THE CULTIVATION POTENTIAL OF INTERCROPPING CORN WITH IMMATURE PLANTS IN COCONUT PLANTATIONS OF ASAHAN REGENCY

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ABSTRACT

The demand for raw corn materials for the food industry in Indonesia, which reached around 1.2 million tons in 2021, can only be fulfilled by a domestic supply of 7,000 tons. In 2022, it is anticipated that the demand for corn in the food industry will rise to between 1.5-1.6 million tons. Corn production can be increased by employing technological advancements and using immature coconut plantation land. One of the strategies to extend the corn planting field is to cultivate corn on expanding coconut plantations. The development of planting corn on plantation land as a high-potential intercrop, particularly in immature coconut areas, is carried out to improve the nation's deficient corn production. The decision and implementation of coconut replanting have significant potential for corn production. Three-year-old immature coconut plants can be used to cultivate corn. The development of corn plants in coconut plantations continues to increase. The area of coconut plantations in Asahan Regency rose from 22,293.11 ha in 2020 to 23,260.86 ha in 2021. Therefore, the cultivation of corn in the coconut plantation field might meet the Ministry of Agriculture's estimated corn requirement of 1,6 million tons. The findings show that Intercropping corn with coconuts increases yields by 80 % to monoculture corn. In addition, corn demands can be supported by efforts to cultivate corn in coconut plantation areas using shade-tolerant corn VUB technology, enhancing soil fertility by restoration, organic fertilizers, and NPK fertilizer.

Keywords: *Intercropping, Corn, Coconut Plantations*

INTRODUCTION

Intercropping is a sort of mixed cropping (polyculture) involving the simultaneous cultivation of two or more plant species on the same land area. This intercropping practice is intended to facilitate the intensification process. According to Hidayat et al. (in Supriatna et al., 2022), several aspects, such as the selection of plant species with various morphologies, the need for growth nutrients, and differences in the development phase durations affect the intercropping system's performance.

Corn (*Zea mays* L.) and coconut (*Cocos nucifera*) are the two most common plant species in intercropping. The combination of corn and coconut is an optimal intercropping combination. Corn and coconut have distinct kinds of root systems; hence, combining them in an intercropping system can reduce competition for soil resources. Additionally, corn and coconut have different kinds of photosynthesis. Coconut is a C3 plant, while corn is a C4 plant. C3 plants have a lower light saturation level than C4 plants, so there is a good likelihood that coconut can be grown under shadowed conditions alongside corn (Supriatna et al., 2022).

According to Tangahu (Baidawi, 2019), many farmers are currently adopting monoculture (single-crop farming) and polyculture (plant farming by intercropping, rotational overlapping, insertion, and rotational cropping) on land under coconut tree stands. Using the land between coconut plants with a cropping system makes it possible to maximize the efficiency of land usage. Generally, the adoption of the cropping system attempts to boost farmers' productivity and income. Planting by cropping system has no negative impact on coconut plants; instead, coconut yield tends to rise.

It can improve corn production by boosting productivity and expanding corn plantations. The rise in corn production due to higher productivity has been very modest. Therefore, expanding corn crops is a quick way to increase corn production. However, as more area is converted to plantations, the optimum expansion of corn farming in paddy fields is becoming increasingly constrained. According to Wijaksono and Navastra (Sahuri, 2017), the annual rate of land conversion from food crops to plantations reached 19,206 ha/year.

In 2016, national corn production was 23.58 million tons, whereas national corn demand was 16.30 million tons (Pusdatin, 2016). Based on this data, Indonesia should have a surplus of 7.28 million tons of corn. However, Indonesia imported 2.40 million tons of corn since the food industry required 8.90 million tons (Statistik, 2016). This situation caused the food industry's corn demand to remain at 1.62 million tons. Meanwhile, the national corn harvest area has remained stagnant during the five years (2010-2016).

Corn production in North Sumatra has increased yearly, which is quite encouraging. According to data from *BPS Sumatera Utara* (2022), North Sumatra produced 1,960,424; 1,965,444; and 1,724,398 tons of corn in 2019, 2020, and 2021, respectively, exceeding the Ministry of Agriculture's initial target of 1.6 million tons. Asahan Regency's production increased from 6,640.60 tons in 2019 to 7,369 tons in 2020. However, there was a decrease in 2021, becoming 5,691 tons. Meanwhile, Dairi and Simalungun Regencies have the most significant production in North Sumatra, with Dairi Regency producing 265,823.80; 231,825.00; and 268,866.00 tons in 2019, 2020, and 2021, respectively. However, this still has failed to fulfill domestic and international markets. Thus, efforts must be strengthened to meet the community's economic needs in terms of the quantity and quality of agricultural products.

According to *Badan Pusat Statistik* (2022), North Sumatra Province has the third largest area of coconut plantations, with an area of 109,226.35; 209,631.71; 110,345.00; and 110,464.00 ha in 2017, 2018, 2019, and 2020, respectively. Meanwhile, in those years, coconut productions in North Sumatra were 96,256.55; 97,033.44; 99,132.00; and 99,972.00 tons, respectively. Coconut plantations are available across 33 regencies, with the largest in three regencies: Asahan Regency (22.12 thousand ha), South Nias Regency (20.50 thousand ha), and North Nias Regency (16.02 thousand ha) in 2021. In addition, the corn productions from those three regencies in 2021 were 23.05, 13.74, and 15.15 thousand tons, respectively. About 30% of the land beneath coconut plantations is suitable for intercropping (food and horticulture) (Barus, 2013). Therefore, intercropping under perennial stands on the dry ground must be highly successful. However, this land has not been used to its total capacity, despite its immense potential for growing corn and other horticultural products. Therefore, planting corn as an intercrop under annual crop stands can be done to provide a beneficial impact on boosting national corn production by increasing planting area (Firmansyah & Pribadi, 2019).

Utilizing marginal (suboptimal) lands with vast potential planting areas enables the planting area to be expanded. One of the strategies to extend the corn planting area is to cultivate corn on expanding coconut plantations. The development of planting corn on plantation land, particularly in immature coconut areas, as a high-potential intercrop is carried out to increase the nation's deficient corn production.

The decision and implementation of coconut replanting have significant potential for corn growth. Three-year-old immature coconut plants can be used to cultivate corn. Corn can be intercropped between the coconut plants in the rows.

Intercropping corn in immature coconut plantations has the following advantages: 1) corn plants can take advantage of the space between rows of immature coconut plants; 2) farmers receive additional yields in a short period (3 months) from corn plants; 3) biomass from leaves falling corn and corn roots forming rhizobium nodules can increase soil fertility; and 4) land productivity and farming economic value increase in one year. Corn cultivation involves a significant amount of labor. Thus, expanding the corn planting area to other areas must take labor into account. Priority should be given to farmers who have previously planted corn or are accustomed to planting corn so that the expansion proceeds can be achieved as intended. Based on those explanations, this study aims to provide information regarding the potential for corn development on immature smallholder coconut plantations in the Asahan Regency.

1. DISCUSSION

Potential for corn cultivation in coconut plantations

Farmers frequently plant corn as an intercrop between plantation crops to maximize available area, especially for immature crops. The results of the study of corn intercrops on immature coconut plants in the arid region of Central Kalimantan indicated that farmers could benefit from corn intercrops in addition to an increase in farm income, as well as a more significant expenditure of energy and time on coconut cultivation. By implementing intercropping corn farming, farmers' income increases with an R/C ratio of 1.13, as stated by *BPTP Kalteng* (in Herman & Pranowo, 2011).

Farmers frequently use available space to plant corn as an intercrop between plantation crops, especially for immature crops. Intercropping corn with coconuts increases yields by 80% compared to monoculture corn (Mahdiannoor & Istiqomah, 2015). Utilizing land under stands of perennial crops through a cropping system (polyculture) can improve land utilization efficiency. The adoption of cropping systems tries to boost farmers' efficiency and income since polyculture is the simultaneous cultivation of multiple plant species on the same plot of land.

The benefits of coconut tree polyculture include increased land productivity, the production of a variety of commodities, the acquisition of additional yields, the improvement of soil fertility, the prevention of soil erosion, savings in the use of production facilities, and a reduction in the risk of crop failure (Nuryati et al., 2018). Consequently, a polyculture cropping system is strongly recommended for land use between coconut trees and corn plants.

Corn plants grow in open areas and in more sunlight. Corn can be cultivated at altitudes 0-1,300 m above sea level. The optimal air temperature for corn plant growth is 23-27 ^{o}C. Additionally, the optimal rainfall for corn plants is between 200-300 mm/month or 800-1,200 mm/year. The ideal pH range for corn's growth and cultivation is between 5.6-6.2. It is not the season that determines when to plant corn but the availability of sufficient water. Meanwhile, the annual average temperature for planting coconut trees is 27 ^{o}C, with annual fluctuations of 6-7 ^{o}C. Coconut plants can grow in soils with a pH between 5.0-8.0, while optimal growth occurs at a pH between 5.5-6.5. Considering the criteria for producing corn, it is possible to cultivate corn on coconut plantations (Riwandi et al., 2014).

In polyculture planting, competition between plants (competition for light, nutrients, etc.) is challenging; hence, the selection of plant species must be guided by reducing competition. According to Kadekoh (in Barus, 2013), to limit competition and maximize results, the following steps might be considered: 1) defoliation of old leaves and detasseling on taller plants, 2) selection of plant species to be paired with high economic value, 3) population control (planting spacing), and 4) determination of relative planting time. It is highly economical to grow intercrops between coconut plantations because 80% of the land beneath coconuts can be used for other crops or livestock. Depending on local soil and climate conditions, intercrops that can be cultivated include plantation crops, food crops, and horticulture. In addition to the proportion of irradiation, limitations on soil fertility hinder the usage of land beneath coconut plantations.

The coconut plant uses only 25% of the available area effectively. However, its root system is effective horizontally and vertically between 0.3 and 1.2 m from the base of the coconut trunk. Thus, around 75% of the coconut planting land is unoccupied, making intercropping highly probable (Atman, 2015). The area of coconuts in Indonesia is equal to the sum of the areas of deep and hybrid coconuts. In the recent decade (2010-2019), the average area of deep coconut is 3.52 million ha. Meanwhile, the area of hybrid coconut is 105,000 ha. Approximately 97.10% of the coconut area in Indonesia is comprised of deep coconut. In contrast, only 2.90% of the land comprises hybrid coconut. It is possible to develop corn on coconut plantations on immature plantation land and rejuvenate mature plantation land with a potential of 3.52 million ha of deep coconut area. Typically, coconuts are planted 8 × 9 m apart. At the age of 1-3 years, there is available space that may be planted with a width of 4 m in the lane and 5 m between the rows of coconuts, suggesting that approximately 75% of the area can be used for corn cultivation. With the usage of shaded land, the yield of corn can be increased to satisfy the demands of the global market.

Technological innovation in the corn cultivation under the shade of coconut

By engineering cultivation techniques and constructing location-specific technology packages based on knowledge of the characteristics of corn plants on dry land, efforts can be made to solve the significant challenges on land under plantation stands, namely drought stress and the presence of shade. According to Sopandie and Trikoesoemaningtyas (Sumarno et al., 2022), increased production on marginal land, especially underbrush land, can be accomplished by enhancing: (1) yield potential, (2) the level of plant adaptability to abiotic and biotic challenges, and (3) cultivation practices based on plant physiology or ecophysiology data. Improving yield potential to develop high-yielding varieties and enhancing plant adaptability to produce tolerant varieties will increase the productivity of intercrops on land under stands of perennial crops with low light intensity. Assembling a corn cultivation technology package capable of growing corn plants that grow well and yield abundantly despite these two environmental variables (drought stress and shade) is one strategy for addressing this issue (Hiola, 2021).

New high-yielding, shade-tolerant corn varieties, fertilization technology based on PUTK recommendations, OPT control based on PHT, and corn planting technology using grain planting equipment are among the innovations that can be applied to the corn cultivation in immature coconut plantations (Babic et al., 2015). Planting drought-tolerant and adaptable low-N fertilizer corn varieties is one strategy to mitigate the decline in yields caused by drought stress and insufficient N fertilizer use (Masuka et al., 2017; Nyombayire et al., 2017; Sayadi et al., 2016; Syafruddin et al., 2013). Through plant breeding projects, drought- and low-nitrogen-tolerant hybrid corn varieties with high yields can be obtained (Harrison et al., 2016).

In 2019, the Cereal Crops Research Institute (Indonesia: *Balitsereal*) introduced shade-tolerant corn plants, specifically Jhana 1 hybrid corn, which has a yield potential without the shade of 12.45 tons/ha dry shell, an average yield without the shade of ±9.29 tons/ha dry shell, and an average yield of ±7.85 tons/ha dry shell in shading intensity conditions of 50% (Hamdani & Susanto, 2020).

In Indonesia, shade- and drought-tolerant technology packages for corn agriculture are still the subject of ongoing research. The Agricultural Research and Development Agency has developed numerous components of corn technology to meet the issue of rising environmental circumstances, including shade-tolerant hybrid corn varieties and several drought-tolerant varieties. The productivity of shade- and drought-tolerant corn necessitates adaptation research and technology assembly to generate site-specific recommendations for corn cultivation technology packages that are adaptive to land with abiotic stress in the form of shade (low light intensity) and drought, as well as economically efficient.

Coconut and corn intercropping have various advantages. According to research by Barus (2013) and Mahdiannoor & Istiqomah (2015), the benefits of combining corn with coconut in intercropping are as follows: 1) It can optimize land usage, as demonstrated by the increase in the land equivalent ratio (LER) from 1.0 to 1.3-1.7; 2) yield a variety of products; 3) reduce the risk of crop failure due to reduced prices or other causes such as pest or disease attacks and climate disturbances; 4) generate income more rapidly; 5) obtain additional yields from crops in the second season; 6) improve soil fertility due to additional N from rhizobium and organic matter from plant litter; and 8) provide forage for livestock.

2. CONCLUSION

One effort to increase the corn harvesting area is cultivating corn plants on continuously expanding coconut plantations. The area of coconut plantations in Asahan Regency rose from 22,293.11 ha in 2020 to 23,260.86 ha in 2021. Therefore, the cultivation of corn in the coconut plantation area might meet the Ministry of Agriculture's estimated corn requirement of 1,6 million tons. Intercropping corn with coconuts increases yields by 80% compared to monoculture corn. To cultivate corn on coconut plantations in order to achieve expected yields, shade-tolerant corn varieties are required, as well as the restoration of the soil with lime (dolomite or calcite) and organic matter, as well as the use of NPK fertilizers.

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