Integration of Sorghum, Porang and Cow Livestock as an Effort to Increase Farmers' Income and Soil Quality in Dry Land

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Abstract. The dry land farming system is an agricultural cultivation practice dependent on climatic factors, so it is easily degraded if managed inappropriately. Degradation will cause a decrease in soil quality, which has an impact on decreasing land productivity and farmers' income. One of the efforts that can be made to overcome these problems is the application of an integrated farming system (Integrated Farming System) for crops and livestock, namely the integration of sorghum, porang, and cattle. The main goal is to reduce the risk of crop failure because dependence on a commodity can be avoided and can save production costs.

Keywords: integrated farming system; dryland; sorghum; porang.

INTRODUCTION

The dry land farming system is an agricultural cultivation practice dependent on climatic factors, so it is easily degraded if managed inappropriately. Soil degradation in dryland agricultural ecosystems is generally caused by natural elements such as erosion and management factors such as conventional farming systems, deforestation or deforestation, and traditional farming patterns. Degradation will impact decreasing dryland productivity because it is almost always followed by a decrease in soil organic C-stores [3].

One practice that can be applied in the dry land to increase land productivity while also maintaining soil quality is integrated farming practices. Integrated farming (Integrated Farming System) is an agricultural system that incorporates the activities of the farm sub-sector of crops and livestock to increase the efficiency and productivity of resources (land, humans, and other growth factors), independence and welfare of farmers in a sustainable manner [1]. Integrated agriculture can reduce the risk of crop failure because dependence on a commodity can be avoided and can save production costs.

An integrated crop and livestock farming system is an agricultural system characterised by a close relationship between plant and livestock components in farming activity. Livestock can play a role in a biological industry, as well as being able to increase meat production and provide compost [9], as well as environmentally friendly organic fertilisers.

Integrating sorghum and porang with cattle is one example of an integrated crop and livestock farming system that can be applied on dry land. Plants combined with cattle can utilise by-products and by-products of plants for animal feed. On the other hand, cattle can provide raw materials for organic fertilisers as a source of nutrients needed by plants, such as manure and bio urine, so that indirectly they can improve soil quality on dry land.

Efforts can be made to increase the yield of sorghum and porang both in terms of quality and quantity, one of which is using fertilisers. So far, farmers have mostly used inorganic fertilisers such as urea or NPK as a source of nutrients for their plants. If this is done continuously, without proper rules and doses, it will hurt the environ-

ment. The utilisation of cattle waste, both manure and urine, is a source of organic fertiliser for sorghum and porang plants that do not require high costs. Porang stems and leaves after a dormant period can also be used as green manure, while sorghum leaf trimmings can be used for animal feed. In addition, the biomass of sorghum plants, both stems, bagasse (cellulose), and seeds (starch), can be used as raw material for sugar [5]. The author [13] reported that sweet sorghum stalk sap's average Brix sugar content was 11%. The author [10] said that all components of sorghum biomass could be used as raw materials for ethanol, food, and feed, namely from:

a) the yield of 4-6 tons/ha of seeds, 3.6 tons of starch, or 1,800 litres of ethanol per ha can be produced;

b) stems it can produce 25 tons/ha of sap, which will produce 2,300 litres of ethanol/ha;

c) leaves can produce 42.4 tons/ha of biomass.

METHODS

The materials used in the preparation of this article are data from relevant agencies and agencies, especially the development of porang plant production and publications in the form of books and scientific papers published in international and national journals and other information related to integrated farming systems in dry land from various sources, analysed descriptively and then poured in critical writing.

RESULTS AND DISCUSSION

Integrated Farming System. *Definition and Concept*. An integrated farming system is an agricultural system that incorporates the activities of the agricultural, crop, livestock, and fish subsectors to increase the efficiency and productivity of resources (land, human, and other growth factors) for the independence and welfare of farmers in a sustainable manner [1]. An integrated farming system manages crops, livestock and fish within their environment to produce an optimal product and tends to be closed to external inputs [6].

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The author [11] states that the applied integrated farming system concept will produce F4, namely:

F1 (food) is a source of food for humans such as rice, corn, soybeans, beans, or even sorghum and porang, which are potential national commodities (plant products); meat, milk, eggs (livestock products)

F2 (feed) is animal feed, including ruminants (cows, goats, buffalo, rabbits), poultry (chickens, ducks, geese, etc.); freshwater cultured fish feed

F3 (fuel) energy will be produced in various forms ranging from heat energy (biogas) for domestic needs

F4 (fertiliser), the remaining agricultural products through decomposers and pyrolysis, will produce compost with various nutrients and relatively high C-organic content.

Principles and Characteristics of Integrated Agriculture. Several principles that must be considered for the integration of integrated farming systems, according to [2], are:

1. Agroecosystems that have high diversity to provide guarantees for farmers in a sustainable manner

2. Functional diversity is needed that can be achieved by combining plants and animals that have complementary properties and are related in synergistic and positive interactions, and not only improved stability but the productivity of agricultural systems with low inputs

3. Determine the combination of plants, animals and inputs that lead to high productivity, production security and resource conservation by limited land, labour, and capital.

The characteristics that can be seen in the integrated farming system, according to [2], are:

1. Comprehensive and comprehensive agricultural management.

2. Oriented to productivity, efficiency, sustainability, and socially acceptable and economically profitable.

3. An independent system with a LIESA (Low External Input Sustainable Agriculture) system that can run well without dependence from outside the system.

4) The system can be measured and evaluated at each stage.

Sorghum Plant. Sorghum is a cereal crop that has the potential to be developed in dry land because it has wide adaptability, is drought resistant, and needs less water than corn or wheat [13]. Several factors that make sorghum more drought resistant are:

1. Roots are sturdy and deep and can form secondary roots when environmental conditions, such as lack of water, are not favourable. In situations of excess water, sorghum can develop air roots that come out of the book, increasing oxygen supply. In addition, the endodermis and silica layer in the root endodermis prevent the roots from rotting quickly due to waterlogging.

2. The endodermis of the leaves contains silica and a waxy coating to reduce water evaporation due to high temperatures and sunlight, as well as in drought stress conditions.

3. Has a dormant nature in arid environmental conditions and can grow back when ecological conditions are favourable.

4. Adaptive to extreme environmental conditions and more competitive with weeds than corn and legumes.

The results of the sorghum crop can be used to meet various needs such as food, animal feed, and energy sources. As a food ingredient, sorghum has a higher nutritional value than rice, corn and cassava. Another advantage is that it has a very high swelling power and is easily soluble in water, so these two properties are indispensable in manufacturing flour-based food products. In addition, sorghum waste such as leaves and stems can be used as animal feed, especially for cattle. The potential for stems and leaves of sorghum can reach 30-40 tons/ha wet weight. The author [10] reported that the leaves could produce 42.4 tons/ha of biomass.

Porang plant (Amorphophallus muelleri). Porang (Amorphophallus muelleri) is a tuber-producing plant currently popular among farmers, which has two life cycles and a dormant period. The two life cycles of porang plants are the vegetative and generative cycles. The vegetative cycle begins in the rainy season, starting with shoot growth, roots growing on shoots above the tubers, followed by pseudo stems and leaves. In the dry season, plants experience a dormant period marked by pseudo stems and dry leaves for 5-6 months. If the next rainy season arrives, the porang plants, which had experienced a vegetative and dormant period, will enter the vegetative or generative cycle. When entering the vegetative cycle, porang plants will grow stems and leaves, but if they undergo a productive cycle, flowers will come out from the tubers and have no leaves [6].

Porang plants benefit from having more diverse tubers than other tubers because they can be used as an alternative to food, mainly because they have a reasonably high glucomannan content [12]. Porang glucomannan content is the highest compared to other tuber plants. The presence of glucomannan makes the porang plant not only a food ingredient. Still, it can be used in the non-food industry as a raw material for paper, textiles, adhesives, celluloid tape, paint, harmful film materials, cosmetics, and cleaners [4]. In addition, glucomannan can form positive effects in the health sector, including reducing the risk of cancer, weight, cholesterol, and constipation [8].

The role of various tuber crops as indicators of the 2020-2024 Medium Term Development Plan causes porang to be one of the potential national commodities.

Benefits of Integration of Sorghum, Porang, and Cattle on Dry Land. The application of an integrated farming system, namely the integration of sorghum, porang, and cattle in a dry land, has enormous potential and benefits, not only for food security but can increase farmers' income while maintaining and improving soil quality in dry ground.

Soil Quality. Naturally, the organic matter content in dry land tends to decrease due to the topography, which is primarily sloping and hilly. The development of sorghum in dry land must be followed by applying organic matter, which improves the soil's physical, chemical, and biological properties. In addition, organic matter is needed for optimal plant growth because it can be a source of nutrients for plants.

To ensure the availability of organic matter sustainably in the dry land, the development of sorghum integrated with porang and cattle is one of the integrated farming systems that can be developed. This is because cow waste has a relatively higher organic matter than other livestock. In addition, the presence of residual products in the form of dormant porang stems and leaves

will increase the supply of organic matter. In contrast, the biomass produced from sorghum is an animal feed ingredient with high nutritional value, so the development of sorghum will significantly support the development of cattle in dry land faced with limited feed.

Land Productivity. Land productivity is the potential of land in farming to produce at a certain production level and unit area, such as the achievable production level per hectare. However, according to [7], land productivity in an integrated farming system can be measured based on economic and non-economic outcomes. The economic results obtained in this integration can be calculated from sorghum crops (seeds, stem juice, sorghum sugar), porang plants (frogs and tubers), and cattle. Meanwhile, non-economic products such as cow dung or urine and remaining dormant porang biomass can be used as organic fertilisers that can reduce chemical fertilisers. Sorghum biomass in leaf trimmings can be used as animal feed. Therefore,

Land Use Efficiency. Applying an integrated farming model for sorghum and porang can increase land use efficiency. Cropping by intercropping will undoubtedly be more efficient in terms of space and light utilisation because the space between rows of sorghum plants can be planted with porang. The author [7] showed that the more intercropping plants planted between the main crops, the more efficient their utilisation would be compared to monoculture plantings.

Thus, the development of sorghum which is integrated with porang and cattle, can not only generate economic value obtained from products produced from the sorghum plant (seeds, flour, other derivative products), porang (tubers, frogs, spores, and other products). Derivatives and cattle products can also potentially improve soil fertility in dry land by using livestock waste and porang waste products like stems and leaves as organic fertiliser.

CONCLUSIONS

The application of an integrated farming system in dry land, through the integration of sorghum, porang, and cattle, can be used as an alternative to increase farmers' income and improve soil quality. Developing integrated sorghum plants with porang and cattle can increase farmers' income through the economic value obtained from diversified products produced from sorghum plants (seeds, flour, and other derivative products) and porang (tubers, frogs, spores, and their derivative products), and cattle products. The utilisation of livestock waste and also porang waste products in the form of stems and leaves as organic fertiliser can reduce farming costs and chemical fertilisers to maintain and improve soil fertility in a dry land.

REFERENCES

1. Arimbawa. (2016). *Several Models of Development of Sustainable Integrated Agricultural Systems*. Unpublished manuscript. Faculty of Agriculture, Udayana University.
2. Bagas. (Ed.). (2015). *Integrated Agricultural System*. Unpublished manuscript.
3. Bolt, A., & Benites, J. (2005). *The Importance of Soil Organic Matter. Key to drought-resistant soil*
4. *and sustained food production*. Retrieved from https://www.fao.org/3/a0100e/a0100e00.htm
5. Harjati, N., Azrianingsih, R., & Widyarti, S. (2010). *Exploration of Amorphophallus sp. Endemic to East Java with High Glucomannan and Low Allergenicity*. Unpublished manuscript. Department of Biology, Brawijaya University.
6. Janick, J., Whipkey, A., & American Society for Horticultural Science. (2002). *Trends in new crops and new uses*. Alexandria, VA: ASHS Press.
7. Kurniawan. (2012). *Growth of Porang (Amorphophalus muelleri) at Various Intensities of Shade and Dosage of Manure*. Unpublished manuscript, Faculty of Forestry, Gadjah Mada University
8. Quaye, A. K., Hall, C. A. S., & Luzadis, V. A. (2010). Agricultural land use efficiency and food crop production in Ghana. *Environment, Development and Sustainability, 12*, 6, 967-983. doi: 10.1007/s10668-010-9234-z

9. Salas-Salvadó, J., Farrés, X., Luque, X., Narejos, S., Borrell, M., … Basora, J. (2008). Effect of two doses of a mixture of soluble fibres on body weight and metabolic variables in overweight or obese patients: a randomised trial. *British Journal of Nutrition, 99*(6), 1380–1387. doi: 10.1017/s0007114507868528

10. Sanchez, M. (n. d.). *Integration of Livestock with perennial crops*. Retrieved from https://www.fao.org/3/v4440t/v4440T0j.htm

11. Sumaryono, W. (2006). *Comprehensive Study and Technology Development of Bioethanol as Biofuel*. Bioenergy Seminar: Business Prospects and Investment Opportunities (Jakarta, 6 December). Agency for the Application and Assessment of Technology.

12. WatonSinau.Work. (2016). *Application of Integrated Agricultural System*. Retrieved from https://www.facebook.com/WatonSinau/

13. Wigoeno, Y. A, Azrianingsih, R., and Roosdiana, A. (2013). Analysis of Glucomannan Levels in Porang Bulbs (Amorphophallus muelleri Blume) Using Reflux Condenser. *Biotropica, 1*(5), 231–235.

14. Zubair. (2016). *Sorghum is a Multi Benefit Plant*. Unpublished manuscript.