Research Note

Mixed intercropping with long-term and short-term crops in Gubuk Alang, Kopang, Lombok, Indonesia

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For farmers who are new, or who recently acquired agricultural land, choosing long-term crops can be problematic, as these farmers must cultivate their long-term crops without revenue for several years. Therefore, they must intercrop them with short-term crops. In this study, researchers assisted a farmer in Gubuk Alang, Kopang, Lombok, Indonesia intending to cultivate long-term crops. The Ministry of Agriculture of Indonesia Pekarangan Pangan Lestari (Sustainable Backyard Production) short-term crop programme was investigated to determine if it could be combined with the long-term crops. Intercropping both long-term and short-term crops would effectively maximise the utilisation of the area, and the revenue generated from the short-term crop would guarantee the farmers' revenue while waiting on the long-term crop. The agricultural procedure developed on the studied farm can be duplicated to foster self-sufficiency, self-regulation, and sustainability in food farming by other farmers in the region and the government could implement measures to render the initiative to be more adaptable following farmers' inclinations and aspirations.

Keywords: Mixed intercropping, Pekarangan Pangan Lestari (P2L), food supply-chain, Indonesia fruit species

When farmers commence the cultivation of commercially viable long-term crops, they encounter a considerable waiting period, spanning from 2 to 4 years before harvest. As a result, it becomes mandatory for farmers to engage in the practice of intercropping. Intercropping boasts a multitude of advantages, which include the optimal utilisation of space and resources, and ensures increased yields in the event of poor returns from the primary crop. The ability to repel nefarious pests, the mitigation of weed proliferation, and the provision of vital nutrients to neighbouring plants, are among a host of other benefits worthy of mention (EOS Data Analytics 2020).

Farmer's ambition and problem statement

The research team worked with a farmer in Gubuk Alang, Kopang, Lombok, Indonesia who intended to commercially cultivate a variety of high-value fruit crops: coconut (*Cocos nucifera*), guava (*Psidium guajava*), and longan (*Dimocarpus longan*). Because these long-term crops require 2 to 4 years before they mature and become ready for harvest, cash flow problems were anticipated. Consequently, the farmer explored alternative options, specifically "quick-growing crops" that could be cultivated while waiting for the maturation of the long-term crops, and the research engaged the farmer with the intercropping proposal.

Possible approach

This study reviewed the potential of amalgamating the Indonesian government's initiative for small-scale farming, with the prevalent Asian practice of intercropping, which entails cultivating both short and long-term crops.

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Pekarangan Pangan Lestari (P2L)

The Kementerian Pertanian (Kementan) (Indonesian Ministry of Agriculture), is implementing the Pekarangan Pangan Lestari (P2L) programme (Sustainable Backyard Production). This programme has two primary objectives. The first objective is to enhance the availability, accessibility, and utilisation of food for households, considering the diverse needs for nutritionally balanced and safe food. The second objective is to boost household income by providing food that is tailored to market demands and preferences (Wibowo 2021).

Mixed intercropping

Mixed intercropping is characterised by the planting of multiple species (two or more), within a single plot of land, without adhering to any specific arrangement in terms of rows or columns (Brandmeier et al. 2023). What sets mixed intercropping apart from other cultivation methods is the synchronisation of the sowing and harvesting processes (Salama and Abdel-Moneim 2021). By engaging in mixed cropping, farmers can enhance the protection afforded to their primary crop, shielding it from potentially detrimental factors such as strong winds, frost, drought, and various other adverse weather conditions. This practice plays a crucial role in safeguarding the overall health and productivity of the agricultural system (EOS Data Analytics 2020).

Background research

A multi-story techno-demo farm model, using coconut as the main crop was established at the Research, Development, and Extension Grounds (RDE) of Central Mindanao University in the Philippines. The purpose was to optimise the utilisation of land resources through the cultivation of coconuts and the incorporation of intercrops, including fruit crops, vegetables, and plantation crops (Valleser et al. 2020). Paramesh et al. (2019) identified guava as one of the fruit crops prevalent in India that can be used as an ideal intercrop. Longan, a popular fruit crop in Cambodia, can also be used extensively in the practice of intercropping (Vernooy 2015). These three crops are widely accepted among farmers, as they are suitable for long-term plantation strategies and high profits. During the first few years of the growth, before the first harvest of these crops, chili (*Capsicum annum* L.) could be introduced as an intercrop as an interim solution for farmers' revenue. Rahman et al. (2012) reported that the active promotion of integrated farming among Malaysian farmers, was to incorporate short-term vegetable crops like chili into the agricultural system. According to the data provided by the Badan Pusat Statistik, BPS (Indonesian Central Bureau of Statistics), red chili has emerged as one of the prominent short-term vegetable intercrops over the past 5 years (Lukas et al. 2023).

Mixed intercropping method with the Pekarangan Pangan Lestari (P2L) concept

Air layering is a horticultural technique that facilitates the creation of a genetically identical copy, or clone, of a desired plant. This process entails the introduction of a small incision into the plant stem to be duplicated: the level of injury inflicted is relatively insignificant since the intention is not to sever the entire stem or leaf. A suitably moistened growing medium is carefully positioned over the incision, thereby providing an environment conducive to the emergence and development of new roots. This method of propagation is an effective means of vegetative reproduction and has been widely adopted in horticulture (Coulter 2023).

The AgroTani Sejahtera, Kediri, East Java, Indonesia, has successfully facilitated the supply of air-layered, "genjah" (high-yield) fruit crops to farmers. These fruit crops include the immensely popular guava (Jambu Kristal Putih) and longan (Kelengkeng New Kristal) varieties. AgroTani has also supplied the farmers with a dwarf, high-yielding coconut

(Kelapa Genjah Entog), thereby improving the farmers' prospects of reaping substantial rewards. These three fruit crops are widely recognised as long-term high value crops.

Sofo and Sofo (2020) proposed that the utilisation of the backyard as a means of home food production could contribute to the enhancement of the food supply-chain, thereby fostering self-sufficiency, self-regulation, sustainability, as well as environmental protection.

Ntbprov (2023) reported, that the Balai Benih Induk Pertanian dan Perkebunan, BBIP (the agricultural and plantation seed centre in Lombok, Indonesia) put forward a recommendation through the P2L programme to engage in the cultivation of short-term crops, specifically chili, within the premises of household back-yards, to contribute towards the enhancement of the financial prosperity of families.

Long-term crops

The long-term crops planted by the farmer were coconut, guava, and longan.

Coconut (Kelapa Genjah Entog)

The coconut variety, Kelapa Genjah Entog, which matures early, originates from Kebumen Regency, Central Java, Indonesia. A single crop of this "genjah" (high yield) species has the potential to yield 95 fruits, which are typically arranged in bunches containing six to seven individual fruits. The fruit has a tender flesh, can weigh up to 450 g, and can be harvested at the relatively young age of 4 years. The average height of a tree is 3 - 4 m. This coconut variety is adaptable to a diverse range of soil types (sandy or clayey compositions) (Arnani and Sumartiningtyas 2022; Jualbenihmurah 2020). This variety of coconut was endorsed by the Ministry of Agriculture of Indonesia as Kebumen origin (Ngayiyi 2021).

Guava (Jambu Kristal Putih)

The Jambu Kristal Putih (Guava White Crystal) was introduced to Indonesia from Kaohsiung, Taiwan in 1991 by a Taiwan Engineering Mission in collaboration with the Institut Pertanian Bogor, IPB (Bogor Agricultural Institute, West Java, Indonesia). The plant produces throughout the year and when the plants are 2 years old can already yield 15 - 30 fruits in a single fruiting period. A single plant is capable of producing 70 - 80 kg over 6 months. The average weight of the fruit is 500g, with some fruit attaining a weight of 900g. The fruit brix is 11 - 12. The Jambi Kristal Putih is drought-tolerant and resistant to pests. It thrives in all types of soil, including clay or marginally sandy soil (Diperpa 2017).

Longan (Kelengkeng New Kristal)

The Kelengkeng New Kristal (Longan New Crystal) starts to bear fruit at the age of 2.5 - 3.5 years. Yields per plant range from 20 - 40 kg per crop, each branch can produce up to 4 kg of fruit. The average fruit diameter is 3 cm, and fruit brix can be as high as 21. Kelengkeng New Kristal has a higher market value than other longan fruits, both imported and local. It is suitable for cultivation in both highland and lowland regions. The flowers of this variety demonstrate strong resistance to aborting, enabling them to withstand up to 75% of exposure to rain or wind (Annas 2017).

Short-term crop

The short-term crop selected for the farmer was chili.

Chili (Cabe Merah Keriting)

Cabe Merah Keriting, often referred to as "Curly Chili", is a chili variety that has the potential to reach a maximum of 2 meters in height, and its fruit-bearing capability remains constant as it progresses towards maturity,

allowing for up to six harvest cycles and each harvest yields a minimum around 8,000 kg per hectare (Soniman et al. 2022). This variety branches extensively and has short fruit segments; flowers and fruit emerge from each segment. The productivity of this crop is known to exceed 1 kg per plant, and it can thrive in both wet and dry conditions. Cabe Merah Keriting seems resistant to attacks from gemini viruses. The fruit possesses a distinct curliness, while maintaining an even, vibrant red hue and a smooth texture (Bisisahabatpetani 2020). Cabe Merah Keriting can be planted at altitudes between 0 - 1,000 metres (Pertanian 2023).

Experiences from Gubuk Alang, Kopang, Lombok, Indonesia

The farmer's plot of land in Gubuk Alang, Kopang, Lombok, Nusa Tenggara Barat, Indonesia measures 300 m^2 at an elevation of 357 metres. The study team used a long-term observation study method (Yang et al. 2021). The initial visit took place in April 2023, and during the visit, the planting of coconut, guava, and longan commenced. In the initial stages, the long-term crops were planted at spacings of 3 meters, that of the intercrop was not decided. The young guava and longan crops were protected by a towering "paranet" (black net with holes to let the flow of air through it) made of four bamboo sticks, forming a vertical structural cage around the crop. There was no paranet for coconut crops as they are more resilient to solar radiation and heat. The farmer built a single water well out of concrete rings, which provided a source of fresh water for irrigation. The farmer irrigated daily by retrieving the water from the shallow well using a simple bucket on a rope and using the same bucket to water the crops.

When the project was 1 month old, it became apparent that the farmer would need an alternative source of revenue. After the background research study was completed, chili was introduced as a short-term crop in July 2023. The chili crop provided complete ground cover, on top of which was placed environmentally friendly plastic mulch for weed control. Rows of chili ran parallel and in between the long-term crops.

The final review of the experimental plots took place in November 2023, and it was observed that both long-term and short-term crops were in a healthy state (Plate 1) and progressing satisfactorily. This is expected to progress until the transition stage when long-term crops start generating revenue. The crop arrangement can be seen in Plate 2.

Plate 1: Intercropping in Gubuk Alang, Indonesia. The left column of paranet houses guava trees, the right column of paranet houses longan trees, and on the far-right are coconut trees; parallel and in between are the chili crops.

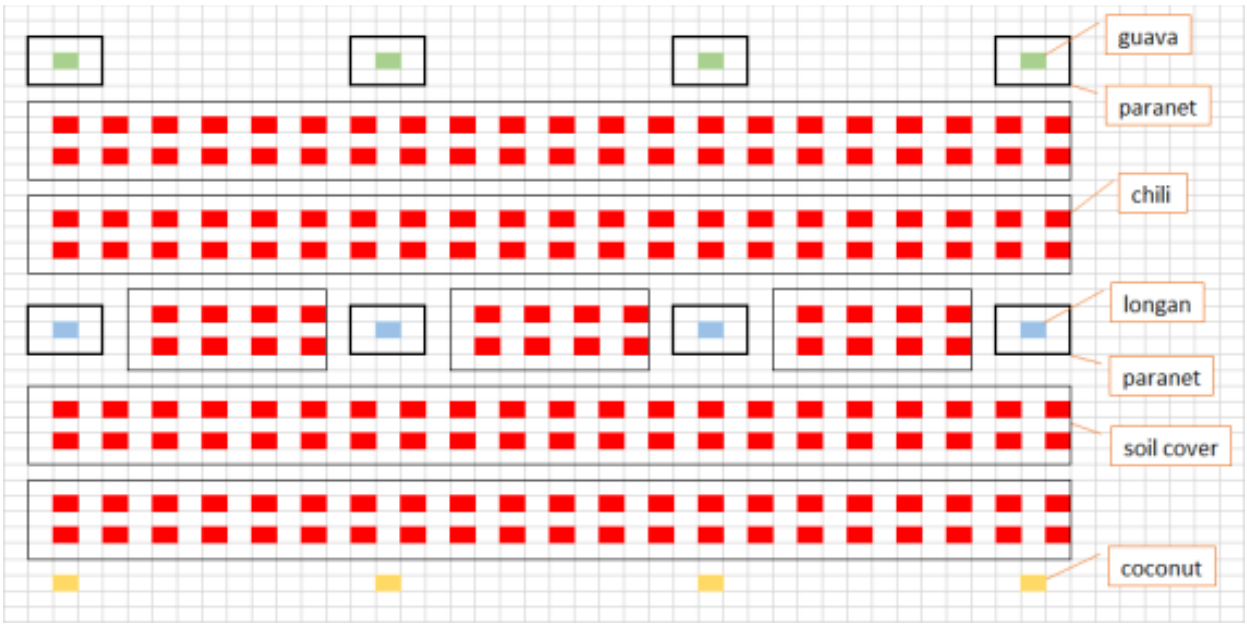

Plate 2: Diagrammatic layout of the plot of land.

Conclusions and recommendation

The farmer was elated, as the short-term chili crop brought in revenues, a mere 6 months after the cultivation date. As the long-term crops are still relatively small, the leaves and branches of these crops will not impede the sunlight from illuminating the intercrops. Consequently, the short-term crops continue to grow and will be harvested for up to 7 months (or up to six harvest cycles) after the initial harvest and before replanting (Dinpertanpangan 2021; Soniman et al. 2022). This project will continue for another 2 - 4 years until the foliage of the long-term crops begins to shade and obstruct the growth of the short-term crops. At that point, the long-term crops will become the primary source of revenue.

Other researchers should conduct studies in various regions of Indonesia and Asia, to facilitate a comprehensive analysis and comparison of the results obtained from intercropping of both long-term and short-term commercial crops. Also, it would be highly advantageous to explore and investigate alternative options for long-term crops, thereby expanding the scope beyond the conventional combination of coconut, guava, and longan. The concept of intercropping, when planned and executed efficiently, has the potential to bring prosperity to farmers and contribute to the overall sustainability of agricultural practices. Researchers and stakeholders must dedicate a significant amount of time and resources towards conducting in-depth analyses and evaluation of intercropping projects, thereby fostering a more robust and sustainable farming industry. The government's mandate is to promote and endorse policies that are conducive to sustainable agricultural development at both the local and national levels. It is therefore highly recommended, that the Kementerian Pertanian (Kementan), considers and implements a series of essential measures, such as calling on local academia and subject matter specialists to join the programme as consultants; to improve the adaptability of the Pekarangan Pangan Lestari (P2L) scheme, whilst taking into careful consideration the inclinations and aspirations of farmers.

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