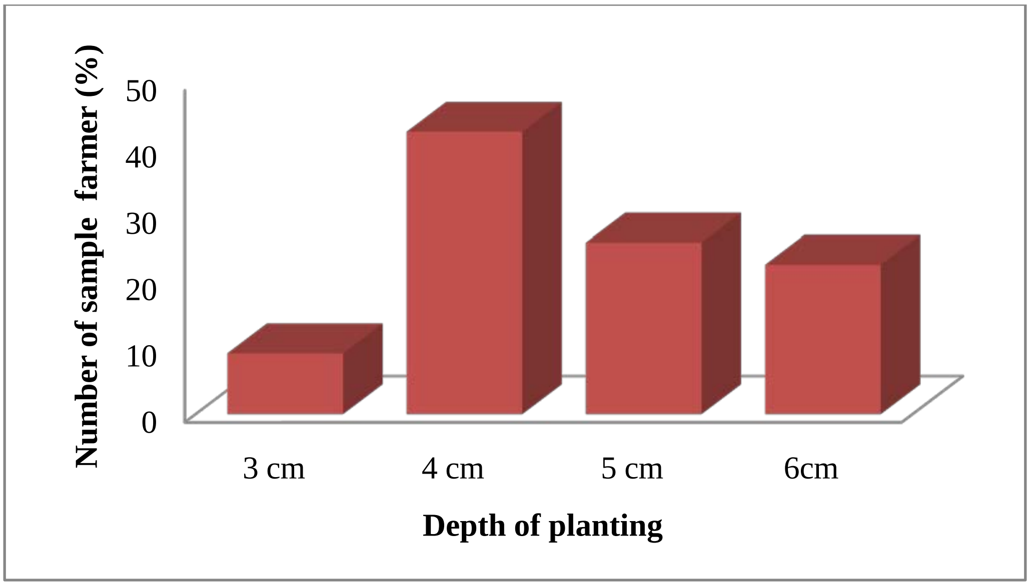
Items	Average	Maximum	Minimum	SD
Land preparation (n=120)				
Ploughing	2	3	1	0.5
Harrowing	1	3	1	0.4
Seed rate (kg)	10.7 kg	17.12 kg	6.42 kg	1.1

4.3.2.3 Plant spacing of maize cultivation in study area by sample farmers

In research finding, the plant spacing of maize is 26×34cm with two or more seeds per hills was used by sample farmers. The recommended spacing for GAP practices of maize is 22× 30 cm with one seed per hill (49,220 to 53,500 plants/ ha). In study area, some of sample farmers cultivated 12 cm for depth of planting. About 9.17 % of sample farmer planted 3cm depth of seeds. Nearly (42.5%) of sample framers cultivated 4 cm depth of sowing, 25.83 % and 22.5% of sample farmers cultivated at the depth of sowing 5cm and 6cm.In GAP practices, the recommended planting depth is 6 cm- 6.35cm.

4.8 Spacing for maize cultivation by sample farmers in study area, 2017

Items	Sample farmer (No = 120)			
	Average	**Maximum**	**Minimum**	SD
Plant Spacing	26 cm	46 cm	3 cm	4.3
Row Spacing	34 cm	61 cm	6 cm	5.0
Depth of Sowing	12 cm	30 cm	6 cm	1.2

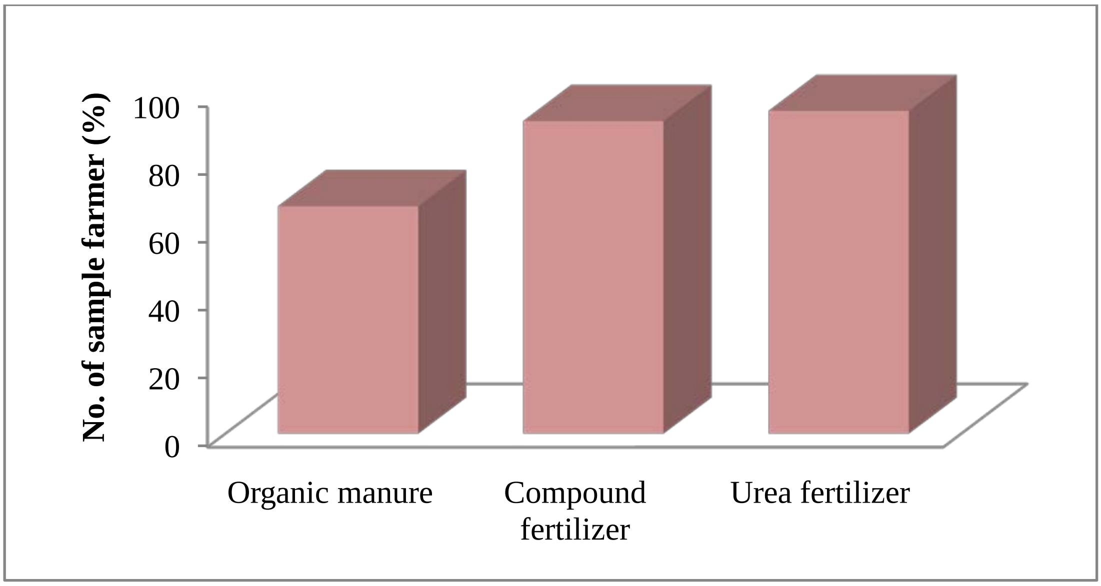


4.2 Depth of sowing by sample farmer in study area, 2017

4.4 Organic manure and different fertilizer application in maize production

Organic manure and different fertilizer application used by sample farmers were summarized in Table 4.9. Among the sample farmer, about sixty seven percent of sample farmers applied organic manure in maize production. However, ninety nine percent of sample farmer applied organic manure at land preparation and one percent of sample farmer applied organic manure at sowing time. In GAP practices, organic manure should be applied at the rate of 5 carts/ac of cow manure. According to the finding, most of the sample farmer used small amount of organic manure in land preparation of maize cultivation. On the other hand, ninety two percentage of sample farmer utilized compound fertilizer application (15:15:15). Ninety five percent of sample farmers used urea fertilizer as a main fertilizer. However, one percent, seven percent, 39%, 38% and 11% of sample farmer used urea fertilizer as 15, 20, 30, 45, 60 days after sowing.

In compound fertilizer application, sample farmer applied average rate was 185.49 kg/ha. The maximum rate of compound fertilizer applied by sample farmer was 364.97 kg/ha and that of minimum was 45.60 kg/ha. Regarding urea fertilizer application in maize production, the average rate of urea application by sample farmer was 136.87 kg/ac. The maximum rate of urea was 273.72 kg/ha in sample farmer. The minimum rate of urea fertilizer application was 91.25 kg/ha bysample farmer.



4.3 Kind of fertilizer application of organic manure and different fertilizer application by sample farmers in study area, 2017

4.9 Time of fertilizer application by using organic manure and different fertilizer application by sample farmer

Items	**Sample Farmers**	
	No. of sample farmers	**Percent**
Organic manure		
Land preparation	79	99
Sowing time	1	1
Compound Fertilizer		
Land preparation	110	92
Urea fertilizer		
15 DAS	1	1
20 DAS	8	7
30 DAS	47	39
45 DAS	45	38
60 DAS	13	11

4.9 Amount of different fertilizer application for maize production by sample farmers

Items	Sample farmers (n=120)		
	Average (kg/ha)	Maximum (kg/ha)	Minimum (kg/ha)
Compound fertilizer (15:15:15)	182.49	364.97	45.60
Urea	136.87	273.72	91.25

4.5 Cultivated maize varieties by sample farmers in study area

According to the study, sample farmers used 6 varieties in maize production namely variety 981, variety NK 621, variety CP 888, variety 029, variety CP 808 and local maize variety. Among these maize varieties, variety 981 was mainly grown by fourth three percent sample farmers, variety NK 621 was grown by 20% of sample farmers, variety CP 888 was grown by thirteen percent of sample farmers, variety 029 was grown by ten percent, variety CP 808 was grown by six percent and the local maize variety was grown by ten percent of sample farmers. Nearly half of the sample farmers grew variety 981 because this variety obtained high yield and these variety was superior in weight than any other variety.

4.10 Cultivated maize varieties by sample farmers in study area, 2017

Varieties	Sample farmers	Percentage
981	52	43.33
CP 888	16	13.33
NK 621	24	20
029	13	10.83
CP-808	7	5.83
Local variety	10	8.3

4.6 Thinning and earthening of maize cultivation by sample farmers in study area

In study area, the eighty seven percent of sample farmers do not thin the maize plant. Thirteen percent of sample farmers thin the maize plant. The good agricultural practice recommended the thinning was done at 14 days after sowing. Six percent, seventy five percent and thirteen percent of sample farmers thin of maize plant as 15 and 20 days after sowing, 30 days after sowing and 45 days after sowing.

As the result, 98% of sample farmers earthen of maize production but two percent of the sample farmers did not earthen their maize field .According to GAP practices, the earthening should be practiced at 39-40 day after sowing.

4.11 Thinning and earthing in maize cultivation by sample farmers in study area, 2017

Items	Sample farmers (n=120)	
	No.	Percent
Thinning	16	13
Nil	104	87
Thinning Time (No = 16)		
15 days after sowing	1	6
20 days after sowing	1	6
30 days after sowing	12	75
45 days after sowing	2	13
Earthening		
Earthening	118	98
Nil	2	2
Earthening Time (No = 118)		
10 DAS	1	1
15 DAS	2	2
20 DAS	8	7
30 DAS	47	40
45 DAS	46	39
60 DAS	14	12

As the result of finding, 99% of sample farmers controlled weed manually and application of herbicides. However, 1% of sample farmers did not used for weed control (agrochemicals) due to the high costs of agricultural inputs. Among farmers who control the weed, Fourty percent and thirty nine percent of sample farmers used labor or herbicide for weed control as 30 to 45 days after sowing while one percent , two percent ,seven percent and twelve percent of sample farmer controlled of weeds at 10 ,15,20 and 60 days after sowing.

In study area, the sample farmers got in average yield was 3356.90 kg/ha and the maximum yield was 6993.46 kg/ha and the minimum yield was 874.17kg/ha. The minimum yield of farmer said that the yield due to continuous cultivation. Some farmer said that, they want to use little effort in agricultural input to maximum output

In drying method of study area, more than half (54%) of the sample farmers dried on the stem of the plant by sun drying. Sixty six percent of sample farmers dried locally in their home by handling. In storage method, most of the sample farmer in study area stored their seed by locally in their home with bas .Thirty three percent and twenty nine percent of sample farmers stored of seed by handling in their home. However, 37 % of sample farmers did not stored because they want to money for investment of next season of crops. Therefore, if the maturity of the maize, they dried nearly 15 days on the stem of the plant and them they trust of seed and immediately sell on their traders.

4.12 Weed control in maize production by sample farmers in study area, 2017

Items	**Sample farmer (n=120)**	
	No.	**Percent**
Weed Control (No = 120)		
Weed Control	119	99
Nil	1	1
Time of Weed Control (No = 119)		
10 days after sowing	3	3
15 days after sowing	4	3
20 days after sowing	8	7
25 days after sowing	2	2
30 days after sowing	54	45
45 days after sowing	38	31
60 days after sowing	9	8
75 days after sowing	1	1

.

4.14 Maize yield of sample farmers in study area of maize production

Items	Unit	Average	Maximum	Minimum
Yield	kg/ha	3356.90	6993.46	874.17

4.15 Number and percentage of drying method and storage by sample farmers in study area, 2017

	Sample farmers (n = 120)	
Items	No. of sample farmers	Percent
Drying method		
On the stem of the plant	54	45
Handling	66	55
Storage method		
Storage	75	62.5
Bas	40	33.33
Handling	35	29.16
No storage	45	37.5

Effect of Different Fertilizer Management on Maize Varieties

Yield and Yield Components of maize

4.7.1 Grain yield

There was highly significantly different in grain yield among fertilizer treatments. The maximum grain yield (8306 kg ha^{-1}) was obtained by SAPA fertilizer management practice (F4) followed by GAP fertilizer management practice (6758 kg ha^{-1}) and the farmer management practice (6545 kg ha^{-1}). The minimum grain yield (4954.9 kg ha^{-1}) was resulted from control. The highest grain yield produced by SAPA fertilizer management practice may due to the production of higher grain yields with respective level of NPK plus micronutrient management practices. Adequate supply of nitrogen and micronutrients in maize can increase the crop growth, photosynthesis process, respiration and other biochemical and physiological activities which helps in increasing yield attributes Zeidan et al. (2010). Farshad and Malakooti 2010 stated that the effect of potassium and microelements on yield was significantly increased at 5% level. This may be due to the complete fertilizer including total nutrient elements and preparing the amount balance of nutrient elements for plant has been produced the highest corn yield.

There were no statistically significant differences in grain yield among five tested varieties. It was observed that grain yield of SA 282, NK 621, CP 888 and NK 625 variety were higher than Yezin 11 variety. The maximum grain yield was obtained from NK-621 (7419kg ha^{-1}) and SA 282 (7089 kg ha^{-1}). The minimum yield was obtained from Yezin 11 (5568 kg ha^{-1}). Interactions of maize varieties by fertilizer management practices were not significantly affected by yield and yield components of maize varieties except thousand seeds weight.

4.7.2 Number of row per ear

There was highly significantly different in number of rows per ear among fertilizer treatments as well as among the tested varieties (Table 4.16).The result indicated that the increased number of rows per ear was directly proportional to the increased levels of fertilizer (Table 4.16).The highest amount of fertilizer in SAPA gave the highest number of rows per ear (13.57) whereas control (no chemical fertilizer management practice) gave the lowest number of rows per ear (12.9).Arifet al. (2010) stated that applying 80 kg N ha-1, 120 kg N ha-1and 160 kg N ha-1 were not significantly increased in yield of maize. Moraditochaeeet al. (2012) also observed that the management practices of N fertilizer not significant on number of row per ear. Ogunlela et al. (1998) observed that ear diameter, seed and number of ear per plant, plant height and dry matter production increased with nitrogen fertilization while tasseling in maize was hastened. In comparison between the varieties, the maximum number of row per ear was found in NK 625 (14.2) and NK 621 (14.01) whereas the minimum number of row per ear was found in CP 888 (11.41).

4.7.3 Number of kernels per row

Number of kernels per row was not significantly different among fertilizer levels while significant variation was found among varieties (Table 4.16). The maximum number of kernels row^{-1}(37.22) was obtained from SAPA management practice followed by GAP fertilizer management practice (37.10). The lowest kernel per row was obtained from control (33.94). Wadileet al. (2016) stated that the source - sink relationship and the rate at which translocation takes place from source during the reproduction stage largely determine grain yield. Maize yield is a function of different yield components such as the number of cobs ha^{-1}, length and girth of cob, number of kernels per row of cob, 1000 grain weight and shelling percentage.

The two tested varieties NK 625 and NK 621gave the larger number of kernels per row as compare to others. The smallest number of kernels per row (34.13) was obtained from CP 888.There was no interaction effect of different fertilizer management practices and different variety on number of kernels row^{-1}. Dawadi and Sah (2012) found that decrease in the number of kernels row $^{-1}$ under lower N management practices might be attributed to poor development of sinks and reduced translocation of photosynthesis.

4.7.4 Thousand seed weight (g)

There was significantly different in thousand seed weight among the different fertilizer management practices at 5% level while highly significantly different was found in different varieties .Among the fertilizer levels, the highest thousand seeds weight (351.66 g) was obtained from SAPA fertilizer management practice (F4) and followed by GAP fertilizer management practice (326.14 g).The minimum thousand seeds weight was obtained from control (301.50 g). It might be due to greater contribution of N and P by producing healthy grains i-e well filled grains and bigger grains while minimum grains weight was obtained at lower levels (0, 0) N:P $kg{\cdot}ha^{-1}$. The interaction of varieties and fertilizer from the data is also significant. Amoruwaet al. 1987 observed that thousand grains weight increased with increasing nitrogen rate.

The maximum thousand seeds weight(350.17 g and 327.76 g) was obtained from NK 621 and NK 625 respectively .The minimum thousand seeds weight (299.92 g) was observed SA 282 which were highly significance different at 1% level with each other among the five varieties. Interaction effect between different fertilizer management practice and different varieties was not significant different in 1000 grains weight. Mastoi et al. (2013) recorded that higher K management application rate (60 kg ha-1) was significantly more superior to the lower management application rate (30 kg ha-1).

4.7.5 Shelling percentage

The differences of mean effect of applied different fertilizer management practices were observed in shelling percent (Table 4.16). Shelling percent of different fertilizer management was not significantly higher than that of control. The maximum shelling percentage (83%, was obtained by GAP fertilizer management practice, followed by SAPA fertilizer management practice (82.48%).The minimum shelling percentage was obtained from control (80.48%). Rasool et al. (1987) stated that increase in K levels (0, 30, 60, 90 and 120 kg ha-1) increase seed yield, thousand seeds weight and shelling percentage significantly over control plots.

There were not significant differences in shelling percentage among five varieties. The maximum shelling percentage (83.43) was detected from SA 282 followed by CP 888 (82.38). The minimum shelling percentage (80.34) was obtained from Yezin 11.

4.7.6 Harvest index (HI)

Different management of fertilizer management practices showed no significant variation but different varieties were highly significantly in harvest index. The comparison of mean observed that the highest harvest index was obtained by SAPA fertilizer management practices practice (39%), followed by the GAP fertilizer management practices practice (39%).The lowest harvest index was obtained from control (34%). The increased in harvest index in SAPA might be due to the increased thousand seed weight. Lawrence 2008, reported that harvest index in corn increases when nitrogen rates increases.

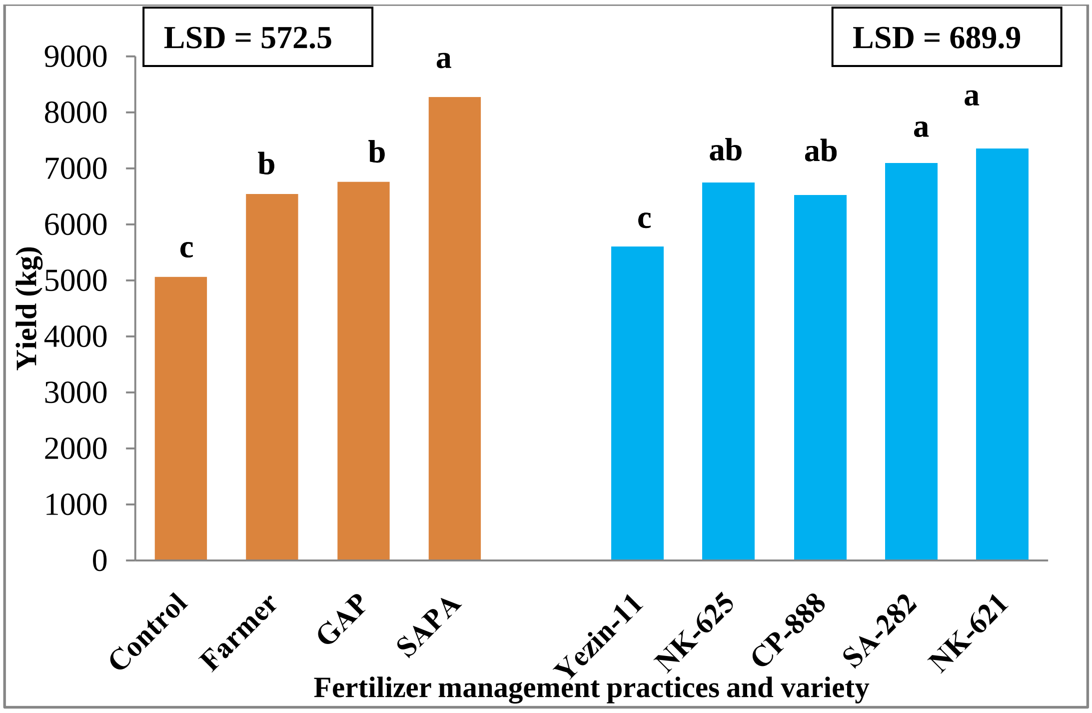
The harvest index (HI) of tested varieties was highly significant differentand the HI of SA-282, NK-621, CP-888, NK-626 and Yezin-11 were 0.41, 0.35, 0.37, 0.38 and 0.34 respectively. There were no interaction affect on different fertilizer management practices and varieties by HI. Havlin et al. (1999) found that HI increased as the nitrogen level increase. He also stated that if consumption of nitrogen increase, the plant will have more use possibility and by more nitrogen absorbing by the root and transferring to reproductive organ, harvest index will increase.

4.16Yield and yield components as affected by fertilizer management practices and five variety

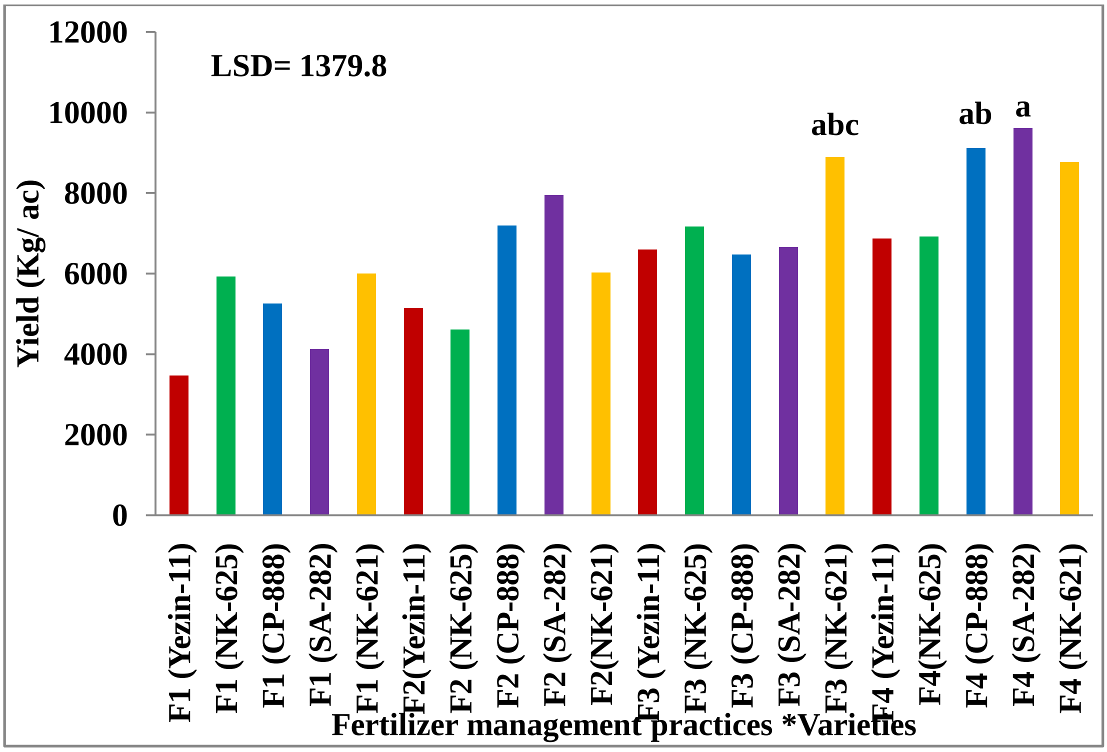
Treatments	Grain Yield (kg)	No. of ear per plant	No. of row per ear	No. of kernels per row	Thousand seed weight (g)	Shelling %	Harvest Index
Fertilizer (A)							
Control	5063 c	1.2 a	12.90 b	33.94 a	301.50 b	80.48 a	0.34 a
Farmer	6545 b	1.29 a	13.06 ab	35.89 a	313.77 b	80.64 a	0.37 a
GAP	6758 b	1.27 a	13.41 ab	37.10 a	326.14 b	83.03 a	0.39 a
SAPA	8279 a	1.29 a	13.57 a	37.22 a	351.66 a	82.48 a	0.39 a
LSD 0.05	572.5	0.25	0.60	3.33	25.31	6.43	0.85
Varieties (B)							
Yezin11	5607 c	1.19 bc	12.64 b	36.2 ab	325.68 abc	80.34 ab	0.34 b
NK 625	6743 ab	1.17 bc	14.20 a	37.92 a	327.76 ab	81.38 ab	0.38 ab
CP 888	6521 ab	1.56 a	11.41 c	34.13 b	312.81 bc	82.38 ab	0.37 ab
SA 282	7090 a	1.33 b	13.92 a	35.19 ab	299.92 c	83.43 a	0.41 a
NK 621	7346 a	1.05 c	14.01 a	36.59 ab	350.17 a	77.97 b	0.35 b
LSD 0.05	689.9	0.20	0.57	2.96	26.94	4.49	0.49
Pr>F							
F	**	ns	*	ns	ns	ns	ns
V	**	**	**	ns	**	ns	**
F*V	ns	ns	ns	ns	*	ns	Ns
CV % (a)	23.54	14.1	3.08	11.14	7.63	4.53	25.61
CV% (b)	25.74	14.76	5.36	9.72	9.89	4.09	15.94

* significant at 5% level, ** highly significant different at 1% level, ns = non significant

Mean followed by same letter were not significant different



4.3 Mean comparison of yield (kg) as affected by different fertilizer management practices and varieties, 2017



4.4 Combination effect of different fertilizer management practices on different varieties on grain yield of maize, 2017

The interaction effect of different fertilizer management practices on different variety of maize of grain yield was obtained from SAPA fertilizer management practices of variety SA 282 followed by SAPA fertilizer management practices of variety CP 888 and GAP fertilizer management practices of variety NK 621.

4.17 Agronomic characters of the varieties as affected by fertilizer management practices

Treatment	Days to 50% tasseling	Days to 50% silking	Days to maturity	Ear weight (g)	Ear Length (cm)	Ear diameter (cm)
Fertilizer (A)						
Control	69.06 a	70.60 a	126.93 a	210.51 b	17.05 a	4.44 c
Farmer	69.07 a	70.87 a	126.80a	237.23 a	17.45 a	4.58 b
GAP	69.13 a	72.13 a	127.00 a	252.12 a	17.81 a	4.72 a
SAPA	69.33 a	71.33 a	127.27 a	259.23 a	19.99 a	4.74 a
LSD $_{0.05}$	0.6	1.64	1.82	23.63	1.03	0.12
Varieties (B)						
Yezin -11	69.08 b	71.58 a	127.58 a	239.27 b	19.93 a	4.41 bc
NK-625	70.25 a	71.83 a	128.08 a	269.64 a	17.03 b	4.49 a
CP- 888	69.17 b	71.00 a	127.58 a	189.60 c	16.64 b	4.33 c
SA-282	68.75 b	69.33 b	124.50 b	207.67 c	16.33 b	4.53 b
NK-621	69.17 b	71.17 a	127.25 a	292.69 a	18.47 a	4.58 a
LSD $_{0.05}$	0.69	1.2	1.22	28.13	1.11	0.15
Pr>F						
F	ns	ns	ns	*	ns	*
V	**	**	**	**	**	**
F*V	ns	ns	ns	ns	ns	Ns
CV% (a)	0.98	2.58	2.58	11.03	7.71	2.85
CV% (b)	1.2	2.04	3.58	14.11	5.79	3.85

***significant at 5% level, ** highly significant different at 1% level, ns non significant**

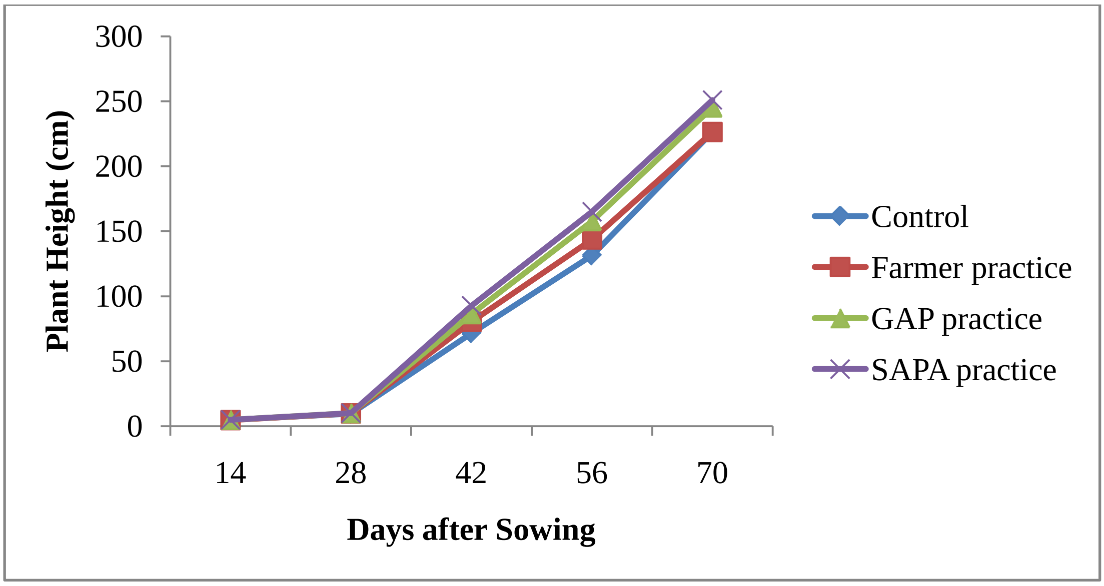
Mean followed by same letter were not significant different.

4.8 Agronomic Characters of Maize

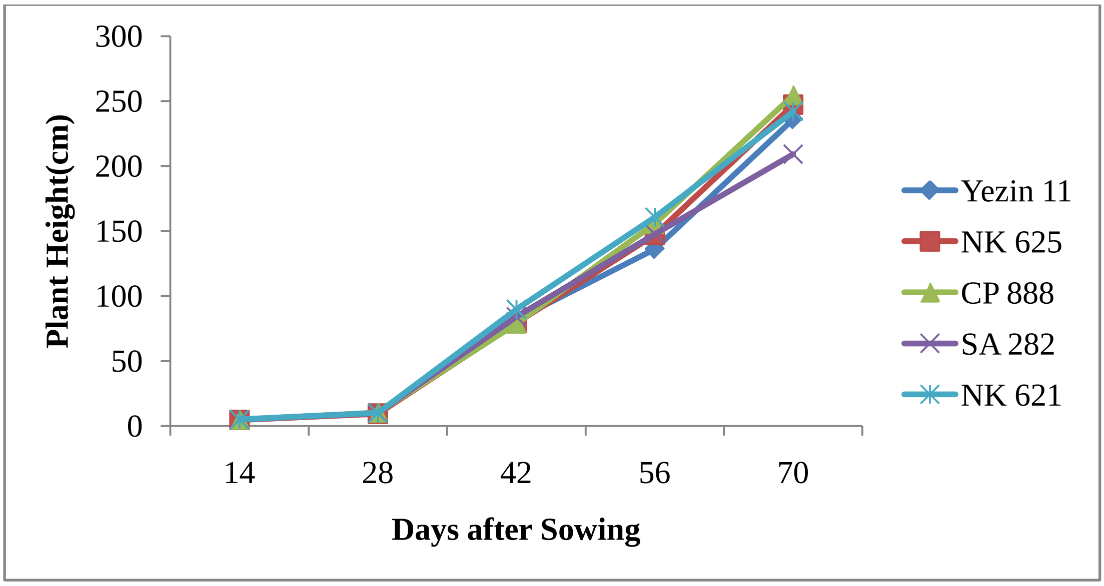
4.8.1 Plant height

Though not significantly different in plant height under different fertilizer levels the maximum plant height (251.13 cm) was observed from SAPA fertilizer management practice followed by (245.47 cm) of GAP fertilizer management practice . The minimum plant height (226.37 cm) was observed from control treatment. The increase in plant height with the increase in nitrogen fertilizer level was due to the positive effect of nitrogen element on plant growth that leads to progressive increase in inter node length and consequently plant height. It might be due to increased root growth, which strengthened the stem against lodging during prolong vegetative growth. Increasing of plant height with increasing nitrogen levels was stated with Hokmalipour et al. (2010).

Significant different in plant height was found in among the tested varieties. The maximum plant height (254.63 and 247.23 cm) was observed from CP 888 and NK 621 respectively while the lowest plant height (209.27 cm) was obtained from SA 282 among other varieties. There was no interaction effect on different fertilizer management practices and different varieties by plant height. Bukhsh et al. (2012) stated that plant height; number of seeds ear^{-1}, ear length, thousand seeds weight, seed and biological yield are significantly increased by K management application.



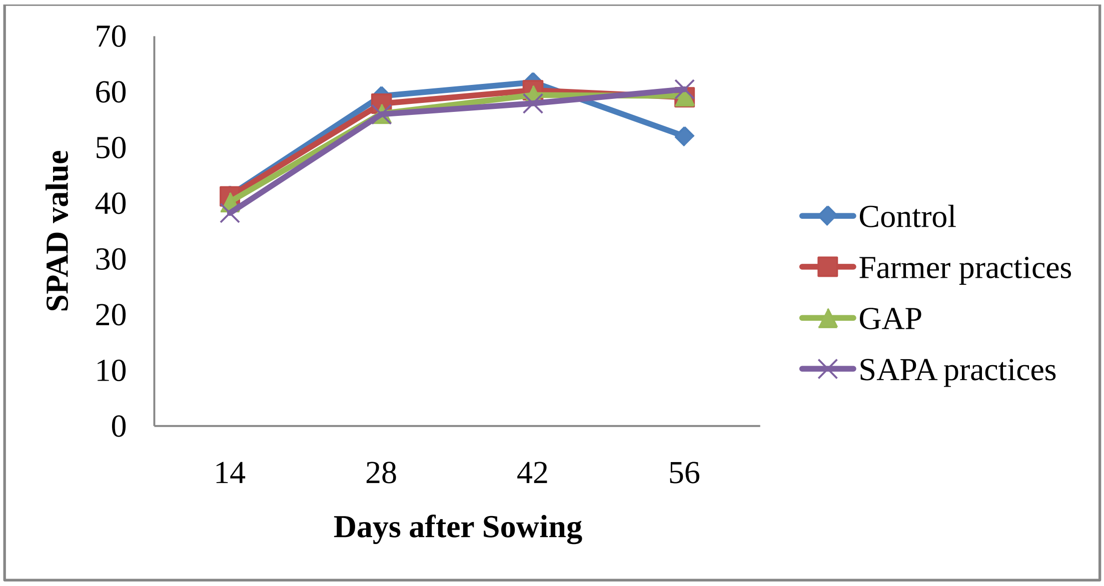
4.6 Mean comparison of plant height as affected by fertilizer management practices, 2017



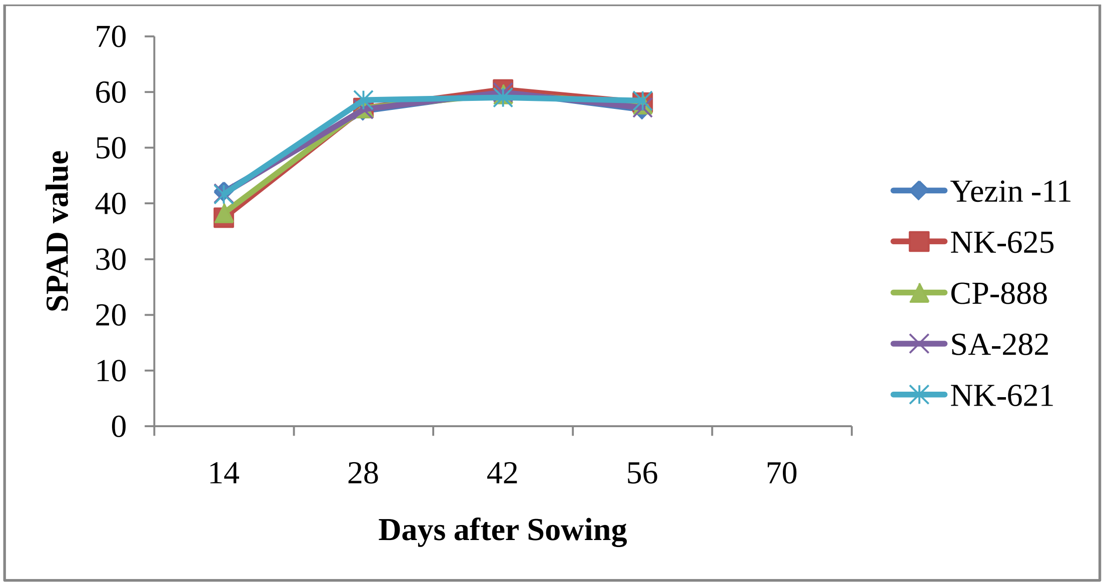
4.7 Mean comparison of plant height as affected by variety, 2017

4.8.2 SPAD value

The mean SPAD value was highly significantly different at 1% level among the fertilizer management practices though not significantly different among different varieties. According to the result, the maximum SPAD meter (60.47) was observed from SAPA fertilizer management practice and followed by farmer practice (F2) (59.22) at 42 days after sowing. The minimum SPAD value (52.02) was observed from control treatment at the same time. Varvel et al. (1997) observed N fertilizer significantly increased both maize seed yield and SPAD readings. The maximum SPAD value (58.47 and 58.11) was observed from NK 621 and NK 625 respectively while the minimum number of SPAD value (56.86) was obtained from Yezin 11 among other varieties. Maize growth, betweenV6 and R1 stages, was reported as an important period due to a strong relationship between plant characteristics and maize seed yield (Raun et al. 2005).There was no interaction effect on different fertilizer management practice and different varieties by SPAD value.



4.8 Mean comparison of SPAD value as affected by fertilizer management practices, 2017



4.9 Mean comparison of SPAD value as affected by variety, 2017

4.8.3 Days to 50% tasseling

Different management of fertilizer management practices showed no significant variation but different varieties were highly significantly in days to 50% tasseling . The comparison of mean observed that, the greater number of days to 50% tasseling (69.13 and 69.07) was obtained by F3 and F4 treatment of GAP fertilizer management practices and SAPA fertilizer management practice. The smallest number of days to 50% tasseling was obtained from F1 treatment of control. This might be the higher level of NPK prolonged the vegetative growth stage of the plant rather longer period of time resulting in more days taken to tasselling.Namvar and SeyedSharifi (2011) suggested that phonological events were significantly delayed by the increasing rate of mineral N than by other sources. The maximum days to 50% tasseling (70.25) was detected from NK 625 followed by NK 621 (69.17). The minimum days to 50% tasseling (68.75) were obtained from SA -282 (68.75).Jantalia and Halvorson 2011 informed that increased growth parameters and decrease in the days to reach 50% tasseling and silking with increasing rate of N management practices. Kwaga. 2014 state that all the fertilizer management practices treatment has comparable number of days to 50% tasseling and tasseled earlier than the without fertilizer management practices treatment. There was no interaction effect of different fertilizer management practices and different varieties by days to 50% tasseling.

4.8.4 Days to 50% silking

Different management of fertilizer management practices showed no significant variation but different varieties were highly significantly in days to 50% silking. The comparison of mean observed that, the greater number of days to 50% siliking(71.13 and 71.33) was obtained by F3 and F4 treatment. The smaller number of days to 50% siliking was obtained from F1 of control. The greater number of days taken to silking may be due to the more succulent vegetativegrowth of the plant. This might be due to the adequatenitrogen in combination with P and K which greatlyinfluenced vegetative growth of plant. The varietieshowever, did not affect the number of days taken tosilking. These results are reported byToor(1990). Low nitrogen level could have adverse effect on the production of reproductive cells. The shortest period to silkingunder 200 kg N ha-1 and longest period to silking under 0 kg N ha-1 were obtained (Shrestha 2013). The maximum days to 50% silking (71.83 and 71.58) was detected from NK 625 and Yezin 11 respectively. The minimum number of days to 50% siliking (69.33) was obtained from SA 282. Dolan et al.(2006) who observed that higher nutrient availability and favorable soil conditions due to nitrogen fertilizer may cause vigorous crop growth and delay phenology such as silking.

4.8.5 Days to maturity

There was no significant fertilizer management practices level of days to maturity, however, different varieties was highly significant different at 1% level. According to the result, the greater number of days to maturity (127 and 127.27 days) was obtained by F3 and F4 treatments .The smaller numbers of days to maturity was obtained from F2 and F1 (126.80 days 126.93 days) treatment of farmer fertilizer management practice and control . Namvar and SeyedShatifi (2011) observed the duration of vegetative and reproductive period what is a proof of lengthening of the time to maturity. The greater days to maturity (128 and 127.58 days) was detected from NK 625 and CP 888 respectively. The smaller days to maturity (124.5) was obtained from SA 282. Dolan et al. (2006) who found that higher nutrient availability and favorable soil conditions due to nitrogen fertilizer might be a possible reason for delayed phenology in N-treated plots.

4.8.6 Ear weight (g)

The mean value of ear weight was significant different at 5% level among fertilizer management practices, however, there was highly significantly different among different varieties in Table 4.17. According to the result, the maximum ear weight (259.23 g) was observed from SAPA fertilizer management practice followed by (252.13g) of GAP fertilizer management practice (F3). The smallest ear weight (210.5 g) was observed from control treatment. Blumenthal et al. (2003) mentioned that increasing nitrogen is significantly increased grain weight in maize. Increasing nitrogen fertilization rates led to a significant increase in ear length, number of seed row^{-1}, ear weight and seed yield. The maximum ear weight (292.69 g) was detected from NK 621 followed by NK 625 (269.64 g) while the minimum ear weight (207.67 g) was obtained from the variety of SA 282.There were no interaction of fertilizer management practices and different varieties by ear weight.

4.8.7 Ear length (cm)

The mean value of ear length showed not significant fertilizer management practices. The result from the study observed that the maximum ear length (18.1 cm) from SAPA fertilizer management practices, F4 treatment have no significant different from other. The second maximum ear length (17.91 cm) was obtained from SAPA fertilizer management practice. The minimum ear length (16.98 cm) was observed from control. This could be due to better nutrient uptake and efficient assimilation of applied nutrients resulted in cob length, cob diameter and number of grains cob-1 and thus more grain yield. Similar findings were observed by Shivranet al.(2013).

Numerically, the maximum ear length(19.23 cm and 18.66 cm) was observed from Yezin 11 and NK 621. The minimum ear length (16.33 cm) was obtained from SA 282 among other varieties. Nemati and Sharifi (2012) informed that management practices of 225 kg N ha^{-1} had the longest ear and the shortest was found in no nitrogen management practices.

4.8.9 Ear diameter (cm)

The mean value of ear diameter was significant different at 5% level among fertilizer management practices, however, there was highly significantly different among different varieties .The result indicated that the largest ear diameter (4.74 cm) was observed from SAPA fertilizer management practice followed by GAP fertilizer management practice (F3). The smallest ear diameter (4.44 cm) was observed from control treatment. Gulet al. (2015) informed that stover yield could be due to better nutrient uptake and efficient assimilation of applied nutrients resulted in more leaf, cob diameter and number of grains ear^{-1}. This might be due to the production of ear diameter with respective levels of NPK and micronutrients applications.

The largest ear diameter (4.86 and 4.53 cm) was observed from NK 621 and SA 282 respectively. The smallest number of ear diameter (4.33cm) was obtained from CP 888 among other varieties. There was no interaction effect on different fertilizer management practices and different varieties by ear diameter. Farshad and Malakuti (2000) stated that the consumption of potassium and micronutrient in addition t increasing the level of grain protein also improved their concentration in grain and effective for other character such as plant height, ear diameter and number of grain per ear.

CHAPTER V

Farmers Participatory Variety Selection in Aung-Ban

5.1 Evaluation of farmers' on maize varieties

The 25 farmers were evaluated and participate from the southern Shan State. They were training of maize good cultural practice, fertilizer calculation, seed germination tests and postharvest storage from SAPA project. The farmers who participated and evaluated the trial were representative to the maize growing area of Southern Shan State and having long experience in farming. The field trial was evaluated based on the variety performances and fertilizers management practices by considering lodging resistance, ear plant^{-1},ear size, plant height, disease resistance, seed color, cob size, husk cover and grain yield as the most important farmers' selection criteria. Ranking of varieties and fertilizer management practices were done as the scale of 1-5, 1 being very poor and 5 being excellent.

5.2 Overall Score of farmer participatory of varieties and fertilizer application selection

The farmer participatory varietal selection showed that variety of NK 621 got the highest score (4.364), followed by SA 282 (3.984). In the case of fertilizer management practice of SAPA (GAP) was ranked as highest (3.81), followed by DOA GAP practice (3.43).

5.2.1 Lodging resistance

Lodging of plant has a financial implication for the farmer, because a number of ears may be laying on the soil, making it uneconomical to be picked up by hand and can not resistance lodging by wind. The variety NK 621 was given by farmers as highest score (4.60) in term of lodging resistance, followed by SA 282 (4.64) and NK 625 (4.44). However, the lowest score was obtained by CP 888 (3.52). The farmer choose the CP 888 was given lowest score because of CP-888 variety was taller than other varieties which lead to less resistance to lodging. In fertilizer application trial, the highest score of lodging resistance was obtained from SAPA fertilizer management practice (4.12), followed by GAP fertilizer management practice. The lowest score of lodging was observed from farmers' practice (2.48).

5.2.2 Ear per plant

The variety of NK 621 was given highest score (4.2), followed by SA 282 (3.88) and NK 625 (3.8).However, the lowest score of ear plant^{-1}was obtained by Yezin11 (3.32).The farmer participatory varietal selected variety of NK621 was given highest score because of NK 621 variety of ear per plant was higher than other than variety. In fertilizer management practices, the highest scored of ear plant^{-1}was found from SAPA fertilizer management practice (3.84), followed by GAP fertilizer management practices (3.34). The lowest score of ear plant^{-1} was observed from farmer fertilizer management practice. (2.28).

5.2.3 Ear size

The highest score of ear size was obtained from NK 621(4.6)followed by NK 625 (3.92) and SA 282 (3.64). However, the lowest score of ear size was obtained from Yezin11 (3.52). In fertilizer management practices, the highest scored of ear size was obtained from SAPA fertilizer management practice (3.80), followed by GAP fertilizer management practices (3.56). The lowest score of ear size was observed from farmer fertilizer management practice (3.00).

5.2.4 Ear length

The highest score of ear length was observed from NK 621(4.52) followed by NK-625 (3.88) and Yezin11 (3.76). The NK 621 variety was given the highest score because of these variety are higher length than other variety as visual. Moreover, they can assect of NK 621 variety in the future. However, the lowest score of ear length was observed from CP-888. In fertilizer management practices, the highest scored of ear length was obtained from SAPA fertilizer management practice (3.8), followed by GAP fertilizer management practice (3.44). The lowest score of ear length was observed from farmers' fertilizer management practice (3.12).

5.2.5 Plant height

The highest score of plant height was observed from SA 282 (4.48) followed by NK 625 (4.12) and NK 621 (4). However, the lowest score of plant height was observed from CP-888 (3.36). In fertilizer management practices, the highest scored of plant height was obtained from SAPA fertilizer management practice (4.00), followed by GAP fertilizer managementpractice (3.72). The lowest score of plant height was observed from farmer fertilizer management practice(3.40).

5.2.6 Disease resistance

The highest score of disease resistance was obtained from NK 621(4.28) followed by Yezin 11 (4.4) and NK 625 (4.08). However, the lowest score of disease resistance was observed from CP 888 (3.48). The NK 621 variety was given highest score because of these variety can resistance of disease than other variety. In fertilizer application practices, the highest scored of disease resistance was obtained from SAPA fertilizer management practice (3.76), followed by GAP fertilizer management practices (3.24). The lowest score of diseases resistance was observed from farmer fertilizer management practice (3.08).

5.2.7 Seed color

The highest score of seed color was obtained from NK 621(4.72) followed by Yezin 11 (4.4) and SA 282 (3.68).The highest score of seed color was obtained from NK- 621 (4.72) because of these variety of grain color is orange and seed weight is choosen than other variety. However, the lowest score of seed color was observed from NK 625 (3.32). In fertilizer management practices, the highest scored of seed color was obtained from SAPA fertilizer management practice (3.52), followed by GAP fertilizer management practices (3.32). The lowest score of seed color was observed from farmer fertilizer management practice (3.24).

5.2.8 Cob size

The highest score of cob size was observed from SA-282 (4.12) followed by NK-621 (3.92) and Yezin-11 (3.88). However, the lowest score of cob size was observed from CP-888 (3.6). In fertilizer application practices, the highest scored of cob size was found from SAPA fertilization practice (3.80), followed by GAP fertilizer application practice (3.28). The lowest score of cob size was observed from farmer fertilizer application practice (3.20).

5.2.9 Husk cover

The farmer participatory varietal selected variety of NK 621 was given by highest score (4.40), followed by NK 625 (4.20) and SA 282 (4.08). However, the lowest score of husk cover was obtained from CP 888 (3.28). NK 621 variety was given the highest score because of these variety have many husk cover of ear and can protect of rodent infection. In fertilizer management practices, the highest scored ofcover was obtained from SAPA fertilizer management practice (3.80), followed by GAP fertilizer management practice (3.44). The lowest score of husk cover was observed from farmer fertilizer management practice (3.24).

5.2.10 Grain yield

The highest score of grain yield was found from NK 621 (4.40) followed by SA 282 (3.84) and NK 626 (3.72). The NK 621 was given high score because of the ear per plant, ear size, ear length, seed color more influence than other varieties. And then, the farmer can asset of NK 621 variety in the future. However, the lowest score of grain yield was obtained from CP-888 and Yezin11 (3.20). In fertilizer management practices, the highest scored of grain yield was obtained from SAPA fertilizer management practice (3.64), followed by GAP fertilizer management practice (3.48). The lowest score of grain yield was observed from farmer fertilizer management practice (2.96).

4.19Farmer participatory variety selection of maize, 2017

	Varieties				
Criteria	Yezin 11	NK 625	CP 888	SA 282	NK 621
Lodging resistance	4.12	4.44	3.52	4.54	4.60
Ear per plant	3.32	3.80	3.48	3.88	4.20
Ear Size	3.52	3.92	2.92	3.64	4.60
Ear length	3.76	3.88	3.08	3.68	4.52
Plant height	3.88	4.12	3.36	4.48	4.00
Disease resistance	4.40	4.08	3.48	3.80	4.28
Seed color	4.40	3.32	3.48	3.68	4.72
Cob size	3.88	3.44	3.60	4.12	3.92
Husk cover	3.64	4.20	3.28	4.08	4.40
Grain yield	3.20	3.72	3.20	3.84	4.40
Overall score	34.68	38.92	33.4	39.84	43.64
Average	3.468	3.892	3.34	3.984	4.364
Rank	4	3	5	2	1

Note score, 1 = very poor, 5 = excellent, Rank, 1 =excellent, 5 = very poor

4.20 Farmers' participatory fertilizer management practices of maize, 2017

	Fertilizer management practices		
Criteria	Farmer	GAP	SAPA
Lodging resistance	2.48	3.48	4.12
Ear per plant	2.88	3.36	3.84
Ear Size	3.00	3.56	3.80
Ear length	3.12	3.44	3.80
Plant height	3.40	3.72	4.00
Disease resistance	3.08	3.24	3.76
Seed color	3.24	3.32	3.52
Cob size	3.20	3.28	3.80
Husk cover	3.24	3.44	3.80
Grain Yield	2.96	3.48	3.64
Overall score	30.6	34.32	38.08
Average Score	3.06	3.432	3.808
Rank	3	2	1

Note 1 = very poor, 5 = excellent, Rank, 1 =excellent, 5 = very poor

CHAPTER VI

CONCLUSION

In the study, nearly half (65%) of sample farmers were at the primary education level. Meanwhile, education is very important for everyone to be able to adopt new technologies. Therefore, extension agent should be trained and empowered to educate farmer on how to process in maize production. Maize production in Southern Shan State is characterized by technological input. Therefore, yield are very low as the average of 3356 kg/ ha. It is therefore important to find of extending high yield maize varieties with fertilizer application rate and good agricultural practices. And then, the sample farmer do not practices of thinning about 87%.The reason why farmer do not practices of thinning at the appropriate time because of they did not know of thinning. Thus, the extension worker and other private sectors should be attributed to lack of information in maize production.The sample farmers did not follow GAP (Good Agricultural Practices) of maize formulated by DOA. Maize yield are decreasing because sample farmers are growing with traditional methods. Therefore, government and private sector should participate on maize GAP training for farmers.

The SAPA fertilizer management practices responded highest yield, highest ear length, row length, ear diameter, rows ear^{-1}, 1000 grain weight and SPAD value. SAPA fertilizer management practices produced more yield than other practices. It may probably due to higher fertilization application of N, P and K with micro nutrients. It is necessary to produce maximum high and quality seed production.

GAP fertilizer management practices produce second higher yield in this experiment. It is also applied higher fertilizer management practices than farmer practices. GAP fertilizer management practice produced more yield than farmer practices but it is necessary to put more K and micro nutrients to get maximum yield. Therefore, if the farmer do not used of micro nutrients, they can be practiced of GAP fertilizer management practice in maze production.

For variety, NK 621 variety produced with highest yield than other varieties. And it also accompanies with ear weight (g), ear diameter (cm), kernels row^{-1}, SPAD value, ear diameter and 1000 seeds weight. It was found that among the different varieties NK 621 produced more yield, followed by NK 625 and SA 282, but there were not significantly different each other. Therefore, these three varieties were suited for high fertilize management practices. For interaction effect, the highest grain yield was obtained from SAPA fertilizer management practices with NK 621, followed by SAPA fertilizer management practices with CP 888, but there were not significantly different. Therefore, SAPA fertilizer management practice with different hybrid varieties will produce more yield than other practices.

Farmers used different parameters and methods to evaluate the tested maize varieties. For fast adoption and dissemination the new varieties considering the preferences of farmers otherwise it is less likely to be widely adopted or accepted by the farming community. Farmers participatory varietal selection and fertilizer management practices were confirmed NK 621, SA 282 varieties and SAPA fertilizer management practices fallowed by GAP fertilizer management practices. Two varieties of NK 621 and SA 282 were found good for yield potential. According to the analysis result and farmers' selection variety NK 621 and SA 282 were as the best performing in grain yields in the future of Southern Shan State.

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