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Application of corn cultivation techniques by smallholder farmers

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Abstract. This research was conducted in one of Indonesian South Sulawesi's regencies i.e. Sidenreng Rappang and specifically in three sub-districts namely Pancalautang, Tellulimpoe, and Watangpulu district. The study aimed to identify and evaluate maize cultivation techniques implemented by smallholder farmers in the three sub-districts. The study employed a survey by collecting primary and secondary data. Primary data include the details on farmers identity and farm related data, including all aspects of cultivation of maize in the field. The secondary data included general conditions study location and recommended farming practices. Site and farmer selection was determined based on the number of households that cultivate maize. Of the six villages determined, namely Teppo, Baula, Wanio, Lise, Mattirotasi, and Buae, 20 sample farmers were selected each based on their level of education, experience and participation in a farmer group. The results indicated that the maize cultivation technique implemented by the smallholder farmers was not in accordance with the recommendations, especially regarding land preparation, fertilizing, spacing, and crop protection. Based on this study, assistance and supports for these farmers need to become high consideration by the government.

1. Introduction

Corn production in South Sulawesi-Indonesia is still dominated by smallholder farmers in areas such as Jeneponto, Bantaeng, Sinjai, Takalar, and Bulukumba. The potential land is 446,500 ha, the majority of which is planted in the period of November to March covering \pm 214,500 ha and from July to September covering \pm 126,500 ha. Production from these centres has not been able to meet the demand for corn which is increasing yearly [1].

Sidenreng Rappang is one of the centers of rice commodity development in the regional commodity concept known as BOSOWASIPILU (Bone, Soppeng, Wajo, Sidrap, Pinrang, and Luwu), it should take a role in fulfilling corn at local, regional and national levels. However, the productivity has not been in optimum amount due to several problems, including: 1) the poor quality of the seeds used by farmers, 2) the improper application of fertilizers by farmers, 3) yield losses due to pests and diseases, 4) mishandling of harvest and post-harvest stage, 5) the application of technology has not been optimal, 6) land plantations are experience decreasing, and 7) limited farmer capital and technical supports [2][3] Low maize production both in quality and quantity requires improvement in farming techniques through efforts to develop crop intensification and extensification to increase corn production and productivity.



1.1. Cultivation Techniques

Corn plants come from tropical regions that can adapt to the environment outside the area. Corn does not have strict requirements and can grow on a variety of soils, even in rather dry soil conditions [4]. Climate components that affect the growth of corn plants include: temperature, rainfall, humidity, irradiation intensity and height of the place [5]. Corn have broad adaptability to the growing environment. In the tropical regions of Indonesia, corn grows and produces well in the lowlands to areas that have an altitude of 1300 m above sea level. Even so, corn plants will grow and produce optimally in the lowlands to an altitude of 750m above sea level. Some of the newly released superior varieties of corn can produce optimally in areas that have an altitude of 500 m above sea level [6].

Proper cultivation techniques for corn started from the seeds selection. According to Rukmana [5], corn seeds for planting are processed through the stages of drying, threshing, re-drying, and packaging in accordance with the rules of hatchery management. Requirements for good corn seeds are as follows: minimum growth capacity of 80%, not porous and hollow; free from pests and diseases; pure and free from a mixture of other varieties or other impurities; uniform in color according to the original color of a variety; uniform seed size and identity of the variety are known.

Land preparation for corn are manageable with three ways, namely no tillage or zero tillage, minimum tillage and maximum tillage. Zero tillage can be practiced on fertile land from previous planting, minimum tillage can be practiced on sandy or light soils, while the maximum tillage is done on heavy soils. The aims of land tillage for corns is to improve the soil condition for the maximum plant root growth. In addition, tillage will also improve soil texture, improve air circulation, and encourage soil microbial activity [7].

Fertilization on corn plant field aims to replace nutrients that have been absorbed by plants, to improve soil conditions so that corn plants can grow well and can absorb elements in sufficient quantities [8]. The type of fertilizer given to corn is organic fertilizer and inorganic fertilizer. Organic fertilizer in the form of manure given on infertile land, given by spreading and leveling together with tillage, the dosage is around 15-20 tons per hectare [9]. The dosage of fertilizer for corn is highly dependent on soil fertility and the variety of the corn. The recommended dosage of inorganic fertilization per hectare are: 200-300 kg urea (for Nitrogen), 100-200 kg SP-36 (for Phospor), and 50-100 kg KCl (for potassium). For hybrid varieties the recommended dosage are: 300 kg urea, 200 kg SP-36, and 100 kg KCl. The recommended dose per hectare for free-bred varieties are 200 kg Urea, 150 kg SP-36, and 100 kg KCl. Provision of fertilizer is done in stages with a predetermined size [7].

Watering is important for corn plants. Lacking of water will result in withering for 1-2 days, and when occur during the flowering period, it can reduce yields up to 22% [5]. When the corn plant withering occurs up to 5-8 days, a decrease in corn yield can reach 50%. Corn requires a lot of water during vegetative growth until the seed filling period. The water demand is increasingly reduced until the ripening period of the cobs [9]. Irrigation becomes more essential when there is no rain for three consecutive days. Decision for irrigation can also be based on observation on the soil and plants condition [7].

For the protection of the corn, Rukmana and Yudirachman [6] emphasized the components of integrated pest and disease control as follows: Planting healthy seeds; planting simultaneously; improve soil drainage; utilizing natural enemies of pests or disease parasites; regulate crop rotation; uproot heavily attacked/infected plants; and apply elective pesticides.

1.2. Biophysical condition of study location

Sidenreng Rappang Regency is located between 3°43 'to 4°09' South Latitude and 119°41 'to 120°10' East Longitude. The distance between the regency capital and the provincial capital is 183 km or can be reached by inter-provincial road an average of 3.5 hours. The administrative area of this regency is 188,325.25 ha which is divided into 11 districts and 105 villages/kelurahan. The distance from the capital could have an influence in the effectiveness of direct control and support from the provincial government to the farmers. Among the eleven districts, three were chosen purposively to represent

Sidenreng Rappang District. They are Pancalautang, Tellulimpoe and Watangpulu District. They were chosen for their status as development area of corn cultivation.

The topography of the Sidenreng Rappang Regency generally consists of lowlands, to hilly and mountainous with heights of 16 - 500 m above sea level. Rainfall occurs throughout the year with an average of 1,450 mm, average temperatures of 27° C. Based on these conditions the region is tropical type A and C [10]. Based on the distribution of monthly rainfall, it is known that there are two growing seasons namely the Rendengan Planting Season (rainy season) which falls in April to September and the Gadu Growing Season (dry season) which falls in October to March [11].

Sidenreng Rappang Regency have several types of soil. The dominant one is podzolic soil types, other types such as alluvial, regosol, grumusol and mediterranean are found in all districts [12].

2. Methodology

A survey was conducted on locations i.e. three sub districts which were selected by purposive sampling method. The selection of sub-districts was based on their existing state as corn potential centress and the potential development farm field for corn. Among the three districts, the representing village was based on the number of households that cultivate corn.

On each selected location as many as 20 sample farmers was chosen, making a total of 60 respondent farmers. These respondents were considered to have represented various level of education, farming experience and participation in a farmer group. Field observation was also carried out in accordance with interviews with community leaders, relevant agencies and individual farmers. During field visits to farmer's farm land, observations are carried out on plantations, agricultural activities undertaken and constraints faced by farmers. To obtain a general description of the location, data collection consisted of primary data and secondary data. Primary data obtained from: a) Direct interviews with farmers about cultivation, production, harvest, and post-harvest techniques and practices using predesigned list of questions that includes all necessary variables; b) Direct observation by observing the state or condition on and off farm which related to the object being studied; c) Intensive direct participation in the implementation of corn cultivation activities and practices in the field. Secondary data concerning regional monographs was obtained from the Village office, District Office, Agricultural Counseling Center (BPP), Central Statistics Bureau (BPS), and other relevant agencies.

3. Results and discussion

This study took two main parameters to observe namely: general conditions of farmers and corn cultivation techniques and practices.

3.1. General Conditions of Farmers

General condition of the farmer includes age, education level, length of farming, and land status. The relationship between age, education level, and farming experience and the relationship between land status and land area can be seen in table 1 and 2.

Table 1. The relationship between age, education level, and respondent farming experience

Age (Years)	Education Level				Farming Experience (Years)		
	No formal education (%)	Elementary school (%)	Junior high school (%)	Senior high school (%)	≤5 (%)	>5 – 25 (%)	>25 (%)
< 25	0.00	0.00	0.00	0.00	3.33	0.00	0.00
25-50	1.69	38.98	27.12	5.08	13.33	56.67	1.67
>50	10.17	15.25	0.00	1.69	0.00	13.33	11.67

Source: Primary data

Table 2. Land status and land area

Land Status	Land area (ha)			
	≤0.5 (%)	>0.5 - 1.0 (%)	>1.0 - 2.0 (%)	>2.0 (%)
own's farm	13.33	41.67	28.33	0.00
rented/ farm labour	6.67	6.67	3.33	0.00

Source: Primary data

Based on the data shown in table 1, it is visible that the level of education was closely related to the technology used and ultimately affects the production that will be produced. When the education level of farmers is higher, it might help in the process of adoption, application of new innovations, both in the implementation of good cultivation techniques, postharvest handling as well as for developing information relating to farming activities.

The experience of farmers in running their farms is one factor that can influence their success. The longer the farmer works in these activities, the more experience he gets. The experience will help farmers to learn more through their experience which will build their understanding and skill in cultivation techniques, postharvest technology and other advanced practices related to his farming. However, in this study, when seeing the production obtained which was very low (1-2 tons ha⁻¹) compared to the potential average national production (5-6 tons ha ha⁻¹). It indicates that these farmers might have long experience but with less opportunities to have best farming practices, techniques and technologies being introduced to them during their farm life. Farm status and area could also affect the farming practices and eventually income from the farming activities [13]

3.2. Cultivation Techniques

Results of observations and interviews with farmers regarding crop cultivation techniques are presented in table 3, 4, and 5.

Table 3. Source of seeds used by respondent farmers

Source of Seeds	Percentage in each village (%)						Total Percentage (%)
	Buae	Mattirotsi	Teppo	Buala	Wanio	Lise	
Local breeder	20	10	20	20	20	50	23.3
Farm Shop	10	20	10	10	0	0	8.33
Agriculture office/agency	10	20	10	10	0	20	15.00
All of the three above	40	40	60	60	60	30	48.33
Own's seeds from previous planting	20	10	0	0	0	0	5.00

Source: Primary data

As described earlier, that seed selection has become an important first consideration for good corn farming. Table 3 shows that farmers generally obtain seeds from local breeder, farm shops and agricultural official agencies (48.33%) and farmers rarely use their own corn seeds. It is an indication that farmers already understand the benefits of using certified seeds which are proven to increase their production yields, besides that the genetic purity of a variety is guaranteed. Efforts to increase corn production, both through intensification and others, are always encouraged by the use of superior seeds [14]. The discovery of new high-yielding varieties in the last ten years turned out to indirectly encourage changes in farmers' patterns in the use of seeds. Initially farmers always depend on seeds from their own crops, eventually starting to change using quality seeds produced by seed producers. The surveyed farmers felt this method is more practical, good quality, plant growth is more uniform and easy to obtain.

Table 4. Aspects of seed variety, harvest time, production, and marketing place

Description	Percentage (%)
Variety	
· Lamuru	21.67
· Bisi-2	53.33
· N-35	25.00
Harvest Age (days)	
· 80-100	60.00
· 100-115	40.00
Production (tons)	
· ≤ 1	20.00
· 1-2	70.00
· ≥ 2	10.00
Place of marketing	
· Local market	3.33
· Collector trader	60.00
· Local market and collector trader	16.67
· Others (Traders, stock farmers, etc)	20.00

Source: Primary data

Table 4 shows that the varieties most widely used by farmers are the Bisi-2 hybrid varieties. Corn harvesting was carried out in average was at 80-100 days. The highest production was 1-2 tons obtained and marketing of the harvest was mostly through collectors. The seeds used by farmers are generally hybrid varieties, some farmers also used the free bred variety of composite varieties. Farmers in general have understood the superiority of hybrid varieties so that most of the farmers have used them. The benefits they have felt was the increase in yields compared to the free bred varieties. Suprpto [15] pointed that superior varieties of hybrid corn are expected to increase corn production in the future for their advantages over the free bred seeds such as higher yield potential, more uniform growth, and disease resistance. The drawbacks of hybrid seeds such as that the treatment must be intensive and the yields cannot be used as seeds for the next growing season. This is the reason for the yield obtained by the famers in this study which were not in the optimal potential amount the variety. This will be seen in the next part about farming practices.

Table 5. Various corn cultivation technical activities carried out by respondent farmers

Farming practices	Yes (%)	No (%)
Land preparation	68.33	31.66
Intercropping plants	66.66	33.33
Fertilization	100.00	0.00
Weeding	100.00	0.00
Soil bedding	66.66	33.33
Irrigation	00.00	100.00
Stitching	100.00	0.00
Plant Protection	100.00	0.00
Harvest criteria implementation	100.00	0.00
Pruning	8.33	91.66

Source: Primary data

Table 5 shows that farmers carried out general corn cultivation techniques apart from irrigation. The survey revealed in general (68.33%) farmers made land preparations prior to planting activities. Land preparation activities included weeding, soil tillaging, and making planting beds. Most farmers practice soil tillaging because almost all farmers farm on dry land. It can be seen from the planting which was carried out only at the beginning of the rainy season, which aims to irrigate the farmers' corn crop. However due to the workload and additional cost required, there were also a small portion of respondent farmers who did not do land processing at all (zero tillage). This has been explained by Adisarwanto and Widyastuti [9] that the method of land management in dry land depends on the farmers' and land condition. Planting beds were also prepared by most of farmers after the soil tillaging activity. Most respondents made one-way beds commonly referred to as 'larikan', the beds were left for 7-10 days before planting.

Plant spacing implemented by farmers varies greatly, but in general they planted the corn in 75 cm x 25 cm and 100 cm x 40 cm spacing. This was because farmers generally plant hybrid varieties which are harvested dry. The application of corn plant spacing indeed depends on the variety [9].

The surveyed farmers did not apply manure as basic fertilizer due to limited funds, and according to them would not really affect the growth. They also assume that naturally basic fertilizers are already on the ground. They believe basic fertilizers are available by the decomposition of waste that is available when the land is not used. This findings indicates the lack of knowledge of farmers about the function of organic fertilizers such as manure for initial soil condition improvement. In addition, farmers' knowledge about the use of other alternative organic fertilizers such as bokashi is still lacking. In general, the surveyed farmers only apply inorganic fertilizer for their crops. Tillage followed by basic fertilization provides an opportunity for plants to grow better and be of high quality. However, organic fertilizers have low nutrient content and release N slowly as opposed to inorganic fertilizers. Therefore it is necessary to have a combination of treatments between the two types of fertilizers in order to obtain the interaction of the two types of fertilizer [16].

Farmers planted at the beginning of the rainy season (September-November) because 100% of farmers planted on dry land where water sources were very dependent on the rain. It's a consequence of no irrigation system. Farmers also plant at the beginning of the dry season (February-April) so in a year they could plant twice. The rest of the time they generally look for other jobs to support their families such as by becoming farm laborers in rice plantations. In general according to Adisarwanto and Widyastuti [9], corn in a dry land are planted maximum two times in a year. This is mainly related to water requirements at the beginning of plant growth. Common planting time is the beginning of the rainy season ('labuhan') between September-November and the beginning of the dry season ('marengan') between February-April. This arrangement is in accordance with the climatic conditions

in Sidrap Regency, where rainfall is between September to January and the highest rainfall occurs in December. August is the peak of the dry season but there are also three months of humid conditions, three dry months and six wet months [11].

3.3. *Maintenance practices*

The survey found that 100% of farmers performed fertilization activities. Fertilization was carried out 10 to 15 days after the release of corn buds. Fertilizers used by the respondents were single fertilizer namely Urea (N), SP-36 (P), TSP (P) and ZA (N), and some compound fertilizer (NPK). Furthermore, at the age of 33 - 45 DAP second fertilizer application was carried out with urea and KCl (Potassium). Fertilization, which is done mostly by farmers was still not according to technical instructions. The use of fertilizer generally uses only as much as 200 kg urea ha⁻¹, while SP-36 and KCl only a small portion uses. The recommended dosage of fertilizer per hectare is 200-300 kg urea, 100-200 kg SP-36, and 50-100 kg KCl. For hybrid varieties the recommended dosage is 300 kg urea, 200 kg SP-36, and 100 kg KCl [7].

Farmers in general have not followed the instructions for the use of fertilizers correctly, the applied dosages have not been in accordance with those recommended. The reason behind this related with limited farming capital or budget by farmers. Furthermore, the distance of fertilizer laying was generally not understood by farmers, fertilizers were planted randomly without a specified planting distance. Fertilizers that are placed incorrectly, too far or too close to the crop can have negative consequences. Placing it is too close could cause plasmolysis whereas if too far away they become ineffective. Therefore, laying fertilizers requires accuracy for optimal results, approximately 10 cm [16].

All surveyed farmers performed weeding twice, ie when the corn were two to three weeks old and 40 days after planting. Weeding was done chemically by spraying herbicides on weeds. In general, farmers used a hand sprayer whose tip nozzle has been modified by adding a cover with a diameter of 30 to 40 cm, this is intended to avoid sprinkling of pesticides on the main crop. The pesticides used are 2-4 D (wide-leaf weed eradication) at a dose of 1 L ha⁻¹. There were also farmers who did weeding manually with tools such as hoes and sickles.

Majority of carry out soil stacking around the corn plant stem. This practice was usually performed together with the second weeding, which is about 40 days after planting. It was done by hoeing the soil around the plant and then piled up at the base of the plant stems. The purpose was to make their corn plants stronger so that the stems that support the establishment of higher plants do not collapse easily. Rukmana [5] supported this practice to also be capable to stimulate the formation or growth of roots freely. However there were also some farmers who did not perform this practice for the reason that it does not really affect the growth of corn.

Farmers in the study location did not irrigate the plants, all surveyed farmers plant on dry land whose water sources only rely on rain water due to the fact that there was no irrigation canal that they can use. Therefore, 100% of the respondent farmers planted corn at the beginning of the rainy season and the beginning of the dry season, where they can still utilize the remnants of rain water.

The study found that the surveyed farmers practised replanting to maintain the optimal population size of the farm. Replanting was carried out one week after planting as necessary.

Pruning is not a very important for corn, since it does not really affect the production [9]. The survey found in general farmers did not prune (91.66%), only a small number of farmers did pruning at the shoots.

Based on the survey results, 100% of surveyed farmers carried out plant protection against pests and diseases. Generally farmers control pests and diseases by relying on chemicals such as insecticides and fungicides. This practice could not really solve the problem, instead could cause problems. The negative effects of excessive use of insecticides include: the explosion of secondary pest populations, target pest resistance, the killing of useful insects, residues and environmental pollution [17].

It is evident that farmers empowering to improve their skill and knowledge in farming practices might be significant in helping them to improve the yields and eventually their income. Empowering

farmers does not always mean through the top down approach. Iswoyo et. al. [18] showed that involving farmers from the very initial proses of problem identification and allowing them to suggest for the solution could make a difference.

4. Conclusion

Cultivation techniques and practices by farmers in the study location need improvement due to the findings that some practices were already in line with the recommended techniques while some others were not. The good practices by farmers such as replanting, growing, and weeding activities, whereas practices that require improvements were land preparation, plant spacing, fertilizer type, rate and methode of application, and pest and disease control. Some factual conditions become the hinders for good farming practices by farmers. Among them were lack of knowledge and limited farming budget for supplying farm inputs and tools. The role of government in assisting and supporting these farmers would become the most viable alternative solution to improve their farming practice, whichh in turn will help them in improving the production.

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