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INTEGRATED FARMING SYSTEM IN THE DRY AND MARGINAL LAND IN SRAGEN DISTRICT, CENTRAL JAVA PROVINCE, INDONESIA

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ABSTRACT

One of the big problems in Indonesia is the increasing land-use conversion from agriculture to non-agriculture. This problem can threaten the sustainability of agricultural development in the future, especially in the provision of food and labor, which ultimately will cause the declining contribution of agriculture to the formation of the Gross Domestic Product (GDP). Integrated crop livestock farming involves technology, management, and variety. This system is economically more profitable. This research is a field experiment conducted in the Integrated Farming System Development Farm of Wiyata Dharma Institute of Education, Training, and Research, located in Sragen district, Central Java Province , Indonesia. The research area is located between 7°23'10 " LS to 7°23'17 " LS and 110°50'28 " BT to 110°50'24 " BT with altitude ranging between 150 and 155 mean sea level.

Research objectives are to know the influence of integrated farming system to the production of peanut and corn, integrated variation applied by the farmers, farm diversity, and farmers' income. Integrated farming system (IFS) has the advantage of both ecological and economic aspects. The challenge is to find a combination of plants, animals, and the inputs that lead to high productivity, safe production, and resource conservation in accordance with a relatively limited land, labor, and capital. IFS development, which is directed at rural and sub-urban areas, is expected to build a sustainable self-reliance of farmers with increased economic and social development and sustainable environment. Successful development of IFS can play a role in controlling land use conversion. This research suggests that in implementing the IFS model, it must be adapted to local resources to produce effective and efficient farming. The results show that, by applying the integrated farming system using cattle, the productivity of peanut and corn has increased simultaneously.

Keywords: integrated agriculture, crop/livestock, animals, pasture, agroecology, local resources

INTRODUCTION

An alternative to specialized agriculture is the integration of crops and livestock at the farm scale. Integrated crop/livestock agriculture could improve soil quality, increase yield, produce a diversity of foods, augment pollinator populations, aid pest management, and improve land use efficiency.

Integrated Farming Systems of Plant and Animal Pattern is integration between crops and livestock or often called integrated farming. This pattern is supportive in the provision of manure on agricultural land, so that it is often called a pattern without farm sewage for livestock waste is used as fertilizer and agricultural waste is used to feed the animals. Integration of livestock and crops is intended to obtain optimal business results and improve soil fertility. Interaction between livestock and crops must be complementary, supportive, and mutually beneficial to encourage increased production efficiency and farm yield advantage.

According to Saputra (2000), to illustrate integrated farming, if an area is planted with corn, then when the corn is harvested, the crop residue is waste that must be disposed of by farmers. It is not the case if ruminants are present in the area, because such waste will become food for them. The interrelationship will occur when cattle excrement is used for fertilizer for the crops grown.

Development of cattle to maintain horticultural crops does not require new land and natural resources. In every harvest, the plant waste can be made fodder so the need for livestock food on a daily basis can be provided. Farmers can more optimally utilize unused land in order to increase economic benefits. Abundant forage between plants, such as grass and legume, can be directly used as animal feed without disrupting productivity while potential waste of horticultural crops, using simple technology, can be used as a cattle forage mixture. Meanwhile, empty land embankment can still be used to cultivate superior grass.

The concept of Integrated Farming System is the concept of farming that can be developed for agricultural land with limited land area. Limited or narrow land owned by farmers generally has to be very precise concept and developed with land intensification. The narrow area will give maximum production with no waste is wasted. As for the wider area, this concept will be a solution to develop more profitable agribusiness farming. Integrated system will be beneficial to land-use efficiency, production optimization, waste management, cross-subsidies to anticipate fluctuations in market prices, and production continuity.

Reijntjes (1999) suggested that animals or livestock can serve a variety of functions in a narrow area of a farm system. They provide several types of products, such as meat, milk, eggs, wool, and leather. In addition, they also have socio-cultural functions, such as for dowry, offerings, and gifts or loans, which can strengthen social bonds. In the low-input conditions, integration of livestock into agricultural systems is important, in particular to increase the subsistence security by expanding the types of businesses to produce food for farmers’ family. It is also essential to move nutrients and energy between animals and plants through manure and fodder and through the utilization of animal pulling ability.

The concept of integrated farming needs to be encouraged to support organic farming methods that are environmentally friendly. Cow commodity is one of the important commodities that should be improved to help achieve national meat security. This initiative can be intensified at the farm level in the context of the fattening, reproduction, and milk production. With the increase in the cattle population, the availability of manure on agricultural land is ensured so that organic farming can be properly done, soil fertility maintained, and agriculture sustained. The increasing diversity of livestock will reduce the risk of excessive crop cultivation, which in turn, will increase the economic stability of farming systems.

Herbivore livestock production systems combined with agricultural land can be adapted to the circumstances of food crops. Livestock do not compete on the same land. The food crop becomes the main component while the livestock serves as the second component. Livestock can graze alongside the crop or in unoccupied areas, and on land after harvesting so that cattle can utilize crop waste, weeds, grass, shrubs, and forage that grow around the area. Through their urine and stool, the animals can restore nutrients and improve soil structure.

One of these programs is the integration of crop and livestock usually known as Crop Livestock System (CLS). CLS objectives are the development of beef cattle fattening with plant-based food and simultaneously increasing the land productivity and crop cultivation. The program strives to increase the production of beef cattle inventory and food production through maintenance of cattle on upland and marginal areas. The basic consideration of this program is the production of agricultural crops and livestock with zero waste principle. The integration of livestock and crop is expected to save the use of animal feed, fertilizer, and land, as economically as possible so that the cost of livestock and crop production can be reduced, which subsequently will increase farmers' income.

CLS program is one alternative to improve commodity production of peanut, corn, and meat, and to increase farmers' income (Haryanto, 2002). Agricultural Research Agency has been researching and reviewing CLS with zero waste approach. Zero waste is to optimize the utilization of local resources such as the use as animal feed, feces, and urine to be processed into organic fertilizer. It means fixing the nutrients to the plant so no waste is wasted (Director General of Livestock Production, 2002).

The main characteristic of crop livestock integration is the existence of synergism or mutually beneficial relationship between plants and animals. Farmers use cattle dung as organic fertilizer for its plantation (peanut and corn), and then use agricultural waste as animal feed (Ismail and Djajanegara, 2004). In the crop livestock integration model, farmers overcome the problems of food availability by utilizing crop residues such as corn straw, pulses waste, and other agricultural wastes for fodder. Especially in the dry season, this waste can provide food ranging from 33.3% of the total grass given (Kariyasa, 2003). The advantages of the waste utilization is, in addition to increasing the feed resilience, especially in the dry season, to save labor in clearing grass, giving the opportunity for farmers to increase the number of livestock.

Utilization of cow dung as organic fertilizer, besides reducing the use of inorganic fertilizers, is also to improve the structure and availability of soil nutrients. This impact is seen with increasing land productivity. The study results by Adnyana, et.al (2003) showed that the CLS models developed by farmers in Central Java and East Java were able to reduce the use of inorganic fertilizers by 25-33% and increase rice productivity by 20-29%. Similar results are shown by Fur, *et.al* (2004) in Nusa Tenggara Barat in that the CLS models applied by farmers were able to increase their income by approximately 8.4%. The findings are also reinforced by CLS models applied by farmers in Bali. The models were able to save fertilizer expenses by 25.2% and increase farmers' income by 41.4% (Sudaratmaja, *et.al*, 2004). Similarly, the results of the study by Suwono, et.al (2004) in East Java showed that all of the farmers stated that the use of organic fertilizers was able to reduce the use of inorganic fertilizers, although in practice the reduction is not actually significant.

The concept of crop livestock integration, whether plantation crop, food, or horticulture, without reducing the plant activity and productivity. The existence of these animals could be able to increase the crop and livestock production altogether. Livestock management is carried out by farmers' family, who, at the same time, carries out the plant production. Therefore, the supply to support livestock management is largely expected to be obtained from the waste products of agricultural plants, although a small part of supply must be obtained from outside. Consequently, the family who will attempt this integration model must master the techniques of maintenance and utilization of livestock and the knowledge of crop framing practice, especially the knowledge in integrating the benefits of livestock in plants and vice versa (Directorate of Aquaculture Ruminant 2010).

A long-term effect of the development of agriculture and industry in the modern agricultural system is the production of significant, negative impacts on natural ecosystems. Contamination by toxic chemicals due to the high intensity of fertilizers, pesticides, and herbicides use has long been recognized. In addition, the increasing pest resistance to pesticides is caused by much higher application of pesticide spraying, and ground water and river pollution by nitrate compounds is due to excessive fertilizer use. Modern agriculture has also reduced the diversity of plant species drastically due to the application of large-scale monoculture systems. Environment that is originally composed of complex natural ecosystems is turned into a very simple ecosystem structure due to the decrease of the plant species. This is in contrast with the concept of sustainable agriculture, which attempts to fulfill the ever increasing and changing human needs while maintaining or improving the quality of the environment and conserve natural resources.

MATERIAL AND METHODS

Location

This research is a field experiment conducted in the Integrated Farming System Development Farm of Wiyata Dharma Institute of Education, Training, and Research, located in Geneng Duwur village, Gemolong sub-district, Sragen district, Central Java Province, Indonesia. The research area is located between 7º23'10 " LS to 7º23'17 " LS and 110º50'28 " BT to 110º50'24 " BT with altitude ranging between 150 and 155 mean sea level.

Research Design

Results measurement of vegetative growth, production, and productivity is performed by comparing monoculture, intercropping, and livestock integration systems. The experimental block consists of four models. The first model is peanut crop monoculture without livestock integration. The second model is peanut crop monoculture with livestock integration. The third model is peanut and corn intercropping without livestock integration. The fourth model is peanut and corn intercropping with livestock integration.

Data collection and mathematical analysis

The data used in this study are primary data done directly by means of measurements in the field. Experiments and field measurements are conducted for six years while the observations were done regularly. The analysis of plant productivity is done by sampling and conversion of plant populations: average yield multiplied by the sample plant population/ha (average sample x plant population/ha). Farm productivity is done by converting the weight of plant samples (total dried shelled peanuts/hectare, stover weight per hectare x value of the price of goods).

The analysis is done by converting animal productivity gain/livestock weight for six months per acre per hectare. Livestock productivity is measured by weight gain multiplied by cattle meat prices minus input.

Analysis of the production and productivity of integrated crop livestock farming is done by adding the results of the analysis of crop production and livestock production. Productivity analysis is also done by converting the results into a farming unit of energy (calorie) by way of referring to a secondary data and the results of previous studies or existing references.

RESULTS AND DISCUSSIONS

Dry lands in Indonesia are divided into two categories: 1) dry land with dry climates found in eastern Indonesia and 2) dry land with wet climates found in the western part of Indonesia (Bamualim, 2004). Dry land with wet climates have a higher risk of degradation because of soil erosion, and degradation from year to year continues to increase in the range of 1 to 2 percent a year (Go Ban Hong, 1976).

Prior to the implementation of integrated crop livestock system, corn and peanuts were complementing one another. The main problem in the development of these plants is low productivity and quality of results in marginal dry lands. This condition is caused by peanut and corn intercropping without livestock integration. The following integration between the intercropping and livestock showed a significant increase of production and productivity. Crop residues are used as organic fertilizer while cow dung and urine as plant fertilizer. Increased productivity of peanut and corn crops commodities in the research area can be done with lower use of land, labor, and fertilizer cost. Fertilizer efficiency can be done if the amount of organic fertilizers is reduced but soil fertility is maintained. This can be done, for example, by providing organic matter or compost that can be obtained with a simple and inexpensive way such as cow dung. This is in accordance with the opinion of Corley (2003) who stated that cattle act as waste processing machines and organic fertilizer, where cattle could potentially produce compost, which is necessary for the maintenance of soil fertility. Dependence of farming on inorganic fertilizers (commercial) are increasing and this may be reduced with the use of organic fertilizer (compost) that can be used as additional fertilizer and could potentially increase the efficiency of plant maintenance costs as illustrated with peanut and corn commodities grown in the experimental farm.

Table 1. Fresh and dry peanut weight and dry peanut productivity (Kw/Ha)

Year	Fresh Peanut weight		Dry Peanut weight		productivity of dry peanut		productivity of dry peanut		Beef Cattle Integration Status
	peanut	peanut intercropping with corn	peanut	peanut intercropping with corn	Peanut	peanut intercropping with corn	peanut	peanut intercropping with corn	
0	6.01	4.59	3.02	3.46	1.04	1.44	2.25	0.73	No integration
1	27.47	27.53	12.59	12.57	5.70	6.68	30.78	8.94	integrated
2	31.99	33.59	15.31	16.41	6.31	7.32	84.46	23.11	integrated
3	45.92	46.10	21.83	22.89	8.14	8.79	90.51	23.58	integrated
4	55.56	56.04	26.31	27.53	9.66	10.22	92.39	24.17	integrated
5	56.61	56.73	26.81	27.75	10.49	10.88	104.39	30.32	integrated
6	58.77	58.35	27.95	28.83	10.40	10.25	89.40	27.11	integrated

Source: Field Direct Measurement and Studio Analysis

Table 1 shows that fresh and dry peanut, grown in either monoculture or intercropping with corn, has very different growth rates between before and after livestock integration. Prior to the integration, peanut weight was relatively lower than after the integration. In addition, each year after the integration shows increasingly higher productivity. It can also be seen that intercropping is more productive than monoculture. Table 1 also displays a similar trend for dry peanut productivity.

Table 2. Fresh and dry corn weight and dry corn productivity (Kw/Ha)

Year	Fresh Corn Weight		Dry Corn weight		productivity of dry corn		productivity of dry corn stover		Beef Cattle Integration Status
	corn	Corn intercropping with peanut	corn	Corn intercropping with peanut	Corn	Corn intercropping with peanut	corn	Corn intercropping with peanut	
0	80.77	88.50	39.98	44.46	4.15	1.14	0.63	0.78	No integration
1	258.75	273.63	98.31	93.42	13.31	3.52	2.83	2.83	Integrated
2	818.67	965.71	340.79	386.63	42.10	12.42	3.45	3.69	Integrated
3	931.54	1307.71	458.13	513.46	47.91	16.81	4.91	5.15	Integrated
4	1084.94	1403.04	481.21	550.54	55.80	18.04	5.92	6.20	Integrated
5	1099.67	1469.96	490.06	555.42	56.55	18.90	6.03	6.24	Integrated
6	1037.63	1223.71	482.58	554.84	39.33	15.73	6.29	6.49	Integrated

Source: Field Direct Measurement and Studio Analysis

Table 2 shows that fresh and dry corn, grown in either monoculture or intercropping with peanuts, has very different growth rates between before and after livestock integration. Prior to the integration, corn weight was relatively lower than after the integration. In addition, each year after the integration shows increasingly higher productivity. It can also be seen that intercropping is more productive than monoculture. Table 1 also displays a similar trend for dry corn productivity.

The productivity of integrated crop livestock farming

Peanut and Corn monoculture farming livestock integration

The above tables show that the Fresh productivity peanut and Corn, both of which do its plant manner that monoculture and intercropping can be compared with that of prior integrated with cattle have very different productivity rates. Prior to integration with cattle a weight of dry peanut and corn were relatively lower than after combined with cattle. Whereas after cattle combined with accelerated productivity more years of more productive. Another phenomenon shown is for peanut and corn plants were cultivated intercropping more productive in comparison with cultivated in monoculture.

Integrated Farming Development Model (IADM) based on local conditions

Based on the above discussion, it can be said that the utilization of functional diversity to the maximum level results in complex and integrated agricultural systems and optimum use of existing resources and inputs. The challenge is to find a combination of plants, animals and inputs that leads to elevated productivity, production security, and resource conservation that can be achieved with limited land, labor, and capital. The appropriate combination of land resources can naturally improve the marginal nature of the land and enhance land productivity, and ultimately advance the local economy.

Integrated farming system can improve farmers' ability in producing organic fertilizer and then can promote organic farming. Organic farming will be able to produce high quality and hygienic agricultural products unadulterated with potentially dangerous chemicals. Intercropping can integrate various components, such as fruit trees, grass (cover crop), and cattle.

The concept of marginal land development on lands with low cover is using plants that serve as land cover without cutting down trees or forest plants. This concept can be integrated to other agricultural development by making use of crops for animal feed, animal manure for biogas and fertilizer, and perennial plants for water conservation. Plants can be grown in erosion-prone lands to act as land cover.

Implementation of Integrated Farming System

The development of integrated farming system is slow and under the standard system. Farmers are applying this system are still partial or linear in nature, meaning that the management of each component of the system is still separate or isolated, for example, only livestock, crops, or fish. The management of integrated farming system consists of several subsystems: Integrated Crop Management (ICM), Integrated Nutrient Management (INM), Integrated Pest Management (IPM), Integrated Moisture management (IMM), Integrated Livestock Management (ILM) (Agus, in the Sovereignty of the People, 2006).

Energy Production Model of Integrated Crop Livestock Farming System

An increased energy production is seen in the integrated crop livestock farming. Based on the calculation of energy production, peanut monoculture with integrated livestock produces y = 2.310x2 - 13.99x - 41.12 with R^2 = 0688; corn monoculture with integrated livestock produces 0.160x2 + y = 7.016x - 42.21 with R2 = 0658; and peanut corn intercropping with integrated livestock produces y = 1.634x2 - 7.129x - 41.25 with R^2 = 0322 as presented in Figure 1.

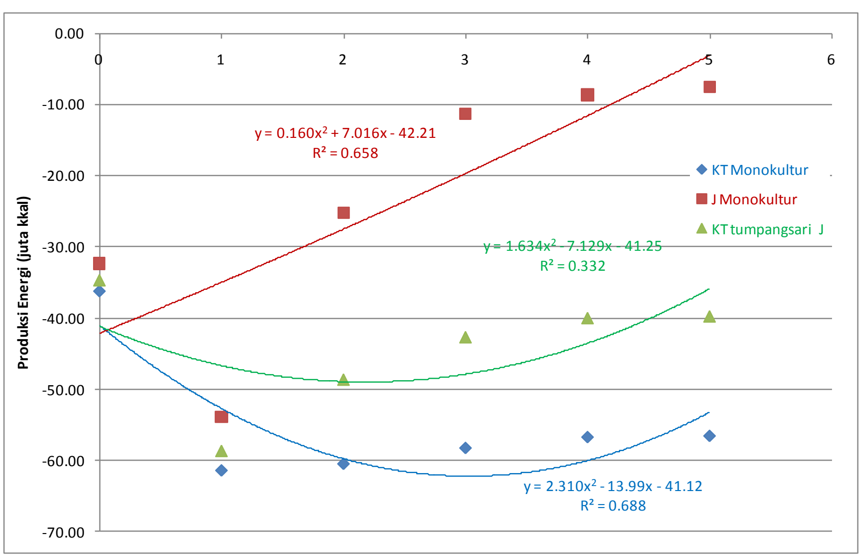

Figure 1 Energy production model of integrated crop livestock farming

Efficiency Model of Corn Monoculture

Based on the calculation of the economic efficiency model, an increased efficiency is seen in corn monoculture with livestock integration, that is, -0.154x2 + y = 1.376x + 0144 with R^2 = 0948 while corn monoculture without livestock integration is -0.101x2 + y = 0.930 x + 0161 with R^2 = 0943 as shown in Figure 2.

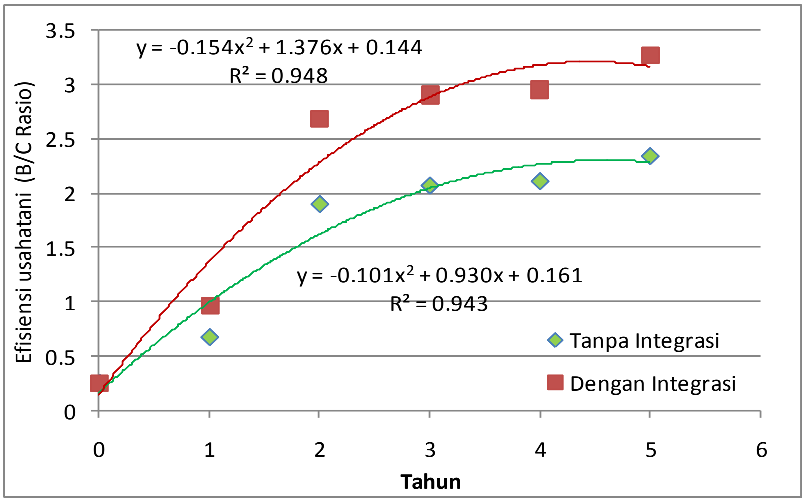

Figure 2 Efficiency Model Improvement of Corn Monoculture with Livestock Integration

Efficiency Model of Peanut Corn Intercropping

Based on the calculation of the economic efficiency, an increased efficiency is seen in peanut corn intercropping with livestock integration, that is, -0.064x2 + y = 0.69x + 0547 with R^2 = 0993 while peanut corn intercropping without livestock integration is y = - 0.037x2 + 0.449x + 0515 with R^2 = 0.997 as shown in Figure 3.

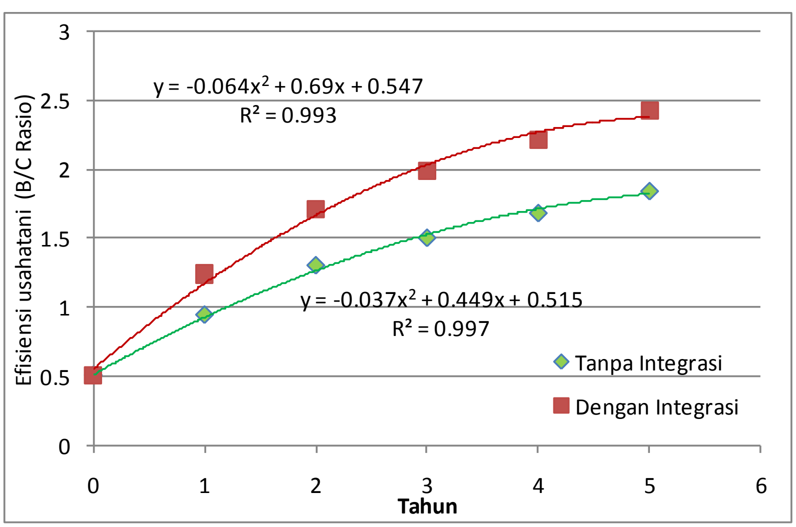

Figure 3 Efficiency Model Improvement of Peanut Corn Intercropping with Livestock Integration

Effectiveness Model of Peanut Corn Intercropping

Based on the calculation of the effectiveness model, an increased efficiency is seen in peanut corn intercropping with livestock integration, that is, -0.12x2 + y = 1.176x + R2 = 8,606 by 0976 while peanut corn intercropping without livestock integration is -0.12x2 + y = 1.176x + 0.503 with R2 = 0976 as shown in Figure 4.

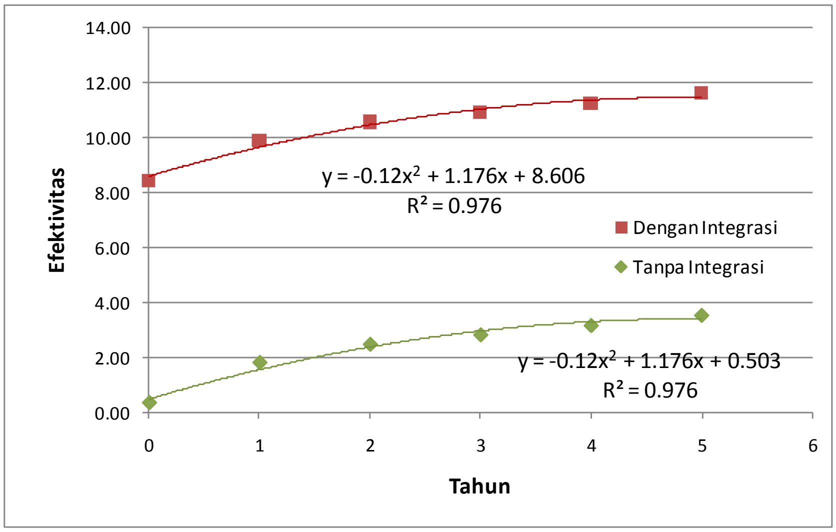

Figure 4 Effectiveness Model Improvement of Peanut Corn Intercropping with Livestock Integration

Based on regression equations and R2 values mentioned above, it can be seen that the effectiveness of peanut corn intercropping with livestock integration reaches a peak in the 6th year (11.62 ha). Meanwhile, the peanut corn intercropping with livestock integration peaks at 6th year (3.51 ha) after which it will decline when treated according to the research and the state of the environment is also in accordance with the study.

Supports Environmental Improvement Model of Intercropping with Livestock Integration

Improved Environmental Carrying Capacity of Peanut Monoculture Farm

Based on the calculation of the environment capacity model, peanut monoculture with integrated livestock increases at -0.022x2 + y = 0.255x + 0.727 with R2 = 0.966 while peanut monoculture without livestock integration is at -0.022x2 + y = 0.255x + 0.128 with R2 = 0.966.

It can be stated that the IFS is a farming system that is capable of realizing sustainable agricultural development and expected to inhibit land conversion. However, there are several problems in the development of IFS so it cannot develop optimally and widely in farming communities. They are: (1) IFS has been proven successful by various parties (farmers and facilitators); (2) The IFS level of yields and productivity has yet to convince farmers in general; (3) IFS Model developed is not in accordance with the conditions of the ecosystem; (4) Vertical and horizontal integration is not based on local potential; (5) Tax return has not been taken into account; (6) Comprehensive and integrated studies related to IFS are unavailable; (7) The policy of agricultural development does not clearly support IFS development. Departing from the problems above, IFS development must consider the principles of rural development, namely, the principle needs of the community, non-governmental, educational, participatory, local potential, integrality (Suharjo, 2008) and openness (Supangkat, 2009).

CONCLUSSIONS AND RECOMMENDATIONS

Conclusion

1. The vegetative and generative growth rate of the peanut and corn tested, in the first, second, third, and fourth model, either through monoculture or intercropping, without livestock integration is much lower than that of with livestock integration.
2. The production and productivity of the peanut and corn tested, in the first, second, third, and fourth model, without livestock integration is much lower than that of with livestock integration.
3. Cow manure can reduce fertilizer cost that can simultaneously reduce production cost in addition to protecting the soil organic matter, especially in experimental farm.
4. Livestock can act as a biological industry to increase the production of meat and provide compost. In this study, optimized utilization of organic fertilizer derived from cow manure can reach up to 40% of revenues (Dwiyanto, dkk.2001). Based on the many programs that increase farmers' income, farmers refer to crop livestock integration (Kusnadi, 2007; Hamdani, 2008: Kariyasa 2005) as the reason of their increasing income.
5. Livestock has a strategic position in integrated farming system (Hasnudi and Saleh, 2004) because, in addition to meat, it also produces solid waste and liquid organic fertilizer and biogas. Manure will be used for the cultivation of organic agriculture and the planting of grasses for livestock feed, resulting in nutrient cycle in a sustainable manner.
6. Integrated crop livestock farming is recognized for its capacity to fertilize soil with an on-farm inputs and livestock manure; encourage and allow farmers to maintain semi-permanent pasture fields, which can improve soil quality; increase crop yield; enhance on-farm biodiversity and related ecosystem services

such as pollination, and weed or pest management; enhance economic gains to the farmers; and offer social benefits to farmers and communities.

Recommendation

Development of Integrated Farming System (IFS) should be directed to the rural and sub-urban areas so that it can support the increased ability to build self-reliance of farmers and sustainability (economic and social improvement and sustainable environment). The successful development of IFS is expected to control land and improve land productivity. The IFS model must be adapted to local resources in order to effectively and efficiently succeed.

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by Nurul Istiqomah

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One of the big problems in Indonesia is the increasing land-use conversion from agriculture to non-agriculture. This problem can threaten the sustainability of agricultural development in the future, especially in the provision of food and labor, which ultimately will cause the declining contribution of agriculture to the formation of the Gross Domestic Product (GDP). Integrated crop livestock farming involves technology, management, and variety. This system is economically more profitable. This research is a field experiment conducted in the Integrated Farming System Development Farm of Wiyata Dharma Institute of Education, Training, and Research, located in Sragen district, Central Java Province , Indonesia. The research area is located between 7º23'10 " LS to 7º23'17 " LS and 110º50'28 " BT to 110º50'24 " BT with altitude ranging between 150 and 155 mean sea level.

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INTRODUCTION

1

An alternative to specialized agriculture is the integration of crops and livestock at the farm scale. Integrated crop/livestock agriculture could improve soil quality, increase yield, produce a diversity of foods, augment pollinator populations, aid pest management, and improve land use efficiency.

Integrated Farming Systems of Plant and Animal Pattern is integration between crops and livestock or often called integrated farming. This pattern is supportive in the provision of manure on agricultural land, so that it is often called a pattern without farm sewage for livestock waste is used as fertilizer and agricultural waste is used to feed the animals. Integration of livestock and crops is intended to obtain optimal business results and improve soil fertility. Interaction between livestock and crops must be complementary, supportive, and mutually beneficial to encourage increased production efficiency and farm yield advantage.

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Reijntjes (1999) suggested that animals or livestock can serve a variety of functions in a narrow area of a farm system. They provide several types of products, such as meat, milk, eggs, wool, and leather. In addition, they also have socio-cultural functions, such as for dowry, offerings, and gifts or loans, which can strengthen social bonds. In the low-input conditions, integration of livestock into agricultural systems is important, in particular to increase the subsistence security by expanding the types of businesses to produce food for farmers’ family. It is also essential to move nutrients and energy between animals and plants through manure and fodder and through the utilization of animal pulling ability.

The concept of integrated farming needs to be encouraged to support organic farming methods that are environmentally friendly. Cow commodity is one of the important commodities that should be improved to help achieve national meat security. This initiative can be intensified at the farm level in the context of the fattening, reproduction, and milk production. With the increase in the cattle population, the availability of manure on agricultural land is ensured so that organic farming can be properly done, soil fertility maintained, and agriculture sustained. The increasing diversity of livestock will reduce the risk of excessive crop cultivation, which in turn, will increase the economic stability of farming systems.

Herbivore livestock production systems combined with agricultural land can be adapted to the circumstances of food crops. Livestock do not compete on the same land. The food crop becomes the main component while the livestock serves as the second component. Livestock can graze alongside the crop or in unoccupied areas, and on land after harvesting so that cattle can utilize crop waste, weeds, grass, shrubs, and forage that grow around the area. Through their urine and stool, the animals can restore nutrients and improve soil structure.

One of these programs is the integration of crop and livestock usually known as Crop Livestock System (CLS). CLS objectives are the development of beef cattle fattening with plant-based food and simultaneously increasing the land productivity and crop cultivation. The program strives to increase the production of beef cattle inventory and food production through maintenance of cattle on upland and marginal areas. The basic consideration of this program is the production of agricultural crops and livestock with zero waste principle. The integration of livestock and crop is expected to save the use of animal feed, fertilizer, and land, as economically as possible so that the cost of livestock and crop production can be reduced, which subsequently will increase farmers' income.

CLS program is one alternative to improve commodity production of peanut, corn, and meat, and to increase farmers' income (Haryanto, 2002). Agricultural Research Agency has been researching and reviewing CLS with zero waste approach. Zero waste is to optimize the utilization of local resources such as the use as animal feed, feces, and urine to be processed into organic fertilizer. It means fixing the nutrients to the plant so no waste is wasted (Director General of Livestock Production, 2002).

The main characteristic of crop livestock integration is the existence of synergism or mutually beneficial relationship between plants and animals. Farmers use cattle dung as organic fertilizer for its plantation (peanut and corn), and then use agricultural waste as animal feed (Ismail and Djajanegara, 2004). In the crop livestock integration model, farmers overcome the problems of food availability by utilizing crop residues such as corn straw, pulses waste, and other agricultural wastes for fodder. Especially in the dry season, this waste can provide food ranging from 33.3% of the total grass given (Kariyasa, 2003). The advantages of the waste utilization is, in addition to increasing the feed resilience, especially in the dry season, to save labor in clearing grass, giving the opportunity for farmers to increase the number of livestock.

Utilization of cow dung as organic fertilizer, besides reducing the use of inorganic fertilizers, is also to improve the structure and availability of soil nutrients. This impact is seen with increasing land productivity. The study results by Adnyana, et.al (2003) showed that the CLS models developed by farmers in Central Java and East Java were able to reduce the use of inorganic fertilizers by 25-33% and increase rice productivity by 20-29%. Similar results are shown by Fur, *et.al* (2004) in Nusa Tenggara Barat in that the CLS models applied by farmers were able to increase their income by approximately 8.4%. The findings are also reinforced by CLS models applied by farmers in Bali. The models were able to save fertilizer expenses by 25.2% and increase farmers' income by 41.4% (Sudaratmaja, *et.al*, 2004). Similarly, the results of the study by Suwono, et.al (2004) in East Java showed that all of the farmers stated that the use of organic fertilizers was able to reduce the use of inorganic fertilizers, although in practice the reduction is not actually significant.

The concept of crop livestock integration, whether plantation crop, food, or horticulture, without reducing the plant activity and productivity. The existence of these animals could be able to increase the crop and livestock production altogether. Livestock management is carried out by farmers' family, who, at the same time, carries out the plant production. Therefore, the supply to support livestock management is largely expected to be obtained from the waste products of agricultural plants, although a small part of supply must be obtained from outside. Consequently, the family who will attempt this integration model must master the techniques of maintenance and utilization of livestock and the knowledge of crop framing practice, especially the knowledge in integrating the benefits of livestock in plants and vice versa (Directorate of Aquaculture Ruminant 2010).

A long-term effect of the development of agriculture and industry in the modern agricultural system is the production of significant, negative impacts on natural ecosystems. Contamination by toxic chemicals due to the high intensity of fertilizers, pesticides, and herbicides use has long been recognized. In addition, the increasing pest resistance to pesticides is caused by much higher application of pesticide spraying, and ground water and river pollution by nitrate compounds is due to excessive fertilizer use. Modern agriculture has also reduced the diversity of plant species drastically due to the application of large-scale monoculture systems. Environment that is originally composed of complex natural ecosystems is turned into a very simple ecosystem structure due to the decrease of the plant species. This is in contrast with the concept of sustainable agriculture, which attempts to fulfill the ever increasing and changing human needs while maintaining or improving the quality of the environment and conserve natural resources.

MATERIAL AND METHODS

Location

This research is a field experiment conducted in the Integrated Farming System Development Farm of Wiyata Dharma Institute of Education, Training, and Research, located in Geneng Duwur village, Gemolong sub-district, Sragen district, Central Java Province, Indonesia. The research area is located between 7°23'10 " LS to 7°23'17 " LS and 110°50'28 " BT to 110°50'24 " BT with altitude ranging between 150 and 155 mean sea level.

Research Design

Results measurement of vegetative growth, production, and productivity is performed by comparing monoculture, intercropping, and livestock integration systems. The experimental block consists of four models. The first model is peanut crop monoculture without livestock integration. The second model is peanut crop monoculture with livestock integration. The third model is peanut and corn intercropping without livestock integration. The fourth model is peanut and corn intercropping with livestock integration.

Data collection and mathematical analysis

The data used in this study are primary data done directly by means of measurements in the field. Experiments and field measurements are conducted for six years while the observations were done regularly. The analysis of plant productivity is done by sampling and conversion of plant populations: average yield multiplied by the sample plant population/ha (average sample x plant population/ha). Farm productivity is done by converting the weight of plant samples (total dried shelled peanuts/hectare, stover weight per hectare x value of the price of goods).

The analysis is done by converting animal productivity gain/livestock weight for six months per acre per hectare. Livestock productivity is measured by weight gain multiplied by cattle meat prices minus input.

Analysis of the production and productivity of integrated crop livestock farming is done by adding the results of the analysis of crop production and livestock production. Productivity analysis is also done by converting the results into a farming unit of energy (calorie) by way of referring to a secondary data and the results of previous studies or existing references.

RESULTS AND DISCUSSIONS

Dry lands in Indonesia are divided into two categories: 1) dry land with dry climates found in eastern Indonesia and 2) dry land with wet climates found in the western part of Indonesia (Bamualim, 2004). Dry land with wet climates have a higher risk of degradation because of soil erosion, and degradation from year to year continues to increase in the range of 1 to 2 percent a year (Go Ban Hong, 1976).

Prior to the implementation of integrated crop livestock system, corn and peanuts were complementing one another. The main problem in the development of these plants is low productivity and quality of results in marginal dry lands. This condition is caused by peanut and corn intercropping without livestock integration. The following integration between the intercropping and livestock showed a significant increase of production and productivity. Crop residues are used as organic fertilizer while cow dung and urine as plant fertilizer. Increased productivity of peanut and corn crops commodities in the research area can be done with lower use of land, labor, and fertilizer cost. Fertilizer efficiency can be done if the amount of organic fertilizers is reduced but soil fertility is maintained. This can be done, for example, by providing organic matter or compost that can be obtained with a simple and inexpensive way such as cow dung. This is in accordance with the opinion of Corley (2003) who stated that cattle act as waste processing machines and organic fertilizer, where cattle could potentially produce compost, which is necessary for the maintenance of soil fertility. Dependence of farming on inorganic fertilizers (commercial) are increasing and this may be reduced with the use of organic fertilizer (compost) that can be used as additional fertilizer and could potentially increase the efficiency of plant maintenance costs as illustrated with peanut and corn commodities grown in the experimental farm.

Table 1. Fresh and dry peanut weight and dry peanut productivity (Kw/Ha)

Year	Fresh Peanut weight		Dry Peanut weight		productivity of dry peanut		productivity of dry peanut		Beef Cattle Integration Status
	peanut	peanut intercropping with corn	peanut	peanut intercropping with corn	Peanut	peanut intercropping with corn	peanut	peanut intercropping with corn	
0	6.01	4.59	3.02	3.46	1.04	1.44	2.25	0.73	No integration
1	27.47	27.53	12.59	12.57	5.70	6.68	30.78	8.94	integrated
2	31.99	33.59	15.31	16.41	6.31	7.32	84.46	23.11	integrated
3	45.92	46.10	21.83	22.89	8.14	8.79	90.51	23.58	integrated
4	55.56	56.04	26.31	27.53	9.66	10.22	92.39	24.17	integrated
5	56.61	56.73	26.81	27.75	10.49	10.88	104.39	30.32	integrated
6	58.77	58.35	27.95	28.83	10.40	10.25	89.40	27.11	integrated

Source: Field Direct Measurement and Studio Analysis

Table 1 shows that fresh and dry peanut, grown in either monoculture or intercropping with corn, has very different growth rates between before and after livestock integration. Prior to the integration, peanut weight was relatively lower than after the integration. In addition, each year after the integration shows increasingly higher productivity. It can also be seen that intercropping is more productive than monoculture. Table 1 also displays a similar trend for dry peanut productivity.

Table 2. Fresh and dry corn weight and dry corn productivity (Kw/Ha)

Year	Fresh Corn Weight		Dry Corn weight		productivity of dry corn		productivity of dry corn stover		Beef Cattle Integration Status
	corn	Corn intercropping with peanut	corn	Corn intercropping with peanut	Corn	Corn intercropping with peanut	corn	Corn intercropping with peanut	
0	80.77	88.50	39.98	44.46	4.15	1.14	0.63	0.78	No integration
1	258.75	273.63	98.31	93.42	13.31	3.52	2.83	2.83	Integrated
2	818.67	965.71	340.79	386.63	42.10	12.42	3.45	3.69	Integrated
3	931.54	1307.71	458.13	513.46	47.91	16.81	4.91	5.15	Integrated
4	1084.94	1403.04	481.21	550.54	55.80	18.04	5.92	6.20	Integrated
5	1099.67	1469.96	490.06	555.42	56.55	18.90	6.03	6.24	Integrated
6	1037.63	1223.71	482.58	554.84	39.33	15.73	6.29	6.49	Integrated

Source: Field Direct Measurement and Studio Analysis

Table 2 shows that fresh and dry corn, grown in either monoculture or intercropping with peanuts, has very different growth rates between before and after livestock integration. Prior to the integration, corn weight was relatively lower than after the integration. In addition, each year after the integration shows increasingly higher productivity. It can also be seen that intercropping is more productive than monoculture. Table 1 also displays a similar trend for dry corn productivity.

The productivity of integrated crop livestock farming

Peanut and Corn monoculture farming livestock integration

The above tables show that the Fresh productivity peanut and Corn, both of which do its plant manner that monoculture and intercropping can be compared with that of prior integrated with cattle have very different productivity rates. Prior to integration with cattle a weight of dry peanut and corn were relatively lower than after combined with cattle. Whereas after cattle combined with accelerated productivity more years of more productive. Another phenomenon shown is for peanut and corn plants were cultivated intercropping more productive in comparison with cultivated in monoculture.

Integrated Farming Development Model (IADM) based on local conditions

Based on the above discussion, it can be said that the utilization of functional diversity to the maximum level results in complex and integrated agricultural systems and optimum use of existing resources and inputs. The challenge is to find a combination of plants, animals and inputs that leads to elevated productivity, production security, and resource conservation that can be achieved with limited land, labor, and capital. The appropriate combination of land resources can naturally improve the marginal nature of the land and enhance land productivity, and ultimately advance the local economy.

Integrated farming system can improve farmers' ability in producing organic fertilizer and then can promote organic farming. Organic farming will be able to produce high quality and hygienic agricultural products unadulterated with potentially dangerous chemicals. Intercropping can integrate various components, such as fruit trees, grass (cover crop), and cattle.

The concept of marginal land development on lands with low cover is using plants that serve as land cover without cutting down trees or forest plants. This concept can be integrated to other agricultural development by making use of crops for animal feed, animal manure for biogas and fertilizer, and perennial plants for water conservation. Plants can be grown in erosion-prone lands to act as land cover.

Implementation of Integrated Farming System

The development of integrated farming system is slow and under the standard system. Farmers are applying this system are still partial or linear in nature, meaning that the management of each component of the system is still separate or isolated, for example, only livestock, crops, or fish. The management of integrated farming system consists of several subsystems: Integrated Crop Management (ICM), Integrated Nutrient Management (INM), Integrated Pest Management (IPM), Integrated Moisture management (IMM), Integrated Livestock Management (ILM) (Agus, in the Sovereignty of the People, 2006).

Energy Production Model of Integrated Crop Livestock Farming System

An increased energy production is seen in the integrated crop livestock farming. Based on the calculation of energy production, peanut monoculture with integrated livestock produces y = 2.310x2 - 13.99x - 41.12 with R ^{2} = 0688; corn monoculture with integrated livestock produces 0.160x2 + y = 7.016x - 42.21 with R2 = 0658; and peanut corn intercropping with integrated livestock produces y = 1.634x2 - 7.129x - 41.25 with R ^{2} = 0322 as presented in Figure 1.

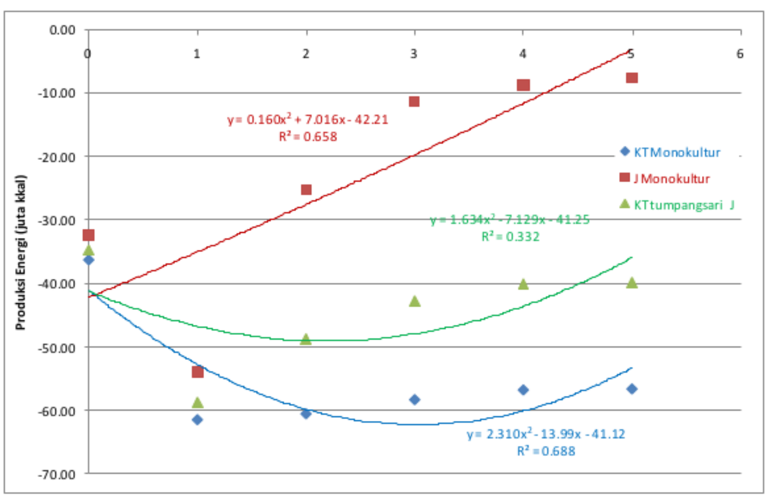

Figure 1 Energy production model of integrated crop livestock farming

Efficiency Model of Corn Monoculture

Based on the calculation of the economic efficiency model, an increased efficiency is seen in corn monoculture with livestock integration, that is, -0.154x2 + y = 1.376x + 0144 with R ^{2} = 0948 while corn monoculture without livestock integration is -0.101x2 + y = 0.930 x + 0161 with R ^{2} = 0943 as shown in Figure 2.

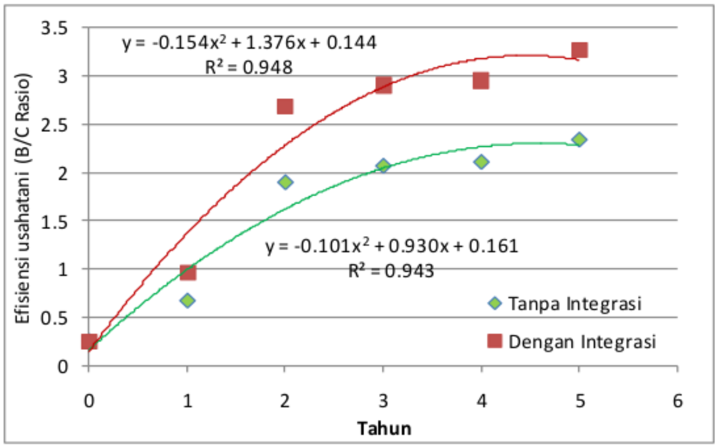

Figure 2 Efficiency Model Improvement of Corn Monoculture with Livestock Integration

Efficiency Model of Peanut Corn Intercropping

Based on the calculation of the economic efficiency, an increased efficiency is seen in peanut corn intercropping with livestock integration, that is, -0.064x2 + y = 0.69x + 0547 with R ^{2} = 0993 while peanut corn intercropping without livestock integration is y = - 0.037x2 + 0.449x + 0515 with R ^{2} = 0.997 as shown in Figure 3.

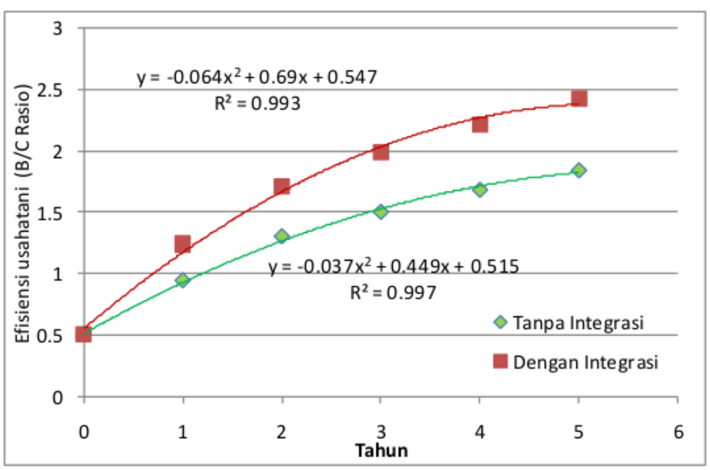

Figure 3 Efficiency Model Improvement of Peanut Corn Intercropping with Livestock Integration

Effectiveness Model of Peanut Corn Intercropping

Based on the calculation of the effectiveness model, an increased efficiency is seen in peanut corn intercropping with livestock integration, that is, -0.12x2 + y = 1.176x + R2 = 8,606 by 0976 while peanut corn intercropping without livestock integration is -0.12x2 + y = 1.176x + 0.503 with R2 = 0976 as shown in Figure 4.

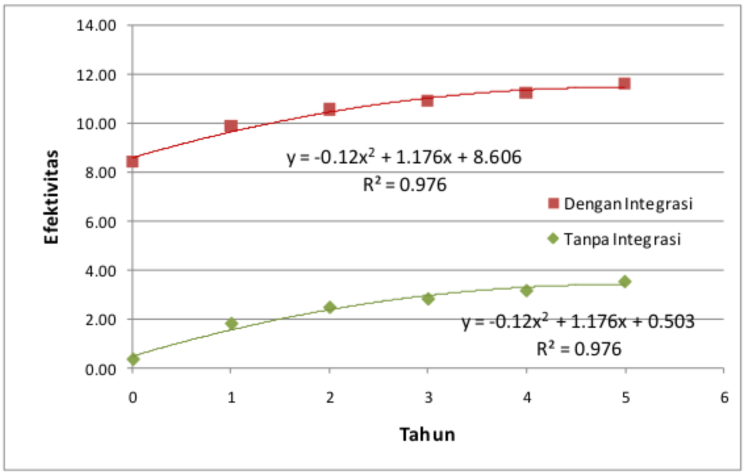

Figure 4 Effectiveness Model Improvement of Peanut Corn Intercropping with Livestock Integration

Based on regression equations and R2 values mentioned above, it can be seen that the effectiveness of peanut corn intercropping with livestock integration reaches a peak in the 6th year (11.62 ha). Meanwhile, the peanut corn intercropping with livestock integration peaks at 6th year (3.51 ha) after which it will decline when treated according to the research and the state of the environment is also in accordance with the study.

Supports Environmental Improvement Model of Intercropping with Livestock Integration

Improved Environmental Carrying Capacity of Peanut Monoculture Farm

Based on the calculation of the environment capacity model, peanut monoculture with integrated livestock increases at -0.022x2 + y = 0.255x + 0.727 with R2 = 0.966 while peanut monoculture without livestock integration is at -0.022x2 + y = 0.255x + 0.128 with R2 = 0.966.

It can be stated that the IFS is a farming system that is capable of realizing sustainable agricultural development and expected to inhibit land conversion. However, there are several problems in the development of IFS so it cannot develop optimally and widely in farming communities. They are: (1) IFS has been proven successful by various parties (farmers and facilitators); (2) The IFS level of yields and productivity has yet to convince farmers in general; (3) IFS Model developed is not in accordance with the conditions of the ecosystem; (4) Vertical and horizontal integration is not based on local potential; (5) Tax return has not been taken into account; (6) Comprehensive and integrated studies related to IFS are unavailable; (7) The policy of agricultural development does not clearly support IFS development. Departing from the problems above, IFS development must consider the principles of rural development, namely, the principle needs of the community, non-governmental, educational, participatory, local potential, integrality (Suharjo, 2008) and openness (Supangkat, 2009).

CONCLUSSIONS AND RECOMMENDATIONS

Conclusion

1. The vegetative and generative growth rate of the peanut and corn tested, in the first, second, third, and fourth model, either through monoculture or intercropping, without livestock integration is much lower than that of with livestock integration.
2. The production and productivity of the peanut and corn tested, in the first, second, third, and fourth model, without livestock integration is much lower than that of with livestock integration.
3. Cow manure can reduce fertilizer cost that can simultaneously reduce production cost in addition to protecting the soil organic matter, especially in experimental farm.
4. Livestock can act as a biological industry to increase the production of meat and provide compost. In this study, optimized utilization of organic fertilizer derived from cow manure can reach up to 40% of revenues (Dwiyanto, dkk.2001). Based on the many programs that increase farmers' income, farmers refer to crop livestock integration (Kusnadi, 2007; Hamdani, 2008: Kariyasa 2005) as the reason of their increasing income.
5. Livestock has a strategic position in integrated farming system (Hasnudi and Saleh, 2004) because, in addition to meat, it also produces solid waste and liquid organic fertilizer and biogas. Manure will be used for the cultivation of organic agriculture and the planting of grasses for livestock feed, resulting in nutrient cycle in a sustainable manner.
6. Integrated crop livestock farming is recognized for its capacity to fertilize soil with an on-farm inputs and livestock manure; encourage and allow farmers to maintain semi-permanent pasture fields, which can improve soil quality; increase crop yield; enhance on-farm biodiversity and related ecosystem services

such as pollination, and weed or pest management; enhance economic gains to the farmers; and offer social benefits to farmers and communities.

Recommendation

Development of Integrated Farming System (IFS) should be directed to the rural and sub-urban areas so that it can support the increased ability to build self-reliance of farmers and sustainability (economic and social improvement and sustainable environment). The successful development of IFS is expected to control land and improve land productivity. The IFS model must be adapted to local resources in order to effectively and efficiently succeed.

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INTEGRATED FARMING SYSTEM IN THE DRY AND MARGINAL LAND IN SRAGEN DISTRICT, CENTRAL JAVA PROVINCE, INDONESIA

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