Chapter

The Role of the Livestock Farming Industry in Supporting the Global Agricultural Industry

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Abstract

The livestock farming industry is a strategic industry and has a very important potential for the advancement of the agricultural industry. The livestock farming industry is an industry that plays a role in providing protein food for most of the world's population. Not only as a food provider, but also having a very large contribution to the progress of agricultural cultivation in the world. The livestock industry contributes part of the needs of the agricultural industry through the provision of environmentally friendly organic fertilizers. The integration of the livestock farming industry and the agricultural industry is a mutually supportive system. The integration of plants with livestock is basically an agricultural system characterized by a close relationship between plant and livestock components in a farm in a certain area. The bio-mass waste products from the agricultural industry can be used as a source of animal feed or as raw material for compost. The combination of the livestock industry with the agricultural industry provides enormous economic value for the development of the livestock and agricultural sectors. In Indonesia, the concept of integration between the livestock industry and the agricultural industry has been proven to improve the standard of living and economic status of the community. Some important materials will be discussed in more depth in this paper, including: (1) integration between livestock and rice, (2) integration between goats and cacao plants, (3) integration of livestock with oil palm, (4) integration of ruminants with cassava plants, and (5) integration of cattle with horticultural crops. Utilization of livestock and agricultural waste can reduce environmental burdens. Livestock farming industrial waste in the form of manure can be combined with agricultural wastes. This waste can be used as raw material for organic fertilizers which can be used as a fertilizer provider to support the cultivation of food crops, horticulture and plantations. The development of livestock in an area can encourage farmers to fill their vacant land to be planted with forage. Guidance efforts that will be carried out will be oriented towards land conservation. This is done through the arrangement of forage planting. Therefore, this will have a positive impact on increasing forage production. This effort will ultimately support the improvement of feeding patterns, proper land arrangement and being able to reduce the rate of erosion. The existence of livestock will add a source of manure. This is certainly synonymous with increasing land fertility which can provide business opportunities in optimizing land use diversification. The role of livestock in the livestock industry is the main support and complement in the system of integration in the livestock industry-agricultural industry.

Keywords: Industry, livestock, farming, agriculture, integrated

1. Introduction

Indonesia, is one of the countries in Asia which has a large proportion of the population making a living in the agricultural sector. This is due to natural conditions, which mostly consist of wide expanses of land, considerable biodiversity, and a tropical climate. With this tropical climate, the sun's rays can continue to shine throughout the year.

Based on 2019 data, the total population in Indonesia reaches 268,074,600 people [1]. The number of farmers in Indonesia reaches 33,400,000 people or around 12.45% of the total population. Based on these data, as many as 8% are young farmers aged 20–39 years, and the rest are farmers aged >39 years. In line with the increasing population, of course the need for animal food consumption (meat) will also increase. The increasing demand for meat for the community will be directly proportional to the rate of demand for meat. Unfortunately, the rate of demand has not been supported by efforts to increase domestic beef production. Currently, the availability of national beef in the country is still experiencing shortages. Therefore, additional imported meat is needed. Based on the data, approximately 35% of the total national demand for beef has been met from the imported component. The availability of meat in the country is quite safe even though it has not been able to meet all the needs of the Indonesian population. In Indonesia, the largest livestock providers for meat are large livestock (cattle, buffalo, horses); small livestock groups (goats, sheep and pigs); poultry (broilers) and various livestock groups (rabbits, quails and pigeons). In 2019, the livestock population for producing meat from large livestock groups amounted to 16,930,000 heads (cattle); 1,134,000 head (buffalo) and 375,000 head (horse). Meanwhile, the population of small livestock groups is 18,463,000 heads (goats); 17,834,000 head (sheep); 8521 head (pigs). Potential sources of meat obtained from the group of poultry (broilers) amounted to: 3,169,805,000 heads. In addition to the potential for producing meat, the potential of livestock as a producer of milk also has a very important role. This potential is obtained from the dairy farming business. The population of dairy cows in Indonesia reaches 565,000 heads. In addition, the potential for egg-producing livestock is obtained from poultry with the respective population for native chickens (301,761,000 heads); laying hens (263,918,000 head); ducks (47,783,000) and muscovy ducks (9446) [2].

The livestock sub-sector is one of the most important and strategic sub-sectors. This role is particularly in the process of meeting the needs of food sources of protein for the community. The demand for food from livestock in Indonesia continues to increase. On average, the consumption of animal protein in the Indonesian population is still low (<4 g/capita/day). The income elasticity of the demand for livestock products is relatively high. Meanwhile, the fulfillment of the need for beef is lower than the amount needed. This condition is an opportunity as well as a challenge for prospective breeders and livestock industry entrepreneurs.

In an effort to meet the needs of animal protein for the entire population, the role of the livestock sub-sector as a provider is very urgent. The need for animal protein is obtained from meat, milk and eggs. The availability of domestic meat has not been able to be fulfilled as a whole. Therefore, efforts to import meat are still an alternative. For milk and egg products, the needs of the people in the country are still relatively sufficient.

In 2020, meat production in Indonesia will reach 425,978 tons. In 2021, it is estimated that the demand for meat will increase significantly to reach 696,956 tons. Apart from domestic production, there is still a remaining supply of imported beef and buffalo as well as live cattle which are equivalent to meat. The amount of meat reached 47,836 tons, so that the total meat stock reached 473,814 tons [3].

Improvements in livestock governance need to be carefully planned. Fulfilling the needs of livestock and improving management is expected to increase livestock productivity. This effort can be made through the application of the concept of integration between the livestock industry and the agricultural industry.

The concept of an integrated farming system (IFS) is one that has been implemented since ancient times. This concept is characterized by the close relationship between the agricultural industry and the livestock industry. In principle, this system will ensure the realization of a sustainable agricultural system. Based on the history of agriculture, the integrated farming system has been abandoned since the end of World War II. By this time, specialized farming systems and monocultures had developed rapidly. This system has received full support, especially in relation to the uncontrolled use of chemical fertilizers, the use of herbicides to control weeds, as well as the use of pesticides and fungicides in controlling pests and plant diseases. In addition, the application of modern agricultural tools has also replaced traditional farming systems.

In general, these changes in agricultural practice patterns have indeed succeeded in significantly increasing yields and productivity of agricultural businesses. However, in the long term, this practice does not show a sustainable effort and ends with a decrease in land quality, an increase in the process of land and water pollution, the emergence of certain variants of pests and plant diseases.

As an agricultural country, the population in Indonesia has utilized most of the natural resources of its life to meet their daily needs. Agricultural products are a basic need and fundamental for the continuity of human life. Agricultural products referred to are products from the activities of the agricultural industry itself, plantations, livestock and fisheries.

2. Integration of cattle with rice plants

Replace Rice (*Oryza sativa* L) is one of the most important cultivated plants in the history of human civilization. Rice is thought to have originated from India or Indochina and entered Indonesia by ancestors who migrated from mainland Asia around 1500 BC [4].

Several countries in Asia are rice producers such as China (28% of total world production). Then followed by India (21%), and Indonesia (9%). However, only a small proportion of world rice production is traded between countries (only 5% -6% of total world production). Thailand is a major rice exporting country (26% of the world's total traded rice). Next followed by Vietnam (15%) and the United States (11%). Indonesia is one of the rice importing countries (14% of the world's traded rice) as well as Bangladesh (4%) and Brazil (3%) [5].

Rice plants are one of the staple foods for most of the population in several countries in Asia, including Indonesia. The use of rice as a staple food has been going on for hundreds of years. Currently, almost 90% of rice production has been produced and consumed by the occupation countries in Asia. This is certainly a sign that the efforts made by humans to increase rice production are uncertain. One of the reasons is that the world's population will continue to grow at a rate of 1.3% per year. It is estimated that in 2025 the world's population is estimated to reach 8.3 billion [6].

Based on data, in Indonesia, the population in 2010 has reached 237.56 million people. To meet these needs, the need for rice has reached 33.06 million tons/year, assuming 139 kg/capita/year. Related to the increase in the population which reached 241 million in 2011, the government has targeted rice production to be 68.59 million tons of milled dry rice (MDR) or the equivalent of 38.57 million tons

of rice. This figure increased by 2.1 million tons of MDR or 3.2% compared to the target of rice production in 2010 [7].

Apart from rice, the commodity of meat is quite important. In the last 10 years, the development of the livestock sub-sector has shown tangible results, especially its contribution to gross domestic product (GDP). Total consumption of meat, eggs, and milk each increased by 7.6%; 5.22%; and 0.92%. However, the increase in consumption has not been matched by an increase in production, especially beef, whose population has even decreased to 4.1%/year [8]. To meet domestic demand for meat, part of this need must be imported. The demand for beef in 2014 refers to the consumption of meat per capita which has increased from 2013 of 2.2 kg/year to 2.36 kg/year. Meanwhile, the fulfillment of beef consumption originating from imported products is only 58,280 tons or 9.8 percent of feeder cattle amounting to 34,970 tons or equivalent to 175,407 head, while in the form of meat is 23,100 tons. To provide local meat needs in 2014, a cattle population of 19.7 million heads is needed, while for beef cattle, 17.6 million must be available, higher than the beef cattle population in 2013 of 16.8 million tons [9].

The beef self-sufficiency program has been launched since 2005 and is targeted to be achieved in 2010, but in reality it has not been achieved. Therefore, the government is re-targeting a new self-sufficiency and finally achieved in 2014. The concept of beef self-sufficiency is certainly not impossible to achieve if there is seriousness from all parties to develop domestic beef cattle agribusiness. Market potential and supporting resources should be an opportunity for the development of beef cattle with a comparative and competitive advantage in both local and export markets [10].

The cattle population in Indonesia can grow because the business is quite prospective. This is evident from the growing business of cattle fattening in a number of regions and the Organic Fertilizer Processing Unit (OFPU) Program since 2011. The farmer groups are given a number of cows and then the farmers process cow dung into compost. There are farmer groups that are able to develop cow dung and urine production as the main business, while cattle fattening is a side business. The sale of cow dung and urine provides an income of IDR 22,000/head/day, while the purchase of feed is only IDR 7000/head/day. The average compost price at OFPU ranges from IDR 600–750/kg [11].

The rice-livestock integration system (RLIS) has become part of the farming culture in Indonesia. This system is able to utilize local resources, namely by-products in the form of straw and bran, and livestock manure efficiently. The main characteristic of RLIS is that there is a link between plants and livestock, for example rice crop waste (straw) is used as animal feed, and vice versa, livestock manure can be used as organic fertilizer to meet plant nutrient requirements [12]. Therefore, the RLIS assessment program was initiated in conjunction with the rice paddy integrated crop management (ICM) assessment program. The ICM recommends the use of organic materials as one of the main components. Organic fertilizers are needed to increase rice yields, improve soil physical and chemical properties [13], and suppress the use of inorganic fertilizers [14]. Excessive use of nitrogen and continuous application of P fertilizer in some rice fields can damage the nutrient balance in the soil. The reduced content of organic matter in agricultural land in Indonesia today shows the need for efforts to increase the quality of soil organic matter content by two times to restore normal soil health conditions [15]. [16] stated that organic fertilizers can increase rice yield by 0.9 ton/ha compared to without organic fertilizers.

The RLIS provides benefits to farmers, namely cow manure and agricultural by-products in the form of straw and bran. Utilization of waste from livestock manure

has not been optimal. It can be used as organic fertilizer to increase soil fertility or can be sold as a source of additional income. The available agricultural waste can be used as a source of quality feed so as to reduce the cost of providing feed [17]. The RLIS pattern is a solution to feeding problems. This pattern can strengthen food security through processing agricultural waste into high nutritional value feed and can meet the needs of cattle. In general, RLIS is one solution to achieve food security, independence and sovereignty.

The application of RLIS in several regions in Indonesia has had a significant effect on increasing farmers' income. The application of an integrated farming system encourages an increase in farmers' income. An overview of the benefits obtained through the implementation of an integrated farming system in Indonesia at 3 different provincial locations is presented in **Table 1**.

Based on the data in **Table 1**, it can be seen that the benefits of rice and livestock farming which are managed in an integrated manner will be able to provide higher profits than only in partial form. Farming that is done partially means farming that is only done singly (rice plants), while integrated farming means farming that combines rice plants with livestock. The straw waste generated from the rice cultivation business is then fermented and given to livestock. In Central Java Province, farming which is carried out in an integrated manner is able to provide a profit of 15.86% higher than that which is carried out partially. The same thing also happened to two other provinces, Bali Province and West Nusa Tenggara (NTB) Province at 29.19% and 27.72%, respectively. Another advantage can be seen in the component of the benefit cost ratio (BCR), which on average is higher in regions that implement

	Partial			Integrated		
Description	**Rice**	**Cattle**	**Total**	**Rice**	**Cattle**	**Total**
1. Jawa Tengah Province						
a. Revenue	6368	4232	10,600	6754	4527	11,281
b. Profit	2958	397	3355	3324	574	3887
				(12.37)	(44.58)	(15.86)
c. Benefit Cost Ratio (BCR)	1.87	1.12	1.47	1.96	1.17	1.57
2. Bali Province						
a. Revenue	6666	5051	11,717	7246	5315	11,281
b. Profit	3283	146	3429	4019	411	4430
				(22.42)	(181.5)	(29.19)
c. Benefit Cost Ratio (BCR)	1.97	1.07	1.45	2.25	1.22	1.86
3. Nusa Tenggara Barat (NTB) Province						
a. Revenue	5203	4497	9700	5360	4723	10,083
b. Profit	1843	329	2172	2207	567	2774
				(19.75)	(72.34)	(27.72)
c. Benefit Cost Ratio (BCR)	1.55	1.16	1.34	1.70	1.30	1.50

Table 1.
Comparison of Revenue and Profits from Farming through the Application of the Rice–Livestock Integration System (RLIS) in 3 (three) Provinces in Indonesia [18].

an integrated system respectively (1.57; 1.86 and 1.50) than partially (1.47; 1.45 and 1.34) for the three study areas. A higher BCR value indicates that an area that implements an integrated system has a high effectiveness in the use of inputs or production costs. Based on the aspect of market demand, there is a tendency for consumers to be more dominant in choosing organic agricultural products (using organic fertilizers and free of pesticides). This is probably due to considerations of health factors, although at a relatively higher price.

Based on the data in **Table 1**, the first assumption used is the cost of fertilizers. For farming that is managed in an integrated manner, the cost of fertilizer used is only around IDR 500,000-600,000/Ha. On the other hand, partially farming requires fertilizer costs ranging from IDR 621,000-733,000/ha. The use of organic fertilizers from livestock waste in integrated farming can save fertilizer costs by around 18.14–19.48% or around 8.8 percent of the total cost. The second assumption is the cost of feed. An integrated livestock business, rice crop waste in the form of straw can be used as feed. The cost required is only IDR 410,000-889,000/head, while partial farming (without hay feed) costs IDR. 735,000-1,377,000/head. Therefore, this cost can be assumed that farming businesses that utilize agricultural waste can save labor costs by 35.44–44.22% or around 5.26–6.38 percent of the total cost of livestock farming.

Since independence, Indonesia has not been able to meet food needs from its own production. Therefore, importing several foodstuffs must be an option. The food sovereignty program is one solution to reduce the rate of imports of food products [19]. The food sovereignty program is able to reverse the concept of modernization into things that are back to basic or back to nature by prioritizing production for the fulfillment and sustainability of local food and local markets through the provision of agricultural production inputs that utilize local wisdom and are environmentally friendly [20]. One thing that needs to be known is that the main principles and problems that arise in the food production process are self-reliance and self-sufficiency. As an effort to achieve self-sufficiency in food production, of course, an economic democracy is needed. For the government, they must take redistribution actions. Special parties such as the government must ensure the people's livelihoods and income by providing capital equitably in the agricultural sector. Matters related to the food production program, must rely on efforts to mobilize the largest portion of small-scale food producers. It is focused on marginal food producing sectors, providing access to resources such as land, water, seeds and livestock [21].

It is known that, Indonesia has absolute advantages (comparative and competitive) in building food independence and sovereignty. Of course, this potential has been characterized by several things, such as: (1) Indonesia is characterized by being on the equator with a tropical climate and a very conducive sunlight intensity for agricultural production; (2) availability of land and water so that it is not a limiting factor which is quite worrying; (3) availability of living natural resources accompanied by local food diversity; (4) advances in food production technology, including those that have developed in Asia; and (5) the government's 15 million ha perennial agricultural land program has not been implemented properly [17].

Food sovereignty and food self-sufficiency programs always require a strong food security. This includes food availability, accessibility, price stability, utilization, quality, and safety [22]. As an effort to create food sovereignty, the government needs to make efforts to protect its farmers. In addition, the government always encourages farmers to be ready to compete with food corporations. Of course, this will have a negative impact on farmers. A state subsidies program by protecting trade and providing adequate subsidies to farmers must be implemented.

The government must allocate an adequate subsidy budget. The percentage of the food subsidy budget must be greater than gross domestic products (GDP) [23].

One alternative strategy that is quite prospective in building food independence and sovereignty is to utilize local resources that are supported by agriculture-based industries, soft credit schemes, and infrastructure development in rural areas. This is predicted to be able to create a market for primary agricultural production and new jobs in rural areas [17].

The concept of integration of the livestock industry with the agricultural industry, especially rice, can be seen from their respective roles. The role of livestock (beef cattle) in the rice cultivation process acts as a land processor by generating energy. Livestock waste in the form of manure released during the soil processing process will be decomposed so that it can fertilize the hardened soil due to the use of very intensive chemical fertilizers. In his calculations, an adult cow can produce approximately 8–10 kg of manure per day which can be processed into 4–5 kg of compost/day [24].

Liquid waste from livestock in the form of urine is collected from livestock disposal. Then stored in a plastic drum, processed with additional ingredients which are then deposited. Liquid fertilizer from urine can be used to fertilize rice plants through leaf spraying techniques. Organic fertilizers from feces and urine are much desired by consumers, but the amount is still very limited [25].

The existence and role of livestock waste has not completely replaced the position of chemical fertilizers, however, the deficiency of several nutrient compounds in chemical fertilizers can at least be complemented by organic fertilizers from livestock manure [26]. The cattle culture management system which is carried out intensively by considering the aspects of feed (concentrate and fermented rice straw), collective cage management, and animal health can increase the average daily gain (ADG) of 0.89 kg/head/day during the fattening period. This value is higher than the farmer method which is only 0.29 kg/head/day. The resulting ADG increased by about 0.6 kg/head/day (67.42%), so that it was able to produce ADG from 0.29 to 0.89 kg/day. The process of fattening cattle is not only for achieving high ADG values, however, how can cattle use rice straw as agricultural waste which has not been optimally used. This of course will be able to reduce farmers' expenses from production costs and most importantly environmentally friendly [27].

The level of livestock productivity is influenced by at least 70% from environmental factors, and the remaining 30% is genetic factors. Feed (up to 60%) is one of the environmental factors that play the biggest role in productivity. Based on this, it can be said that, although livestock have prime genetic potential, but not supported by quality and available feed, livestock productivity will be difficult to achieve. The important role and contribution of the rice plant business in the management of cattle feed is the presence of agricultural waste in the form of rice straw (whether or not fermented). However, rice straw that does not undergo a fermentation process, of course, cannot be fully digested by livestock. This is caused by the high lignin and hemicellulose compounds in the straw waste [28].

The biodegradation process of lignin compounds in straw aims to remove lignin, increase the digestibility of cellulose so that the quality of straw as animal feed will increase. The use of TLiD and BOpR bacterial isolates is able to degrade lignin and organochlorin (lignolytic). These isolates are specific for growth on rice straw. Application of TLiD and BOpR isolates in the fermentation process of rice straw can reduce the lignin content of rice straw up to 100% on the 7th day of fermentation and increase the crude protein of rice straw. High degradation efficiency of isolates where lignin degradation is higher than cellulose [29] Processed agricultural waste (by-product) has a protein content of 12% higher than grass protein content of

around 9%. The palatability of processed feed is better because it contains molasses and pikuten (commercial minerals) [30].

Rice plant waste in the form of straw needs to be utilized optimally. The straw burning activity will reduce the nutrients contained in it. The straw that is stored in the land without fermentation is very difficult to be bound by soil particles. Therefore, this waste requires special attention so that its quality can be improved. Compost processing from straw can be done in two ways, namely: 1) stacked and turned and 2) stacked with ventilation without turning. The decomposition process can be accelerated by using a decomposer in the form of microorganisms. Several commercial decomposers are known to contain several kinds of microbes, for example M-Dec products containing *Trichoderma harzianum*, *Aspergillus sp*., and *Trametes sp*. Orgadec products contain *Trichoderma pseudokoningi*, and *Cytophaga sp*. EM-4 products contain photosynthetic bacteria, lactic acid, actinomycetes, yeast, and fermented fungi [31].

Probion product is a type of animal feed additive that can be used directly as a concentrate feed mixture to improve the quality of rice straw through the fermentation process. Probion's product is a consortium of microbes from ruminants that have been enriched with essential minerals for microbial growth needs. Ripe compost is characterized by a temperature that is already constant (40–50°C), crumbs, and has a dark brown color. The compost obtained is ± 500 kg with C-organic quality >12%, C/N ratio 15–25%, 40–50% moisture content, and light brown-black color [32].

Rice straw as agricultural waste has abundant potential, but has not been utilized optimally as cattle feed. One of the obstacles is the high crude fiber content, but very low protein content and digestibility. The use of straw directly or as single feed for livestock certainly cannot meet the nutritional value needed by livestock during the production process [33]. Utilization of straw waste from rice plants as animal feed is one of the efforts in realizing an integrated system of rice plants with livestock. A complete description of the integration model was presented in **Figure 1**.

The nutritional content of straw can be increased through the fermentation process using probiotics as a bio-degradation. The fermented straw has a protein content that almost matches the quality of elephant grass. The fermented straw should be stored as soon as possible in a dry place so that its quality and quality are maintained. The potential of straw as animal feed is able to streamline the labor

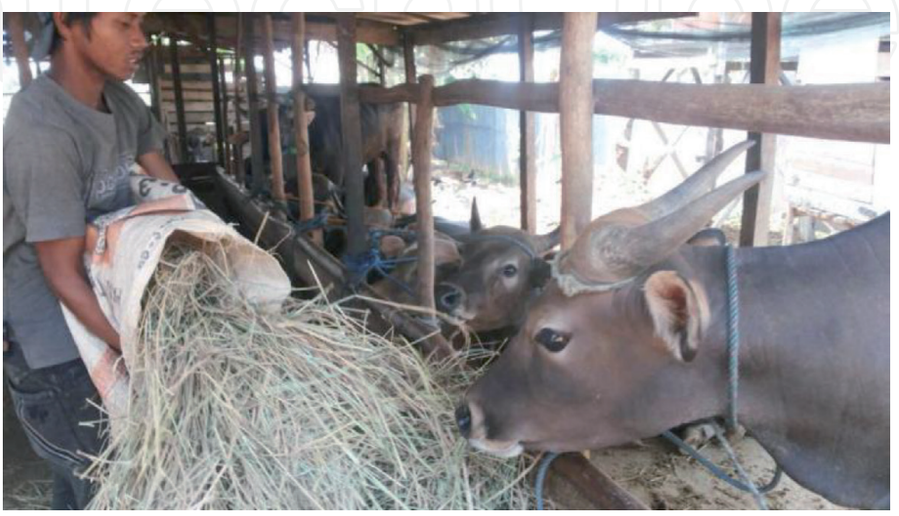

Figure 1.
Utilization of straw waste as animal feed to support the integration of rice plants with cattle. Source: https://banjarmasin.tribunnews.com/2015/09/02/peternak-ganti-rumput-dengan-jerami.

that farmers have to prepare to find grass. In fact, the results of the study show that providing agricultural straw waste to livestock by adding microbes and urea has been shown to improve livestock productivity [34]. Rice plants will produce straw as a by-product. In each hectare, rice fields will produce fresh straw waste of 12–15 tonnes/ha/season. Furthermore, waste that has gone through the fermentation process will produce 5–8 tons/ha which can be used to meet the feed needs of 2–3 cows/year [14].

The use of microbes in the straw fermentation process is very effective in improving the quality of the straw. The nutritional composition of rice straw that has been fermented using a Starbio starter as much as 0.06% of the weight of rice straw generally shows an increase in quality compared to unfermented rice straw. The fermentation process is able to increase the crude protein content of rice straw from 4.23% to 8.14% which is then followed by a decrease in crude fiber content. These results indicate that, Starbio starter is a proteolytic microbe that can produce enzymes to break down proteins into polypeptides which then become simple peptides. The application of microbial starter was able to reduce the rice straw cell wall content from 73.41% to 66.14%. The lignocellulose and hemicellulose bonds of rice straw will be released during the fermentation process. The activity of lignolytic microbes in the microbial starter helps to break down the lignocellulose bonds so that cellulose and lignin can be released from these bonds by the activity of the lignase enzyme. The decrease in cellulose and lignin content during fermentation is one proof that these bacteria are working well. Lignin compounds in straw are a physical barrier that can inhibit the digestibility of enzymes in plant tissue. In addition, lignin binds closely to hemicellulose. The decrease in cell wall content indicates that the process of breaking down cellulose cell walls has occurred so that the feed will be more easily digested by livestock [35]. The fermentation results can increase the nutritional level of the straw Thus, the increase in live weight of livestock can increase very significantly. Cattle that are given additional feed such as straw and probiotics are able to give a live weight gain of 0.56–0.68 kg/head/day higher than the control [36].

One type of waste produced from the rice processing is bran. This bran consists of a layer of aleurone and a small portion of endosperm, pericarp, pigment, and germ [37]. The amount of bran that can be produced is as much as 8–10% of the weight of milled rice, so that its availability is quite abundant. Rice bran contains dry ingredients as much as 88.30%; crude fiber 15.30%; ash 9.90%, 10.10% crude protein, 4.90% crude fat, and 48.10% BETN [36]. Bran is a source of carbohydrates that are easily available and very effective in improving the quality of fermentation in rice straw [38]. Giving rice bran and Bioplas probiotics to pregnant cows of local cattle can increase the body weight of the cows by about 0.5 kg/head/day and can increase the birth weight of the calves by about 10.5 kg compared to the control 8.9 kg. Feed consumption has increased by about 5.2 kg. In addition, giving bioplas bran and probiotics to cows could re-estrus after 62 days after giving birth compared to controls about 85 days after giving birth [39].

Utilization of solid waste (manure) and liquid (urine) in cattle cultivation as organic fertilizer is expected to be used as a source of additional income for breeders. In addition, it can improve the fertility of agricultural land. The introduction of technology for the integration of livestock with rice plants was able to increase farmers' income by IDR 34,488,800, – higher than traditional technology of IDR 22,903,200, – Based on the results of the R/C ratio analysis, the value was 6, higher than the traditional pattern with R/C ratio of 4, so it is feasible to be cultivated by farmers. Rice farming which is integrated with cattle is an efficient and effective farming for improving the farming income of the people by selecting narrow land in rural areas. Farming with rice-cattle integration pattern can

increase farmers' income by 70% on rice scale farming with 5 ha of plant area and cattle ownership of 20 heads [25].

The development of cattle using the RLIS method in several potential areas has a positive impact on increasing the domestic cattle population. The result is expected to be able to be self-sufficient in meat. This program aims to maintain the balance of local livestock stocks as highly valuable germplasm. In addition, it is also aimed at reducing the need for meat imports which have been very difficult to stem due to the high domestic demand for meat [40]. Another positive impact that occurs is the ability to improve the performance of other farmer groups in terms of buying and selling cattle. With a pattern of planting rice 3 times/year and being a technical irrigation area, the straw is entirely for animal feed needs. The provision of straw for animal feed is quite high, namely 25 kg/day/head for seed cows and 31 kg/day/head for fattened cows. Several obstacles faced in implementing the RLIS pattern, namely: (1) the working mechanism of the group did not work well; (2) the utilization of the collective pen is not optimal at all so that the level of utilization of the pen facilities is still low, (3) the process of mentoring and coaching is not effective because the position of the cattle cannot be kept in one collective pen. As a result, the existing livestock will be scattered according to the domicile position of the breeders. Another obstacle faced is that the transportation process from the compost location to the fields is still burdensome. On the other hand, the use of manure by group farmers is not yet entrenched. This requires socialization so that available manure can be utilized [41].

The RLIS program was initiated in conjunction with the ICM program. In addition, the development of the RLIS needs to be carried out through a farmer group approach to facilitate agricultural extension, adoption of rice-livestock technology, and government assistance channels. The advantage of the rice-livestock integration pattern is the use of potential plant waste as a source of animal feed, utilizing livestock manure as manure, creating new jobs in rural areas, and increasing community participation in realizing agribusiness that is competitive, environmentally friendly, and independent. Obstacles to SIPT in realizing food security include the working mechanism of farmer groups that has not been running well, the use of collective cages has not been optimal, the process of mentoring and coaching has not been effective because the location of livestock is scattered, the use of manure has not become a culture among rice farmers, and the implementation of RLIS is carried out throughout province and no clear progress. Future improvements in RLIS should be focused on areas of production centers so that they are large-scale and have a significant impact on population growth and livestock productivity. The processing of livestock waste is close to the rice planting location to minimize transportation costs so as to create zero waste and a good integrated farming system to realize food sovereignty [42].

Rice-livestock integration technology can improve additional income for farmers in a condition of synergy. Utilization of farm input from sources has been available optimally. Products produced during the rice production process have been integrated with cattle fattening, including straw and feed which have economic value. Cow manure is used through the recycling process into biogas. Worms and organic fertilizers are used for fertilizing plants, while livestock waste is used to fertilize fish ponds. Paddy fields, in addition to the main products of rice, also produce bran and straw which can be used as animal feed. In this case, all waste, both livestock and plants, has added value and does not pollute the environment.

The RLIS in the agricultural system is a very important strategy to realize environmentally friendly farming, the welfare of farmers and rural communities. RLIS is one of the government's programs to realize food sovereignty which has become the right of all Indonesian people to obtain food that is healthy, sufficient,

and easily accessible for survival. The principle of RLIS is farming that applies the concept of zero waste by utilizing local resources, namely rice straw, bran, and livestock manure efficiently. The potential for agricultural by-product (by-product) in the form of straw is very abundant, but it has not been used as cattle feed for cattle. The nutritional value of straw can be increased through probiotic fermentation and almost matches the quality of elephant grass. The technology of processing livestock manure into compost is an alternative solution to environmental problems that can solve critical rice field problems. The integration of cattle and rice farming is an efficient and effective farming for improving the farming income of the people with narrow land ownership in rural areas.

3. Integration of goats with cocoa plants

The availability of agricultural land as the main capital for farming tends to decline from year to year. This is due to the rapid development of the population and changes in regional spatial patterns. As an impact, the production system changes. This will also have an impact on declining farming businesses.

Another problem that arises is the decrease in soil productivity. This is caused by soil erosion and nutrient leaching. The major impact that may occur is the increasing costs and dependence on external inputs (chemicals and energy). In addition, there is an increasing threat of agrochemical residues to food quality and safety due to the increasing activity of water pollution (fertilizers and pesticides).

The potential for the development of the estate sub-sector to support the development of modern livestock businesses as a source of feed is developed through various systems. The integration pattern of livestock and plantation products in the form of utilization of staple crop waste and intercropping waste is very interesting to be developed.

In the last 2 decades, the development of cocoa cultivation has developed rapidly. Plantation statistics show that in 1997, in Indonesia, the land area for plantations was 529,057 ha. However, in 2015 the land area had reached 1,722,315 with production reaching 760,429 tons. Indonesia ranks as the 3rd largest cocoa bean producing country after Pantai Gading and Ghana. These three countries have contributed more than 70% of the world's cocoa needs. In Indonesia, the cocoa plantation industry is spread across various provinces, such as South Sulawesi, Southeast Sulawesi, West Sulawesi and Central Sulawesi. Cocoa is one of the main plantation commodities in Indonesia, which ranks as the third largest source of non-oil and gas foreign exchange after rubber and palm oil commodities. Most of the cocoa farmers support their families from this commodity. However, there were significant problems. The productivity of the cocoa plant is still very low (650 kg/ha/year). Farmers sell their produce in the form of cocoa beans in the form of dry beans. In addition, farmers also cultivate cocoa only in monoculture form and do not make efforts to diversify products, so that farmers' income is very minimal. On the other hand, the production costs for cocoa cultivation are getting bigger, especially in meeting the needs for fertilizers and pesticides [43].

Livestock farming that has been widely developed by rural communities is goats. Indonesia is one of the countries with a tropical climate, has a climate type suitable for the development of goats, extensive land and forage production that is far from sufficient to raise 100 million goats or 10 times the current population of goats. On the other hand, domestic marketing of goats has reached a saturation point. The amount of supply of goat meat is greater than the amount of demand.

One of the problems faced by goat breeders is the availability of feed which is quite far from the location of the pen. So far, livestock feed has been obtained from

the forest edge. There is no planting of animal feed. Forage crops are allowed to grow wild without any maintenance. The livestock feed is further away from the village or location of the goat pen. As a result, 1 farmer is only able to raise 2–3 goats on average.

As an effort to develop the population of ruminants (goats), it is no longer possible to rely solely on grass or grazing sources. Land for growing feed is increasingly limited. On the other hand, the potential for alternative feed sources for ruminants (goats) is very large, especially fiber feed sources. The potential for fiber feed can come from the by-product of the agricultural and plantation industries. The use of agricultural/plantation byproducts as feed ingredients is a wise action to create food security based on local resources and help reduce environmental pollution [44].

Based on these problems, of course we need a system that can support mutually beneficial synergy. It is hoped that this pattern and system will provide benefits to both parties. One possible synergy pattern that can be done is the integration pattern between goat livestock and the cocoa plantation industry. Steps that must be taken in anticipating a sustainable farming system are diversification (multi-commodity) farming. One of them is implementing the integrated farming model of plants and livestock. This is one of the alternatives in carrying out business efficiency on a relatively fixed land area, but it can increase business productivity. This activity will provide added value from various business sectors that support each other. Integrated agriculture (crop-livestock integration) is an agricultural system characterized by a close relationship between plant and livestock components in a farm or within an area. One of the characteristics of this relationship is the existence of various resources such as forages, plant residues, and organic fertilizers produced by livestock in a production process. The most important thing that needs to be understood from the concept of crop-livestock integration is its ability to stop agricultural practices that destroy land resources and reduce agricultural productivity. The impact of these activities is that farmers can slowly escape poverty.

Due to the large population with a growth rate of around 1.5% and the increasing elasticity of demand for livestock production, of course, the need for ruminant livestock production (meat, milk and skin) will also increase. In recent years, the number of imports of live livestock and frozen meat along with milk and skins has increased to meet domestic demand. Therefore, the level of economic disparity between domestic demand and production capacity will increase. The domestic market will certainly be the target of producing countries. This can happen if there are no serious efforts to increase domestic production.

The potential for ruminant livestock development can be integrated with various types of plants, fish and forests. Therefore, if this potential can be utilized, the shortage of domestic supply can be met. The excess production can then be exported. Most of the breeders are rice field farmers, garden workers, cultivators and fishermen. Therefore, the combination of livestock business activities with other farming activities can increase business efficiency. The competitiveness of the products will also experience a very significant increase [45].

The system of integration of crops and livestock in the Sahel, Africa has been carried out in everyday life by farmers [46]. Farmers have considered climate risks, economic factors and livestock health. Although the integration pattern has its drawbacks, however, they can anticipate through various strategies based on livestock mobilization as well as regulation or diversification of activities.

In Indonesia, the cocoa plantation industry is dominated by smallholder plantations. Cocoa farmers usually use the waste of cocoa pod husks and forage from protective plants (*gamal* and *lamtoro*) as feed for goat farming. Cocoa pod husk waste is always available because cocoa pods on smallholder plantations can be

harvested almost all year round. Meanwhile, with the correct intervals and cutting methods, forage from *gamal* and *lamtoro* plants as cover crops in cocoa plantations is also a readily available feed ingredient. However, these activities have not been managed optimally and efficiently.

Goat farming with a cage system in the cocoa plantation area will produce solid material in the form of goat manure. This material comes from goat manure and can be used directly in plantation areas. This will spur an increase in production and productivity of cocoa plants in each hectare. In fact, this can certainly reduce the costs incurred by farmers to meet the needs of production facilities such as chemical fertilizers. In addition, goats that are grazed in the cocoa plantation area will utilize grass and weeds around the cocoa trees. This of course will greatly save the use of pesticide costs and the cost of maintaining the garden. Farmers do not need to look for food because the plantation area has grass and waste from cocoa plants such as cocoa shells. This waste can be used by goats as animal feed. Thus, the daily activities of farmers looking for grass can be diverted to other activities that are more useful. The model for implementing the integration of cocoa plants with goats is clearly presented in **Figure 2**.

Cocoa pod husk (CPH) has the potential as an alternative feed source for ruminants. The potential for CPH in Indonesia is quite large, both in terms of quantity and quality. The availability of CPH during the harvest season is very large and able to meet the needs of 635,305 livestock units per year. The husks as a source of fiber feed can replace grass. CPH contains crude protein 6.80–13.78%; neutral detergent fiber (NDF) 55.30–73.90% and acid detergent fiber (ADF) 38.31–58.98%. In addition, CPH also contains anti-nutritional compounds, including lignin, tannins and theobromine. In an effort to optimize the potential of CPH as feed, processing is needed to increase nutrient value and digestibility, reduce the content of anti-nutritional compounds so that the negative effects of antinutrient compounds can be minimized and extend shelf life. Through a system of integrating plants with livestock, environmentally friendly agriculture can be developed, agricultural systems can run sustainably, optimal use of resources, human health status will be improved and maintained, the environment will be protected and foodstuffs will be fulfilled. Goats get their feed from parts of the cocoa plant (pruned cocoa leaves,

Figure 2.
Utilization of cocoa waste as animal feed to support the integration of cocoa plants with goats. Source: https://dpkp.jogjaprov.go.id/baca/Pemanfaatan+Limbah+Kakao+Untuk+Pakan+Ternak+Mendukung+Integrasi+Kakao-Ternak/190221/e84ce4d623c0e94ef3b54c3d9ec9d7dd1313653ca54a3e8aef9b95204b6ce0e9280.

husks and leaves from pruned protective plants such as *Gliricidia* or Lamtoro. Based on their nutritional content, feed ingredients (*Gliricidia* or Lamtoro) are quality feed ingredients. Crude protein content of the CPH are around 10% while forages from Gamal and Lamtoro are more than 20% [47].

4. Integration of cattle with palm plants

The low productivity of cattle has forced the government to import, especially heifers. This of course raises concerns on the part of the government. Total imports of heifers reached 800,000 head and frozen meat equivalent to 781,117 head of cattle. The total national population of beef cattle in 2016 reached 15.4 million heads [48].

The beef cattle rearing system is generally still done conventionally. Sources of forage are obtained from grazing land. This feed is a mainstay of breeders as a source of forage, so that the productivity of cattle is low. The oil palm plantation industry is an industry that can be integrated with the livestock industry, especially related to beef cattle cultivation. In Indonesia, local beef cattle has a number of advantages. One of the advantages is the ability to consume high fiber feed such as forages and concentrates in large quantities [49]. An illustration of a model that integrates cattle with palm plantations was presented in **Figure 3**.

Types of feed with high fiber content are also available in the palm oil industry. Several by-products from the oil palm plantation industry can be used as cattle feed. The land area is directly proportional to the potential use of the oil palm plantation industry by-products. The wider land will increase the use of by-products from the plantation industry. in 1 ha of oil palm land will be able to accommodate 3–5 adult cows [50].

The amount of waste from the oil palm plantation industry in the form of fronds and leaves that can be obtained for every hectare of oil palm plantation reaches more than 2.3 tons of dry matter. This amount is obtained with the assumption that each oil palm tree can produce 22 fronds and fresh leaves/year. Weeds that grow in the form of grass around trees can also be used by cows as a source of forage [51] . In every hectare of industrial land for oil palm plantations, grass or weeds that grow around the plant can reach 3–5 tons/year. In the first 2 years of planting, legumes can reach 5–7 tons of dry matter/year. After that, the production will decrease 1–5 tons/year at the age of 2–5 years [52].

Figure 3.
A farming system model that integrates cattle with palm plants. Source: https://www.agrofarm.co.id/2019/10/19517/.

Several years ago, in several provinces in Indonesia, the government has initiated an integration concept between the livestock industry, especially cattle, and the oil palm plantation industry. This concept basically aims to increase meat production. In addition, to optimize natural resources in order to support one another. There are several efforts that can be made to optimize meat production including: 1) optimizing the use of critical land, 2) optimizing the use of alternative feed material sources and 3) integrating the livestock industry with the plantation industry, especially oil palm plants. Efforts to combine the two industries are then known as LEISA (Low External Input Sustainable Agriculture) [53]. This concept is a symbiotic mutualism between livestock and plantation crops which can provide benefits to both parties. The application of this concept includes: 1) utilizing waste from oil palm plantations in the form of solid waste, midrib and meal as a source of animal feed ingredients, 2) waste from livestock in the form of manure and waste from oil palm plants (non-feed) then formulated and processed into compost. The compost will later be used as organic fertilizer which can improve the physical, chemical and biological properties of the soil in the plantation area, and 3) weeds that grow wild among oil palm plants can be used by livestock (cows) as a source of feed so that it will improve the productivity of oil palm plants [54].

In the future, livestock business development activities are expected to be able to change the view of breeders from a production system to a livestock system with an optimally integrated agribusiness concept. The concept of agribusiness is a development concept in the livestock sector which is a system and consists of several sub-systems, namely; (1) upstream agribusiness sub-system, namely the entire economic activity that produces production facilities (breeding industry and feed industry); (2) on-farm agribusiness, namely all activities related to livestock cultivation; and (3) down-stream agribusiness, namely all economic activities related to the processing of primary livestock commodities into processed products (livestock processing and marketing industries); and (4) supporting system, namely all activities that provide services from the three agribusiness sub-systems [55].

According to [56], the application of an integrated business system between cattle and the oil palm plantation industry is expected to be part of a farming system that can be carried out in a sustainable manner. The pattern and system of integrating cattle with oil palm plantations are expected to reduce the problem of waste from cows (manure and urine) and waste from oil palm plantation business activities. Efforts to use land must be based on: (1) land as a source of animal feed; (2) all types of land are focused as a source of animal feed; (3) The use of land for livestock can be interpreted as an attempt to harmonize the land use with the agricultural business system. The potential for beef cattle development still needs to be improved through technological innovation and the implementation of the concept of integration of crop livestock with livestock (crop livestock system) through optimizing the use of agricultural waste for feed and the use of manure for organic fertilizer for agricultural crops.

5. Integration of ruminants with cassava plants

The livestock development program is one of the important aspects in the agricultural development program, so that the role of farmers and breeders will determine the success of this development. In an effort to meet these expectations, the main challenge facing the livestock sector today is how to produce livestock products that are highly competitive in terms of quality, quantity, variety and price. This can be done by optimizing the use of local feed so that domestic and global market needs can be met. In Indonesia, both the potential and available land for expansion

of agricultural areas are still quite large. However, this requires caution because the need for land use for agriculture and non-agriculture is currently increasing. The impact that occurs is of course the existence of competition in land use.

Based on data, Indonesia is the second largest cassava producing country with a production of 24 million tons after Nigeria country (52.4 million tons) [55]. In 2011, cassava production in Indonesia has reached 24 million tons, which is produced from a harvest area of around 1.2 million hectares of land with a productivity of 20 tons/ha [57]. This production results in cassava being the second largest production after rice (65 million tons) [58]. The development of cassava growth over the last 10 years shows that the area of cassava plants is relatively constant and even tends to decline in 2012 (−0.56%/year), however, the production has actually increased with a growth rate of 2.62% /year. This is due to improved productivity and shows an increase with an average growth rate of 3.97%/year [59].

The cassava plant (*Manihot esculenta*/*Manihot utilisima*) is a root tuber plant that has an elongated shape with a center line of about 2–3 cm and a length of 50–80 cm, depending on the type and variety. The plant consists of several parts, namely tubers, stems, roots, flowers and leaves. The tuber part of cassava can be used as an alternative feed material for livestock. The nutritional content of cassava tubers is more complete than grass and legumes which are often used as animal feed for rural communities. The integration pattern between ruminants (cattle, buffalo, goat and sheep) with cassava plants can benefit cassava farmers. In addition, there can be reciprocal relationships with breeders so as to minimize vacant land. Empty land can be planted with cassava plants which can also serve as land for grazing for livestock. However, it should be understood that the cassava plant also has several drawbacks. One of the disadvantages is the presence of toxic compounds in cassava plants in the form of cyanide acid (HCN). The presence of this compound causes its use in poultry to be limited. Cassava plants contain two types of cyanogenic glycosides, namely a type of secondary metabolite in plants in the form of derivatives amino acids which are toxic. The types of cyanogenic glycosides in question are linamarin and small amounts of lotaustralin (methyl linamarin). Linamarin is rapidly hydrolyzed to glucose and acetone cyanohydrin while lotaustralin is hydrolyzed to cyanohydrin and glucose. Under neutral conditions, acetone cyanohydrin is decomposed to acetone and hydrogen cyanide. This cyanide acid causes the availability of the amino acid methionine in cassava to be low [60]. The content of cyanide acid compounds can be removed through a heating process. In addition, cassava plants, especially their leaves, are voluminous so they are not efficient in terms of transportation. Cassava is a wasteful plant in taking nutrients, so that many farmers are not interested in planting it.

The optimal use of cassava plants as ruminant feed can be done. One of them is by implementing an integration model of cassava plants with ruminant livestock cultivation (cattle, buffalo, goats and sheep). This model uses the principle that the livestock will come to the feed source. Some steps that can be taken include: (1) Livestock are raised around the cassava plantation. Efforts to use cassava plants in developing ruminant farms around or near the cassava planting area are carried out in the form of providing feed. This step is one way to take advantage of cassava plants, especially the leaves and tubers that have been rejected. The application of this system is carried out by raising livestock near cassava gardens which are then given by products from cassava plants such as leaves, rejected tubers and skin from the tubers. This system is quite beneficial because during the cultivation process of cassava plants, the manure produced by ruminants can then be used as organic fertilizer so that the fertility of the cassava plant land is maintained. For example, with the production of cassava leaves of 1.2 tons/ha, it is predicted to be able to meet the needs of 2 cows or buffaloes during the fattening period or the equivalent

of 14 small ruminants (goats/sheep). The tuber part can be processed into tapioca products or chips. The waste products from cassava processing (skin and tuber) can be used as a mixture of animal feed ingredients. (2) Livestock are placed around the tapioca/chips factory area.

Every day, approximately tens of tons of cassava are produced into tapioca or chips. Furthermore, the waste generated from the production process in the form of skin and tuber can be used as a mixture of animal feed ingredients. Companies can use the land around the tapioca factory for the development of a livestock business. The company will have a very big opportunity to increase livestock production so that the meat needs of the Indonesian people can be met. The application of an integrated farm system through a combination of ruminant and non-ruminant livestock cultivation is thought to be more effective in optimizing the use of cassava plants. In order for this goal to be fulfilled, efforts that can be made are to raise livestock around the plantation. Through this integrated farm system, non-ruminant livestock (poultry, pig and horse) can be prioritized to utilize dried cassava and its leaves as a source of energy and protein. Meanwhile, the bark, leaves and cassava that have been rejected are used as a source of feed for ruminants (cattle, buffalo, goats and sheep). The system of integration of livestock in the main cassava plantation business has great opportunities and hopes because there are quite a lot of farmers and breeders engaged in this field.

Based on the results of economic analysis, the profit of a cassava farmer who owns land with an area of 1 ha is IDR 2,800,000 (assuming costs for planting a monoculture pattern for one growing season of 8 months). This means, the farmer only gets a profit of IDR 350,000 per month. This profit can be said to be inappropriate if used as the main business of a farmer. The value of profits obtained by a farmer will certainly increase if his business is integrated with livestock business (ruminants and/or non-ruminants). Competition in land use in the future as a consequence of efforts to maintain national food security and bioenergy development (bio-fuel) needs to be addressed immediately. Increasing productivity (intensification), especially on existing land, expanding the land area, and developing superior technological innovations are things that need to be done. Therefore, the use of vacant land for the development of an integrated system of plantations, agriculture and livestock is an appropriate and efficient innovation to do. This is an effort to find solutions to food security problems in Indonesia. This integration can increase food production in order to achieve the target food needs of the Indonesian people and increase the welfare of the community.

There is no doubt regarding the benefits of integrating cassava plants with livestock, for both farmers and breeders. The integration of plantation, agriculture and livestock crops is the best strategy in overcoming scarcity of resources in food production so that food can be fulfilled. With this integration, all agricultural activities can be economically profitable and ecologically sustainable. With the integrated pattern of plantations, agriculture and livestock, consumer demands for environmental sustainability, health and food safety, and the welfare of workers can be answered.

6. Integration of cattle with horticultural plants

Horticultural plants are one type of plant that is needed by humans to meet the needs of vitamins and minerals. Horticultural plants in the form of green vegetables have benefits as a source of vitamins and minerals that are important for fulfilling community nutrition. Increasing population, income and education will certainly affect public awareness of the importance of nutritional and health values.

Various efforts have been made by farmers so that horticultural crops can provide maximum results. Efforts that have been implemented include: (1) the use of superior variety seeds; (2) regular pest and disease control; (3) proper arrangement of spacing patterns; (4) timeliness and harvest time and (5) proper use of fertilizers. The application of fertilizers to horticultural crops needs attention, especially related to the type, dose, method and raw material (organic or inorganic). Continuous application of inorganic fertilizers can cause negative impacts on the environment. The impact that can arise is that the soil becomes solid due to the gluing effect, especially the type of ammonium fertilizer. The process of washing inorganic fertilizers in the soil can also have an effect on health when used as a source of drinking water. As an alternative, the use of organic fertilizers on land needs to be increased in availability for the balance of soil nutrients. Both types of fertilizers still need the right combination, because the availability of nutrients in organic fertilizers is not as complete as the nutrients in inorganic fertilizers [61]. Cow manure can reduce the cost of procuring fertilizers which at the same time can reduce production costs in addition to preserving soil organic matter, especially in sloped plantation areas [62].

The cultivation and development of cattle raised together with horticultural crops does not require new land resources. Horticultural crop waste can be used as animal feed that has been harvested so that the need for animal feed is always available every day. Farmers can make optimal use of vacant land to increase economic benefits. The input resources for livestock that are quite abundant, such as forage between plants (grass and legumes), can be directly used as a source of animal feed without disturbing the productivity of horticultural crops. Meanwhile, the potential for horticultural crop waste with simple technology can be used as a mixture of forage for cattle. The embankment area on horticultural plantations is still empty so it is still possible to use it as a superior grass cultivation area. One of the models applied in the implementation of the integration system between cattle and horticultural crops is the process of making fermented feed. The complete application of the model was presented in **Figure 4**.

With an integrated agricultural system, farmers will be more prosperous because there has been an increase in income. If the price of vegetables falls, the farmers still have other income, namely livestock. Cows can produce calves and fertilizer every year. Farmers who own cows use cow dung as raw material for biogas

Figure 4.
Utilization of vegetable waste as animal feed as a model for integrating cattle with horticultural crops. Source:: https://www.google.com/search?q=pemanfaatan+limbah+pasar+sebagai+pakan+sapi&tbm=isch&ved=2ahUKEwjp0oj_rv3vAhWMUH0KHQoIAqQQ2-cCegQIABAA&oq=pemanfaatan+limbah+pasar+sebagai+pakan+sapi&gs_lcp=CgNpbWcQA1DI6AdY4P8HYKmJCGgAcAB4AIABkQGIAawKkgEDNC44mAEAoAEBqgELZ3dzLXdpei1pbWfAAQE&sclient=img&ei=e652YKmpF4yh9QOKkIigCg&bih=634&biw=1087&safe=strict&hl=id#imgrc=7qM2SDvdCt306M.

Description	Treatment	
	T_1	T_2
Initial Weight (IW) (kg)	269	270.42^{ns}
Final Weight (FW) (kg)	318.33	333.50*
Average Daily Gain (ADG) (kg/day)	0.43	0.55*
Consumption of Dry Matter (DM) (kg/day)	4.81	4.18^{ns}
Feed Cost Ratio (FCR)	11.19	7.69*

Note: T_1 = 100% of grass + rice bran (1 kg/head/day); T_2 = 50% of grass + 50% of vegetable waste + rice bran (1 kg/head/day).
*Different superscripts on the same line indicate a marked difference.
ns=no significant

Table 2.
Comparison of cattle productivity without the application of an integrated system (T_1) with the application of an integrated system with horticultural crops (vegetable waste) (T_2) at Antapan village, Baturiti district, Tabanan regency, Bali Province, Indonesia.

so they don't need to buy gas for cooking. An overview of the comparison of the productivity of cattle raised without the application of an integrated system with cattle raised using an integrated system with horticultural crops (vegetable waste) was presented in **Table 2**.

Based on the data in **Table 2**, it can be seen that the comparison of cattle groups that do not use an integrated system (T_1) has a lower average daily body weight (0.43 kg /day) than cattle raised in an integrated manner with horticultural crops (T_2) (0.55 kg/day). In addition, T2 treatment also has a lower FCR value (7.69) than T_1 (11.19). This shows that the T_2 treatment group is more efficient in utilizing feed to produce meat than T_1.

7. Conclusions

The integration model between plants and livestock or better known as integrated agriculture. This model combines the activities of the livestock industry with the agricultural industry. This model is often called a waste-free farming pattern because livestock waste is used as fertilizer for crops and agricultural waste is used as animal feed. The interaction between livestock and plants must be complementary, supportive and mutually beneficial so as to encourage an increase in the efficiency of profits from their farming.

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Conflict of interest

The author hereby states that there is no conflict of interest between the author and other parties in the preparation of this article.

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References

[1] BPS. Statistical Yearbook of Indonesia 2020. BPS-Statistics Indonesia: Jakarta; 2020. ISSN 0126-2912

[2] Ministry of Agriculture. Agricultural Statistics. Ministry of Agriculture, Jakarta. [Internet]. 2020. Avalaible from: https://www.pertanian.go.id/ [Accessed: 2020-11-22]

[3] Anonymous. The need for beef is increasing. The Ministry of Agriculture will import. [Internet]. 2021. Avalaible from: https://www.republika.co.id/berita/qn9s7s423/kebutuhan-daging-sapi-meningkat-kementan-akan-impor [Accessed: 2021-04-15]

[4] Shadily, H. Indonesian Encyclopedia. Ichtiar Baru-Van Hoeve and Elsevier Publishing Projects: Jakarta; 1984. 2503 p

[5] FAO. Largest Rice Producer. [Internet]. 2011. Avalaible from: http://www.fao.org/faostat/en/#data; [Accessed: 2020-11-24]

[6] Balitbangtan. Superior Rice Varieties for the People Support Sustainable Rice Self-Sufficiency. Agricultural Research and Development Agency. Ministry of Agriculture: Jakarta; 68 p.

[7] Ministry of Agriculture. Roadmap to Increase National Rice Production (P2BN) towards a Rice Surplus of 10 Million Tons. Ministry of Agriculture: Jakarta; 2011. 40 p.

[8] Kusnadi U. Livestock technology innovation in the rice-livestock integration system to support beef self-sufficiency. Agricultural Innovation Development. 2008; 1(3): 189-205.

[9] Anonymous. The Predicted Demand for Beef in 2014 is 593,040 tons. [Internet]. 2013. Avalaible from: https://investor.id/agribusiness/ [Accessed 2020-11-24].

[10] Livestock Review. Meat Self-Sufficiency 2014: Hope or Dream. [Internet]. 2013. Avalaible from: http://livestockreview.com/swasembada-daging-2014-harapan-atau-mimpi-bag-i/ [Accessed: 2020-11-24]

[11] Livestock Review. If the Import Quota for Feeder Cattle is Reduced, The Breeders Will Benefit. [Internet]. 2013. Avalaible from: http://livestockreview.com/page/29/ [Accessed: 2020-11-24]

[12] Fagi AM, Ismail IG and Kartaatmadja S. Preliminary Evaluation of Crop-Livestock Farming Institutions In Several Districts in Central and East Java. In Fagi, A.M., and Hermanto (eds.). Plant-Animal Farming System. Agricultural Research and Development Agency. Ministry of Agriculture: Jakarta; 2004.

[13] Syam A, Sariubang M. Effect of organic fertilizers (cow dung compost) on rice productivity in irrigated land. In: Proceedings of the National Seminar on Plant-Animal Integration System. Livestock Research and Development Center and Casren; 20-24 July 2004: Denpasar, Bali; 93-103p.

[14] Sutardi, Musofie A, Soeharsono. Optimization of paddy production by utilizing organic fertilizers and integrated rice-livestock farming systems in lowland agro-ecosystems. In: Proceedings of the National Seminar on Plant-Animal Integration System. Livestock Research and Development Center and Casren; 20-24 July 2004: Denpasar, Bali; 1224-233 p.

[15] Haryanto B. The integrated system for livestock rice and cattle (SIPT) in the P3T program. In: Proceedings of the National Rice Week Seminar. Indonesian Rice Research Institute. 15-19 July 2004: Sukamandi.

[16] Nurawan A, Hadiana H, Sugandi D, Bachren S. The crop-livestock integration

farming system in Ciamis Regency, West Java. In: Proceedings of the National Seminar on Plant-Animal Integration System. Livestock Research and Development Center and Casren; 20-24 July 2004: Denpasar, Bali; 2004; p.133-141.

[17] Basuni R, Muladno, Kusmana C, Suryahadi. Beef cattle rice integration system in paddy fields. Food Crops Science and Technology Bulletin. 2010; 5(1): 31-48.

[18] Kariyasa, K. The crop-livestock integration system in the perspective of reorienting the fertilizer subsidy policy and increasing farmers' income. Analysis of Agricultural Policy. 2005; 3(1): 68-80.

[19] Swastika DKS. Building food independence and sovereignty to alleviate farmers from poverty. Agricultural Innovation Development. 2011; 4(2): 103-117.

[20] Sudirja R. Realizing food sovereignty through the policy of agri-food land management. In: Proceedings of Regional Seminar on Work Deliberation of the Executive Board of the Region II Indonesian Soil Science Student Association. Faculty of Agriculture, University of Padjajaran; Bandung; 2008. 8 p.

[21] Jenifer del RM. Module on Food Sovereignty. Malaysia: Pesticide Action Network Asia and the Pacific Press; 2007. 30 p.

[22] Arifin B. Building Food Independence and Sovereignty. Indonesian Science Congress: Jakarta; 2011. 24 p.

[23] Ika S. Food Sovereignty and Food Security: The state is obliged to make it happen: Fiscal Education Rubric; 2014. 12 p.

[24] Haryanto B, B. Harsana B, Ismet I. Integrated livestock rice system (SIPT). Technical Guidance. Balitnak: Bogor; 2003.

[25] Khairiah, Handoko DD. Fertilizer problems and the role of organic matter in the rice-cattle integration system in Perbaungan Sub-District, Serdang Bedagai Regency, North Sumatra. In : Proceedings of National Rice 2008. Center for Rice Research; Jakarta: 2009; p.1069-1076.

[26] Siswanto M, Patmawati NW, Trinayani NN, Wandia IN, Puja IK. Journal of Animal Science and Health. 2013; 1(1): 11-15.

[27] Basuni R, Muladno, Kusmana C, Suryahadi. Rice-beef cattle integration system model in paddy fields. Postgraduate Forum. 2010; 33(3): 177-190.

[28] Mariyono, Romjali E. Cheap Feed Innovation Technology For Beef Cattle Breeding Business. Center for Livestock Research and Development: Bogor; 2007.

[29] Prihartini I, Soebarinoto S, Chuzaemi, Winugroho M. Characteristics and degradation of fermented rice straw by lignolytic inoculum TLiD and BOpR. Journal of Animal Production. 2009; 11(1): 1-7.

[30] Sariubang M. The integrated farming system of Balinese cattle breeding with rice plants in paddy fields. Journal of Agrisistem. 2010; 6(1): 36-41.

[31] Abdulrachman S, Mejaya MJ, Sasmita P, Guswara A. Composting of Straw. Agricultural Research and Development Agency. Ministry of Agriculture: Jakarta; 2013.

[32] Haryanto B. Development of ruminant nutrition research. Wartazoa. 2012; 22(4):169-177.

[33] Yunilas. Rice Straw Biotechnology through Fermentation as a Feed

Ingredient for Ruminants. Scientific Work. Department of Animal Husbandry. Faculty of Agriculture. University of Northern Sumatra: Medan; 2009. 13 p.

[34] Ibrahim TM, Batubara LP, Simon P, Ginting, Doloksaribu M. Techniques for preserving and improving the quality of rice and corn straw using Starbio, Silage and Ammonia. Eds. Rusastra I.W. In: Proceedings of Site-Specific Technologies Towards Decentralization of Agricultural Development. Center for Agricultural Socio-Economic Research. Agricultural Research and Development Agency: Jakarta; 2000; p.397-401.

[35] Syamsu JA. Study on the Use of Microbial Starter in Rice Straw Fermentation as a Source of Feed on Smallholder Farms in Southeast Sulawesi. National Seminar on Biotechnology. Center for Biotechnology LIPI: Bogor; 2006.

[36] Suyasa IN, Guntoro S, Parwati, Suprapto, and Soethama IKW. The use of probiotics in the development of agribusiness-oriented beef cattle in Bali. Journal of the Assessment and Development of Agricultural Technology. Bogor Agricultural Socio-Economic Research Center: Bogor; 2004. 2(1).

[37] Tangendjaja B. The use of bran to make simple rations for laying ducks. In: Proceedings of the National Seminar on Livestock and the Second Poultry and Various Livestock Breeder Forum in Bogor. Ciawi Animal Research Institute; Bogor; 1988. 317-322 p.

[38] Udiyono. Possible use of rice bran as an ingredient for enzymes. In: Proceedings of Symposium on Bioprocess in Food Industry. 12-14 January 1987; Yogyakarta: 326-334 p.

[39] Bolsen KK, Ashbell G, Weinberg ZG. Silage fermentation and silage additives (Rev.). Asian-Australian J. of Anim. Sci. 1996; 9(5): 483-493.

[40] Salfina. Assessment of the provision of bran and probiotic bioplas to pregnant female DAS Katingan watershed local cows in Tumbang Liting Village, Katingan Hilir District, Central Kalimantan. Ziraa'ah. 2012; 33(1): 52-60.

[41] Muslim C, Nurasa T. Policy on beef cattle development in food crop-based production centers in Indonesia. Center for Socio-Economic Analysis and Agricultural Policy. Agricultural Research and Development Agency. Ministry of Agriculture: Jakarta; 2006. 13p.

[42] Muslim C. The Role of Beef Cattle Farmer Groups using the Rice-Livestock Integration System (RLIS) Approach in West Nusa Tenggara, East Java and West Java. Center for Socio-Economic Analysis and Agricultural Policy. Agricultural Research and Development Agency. Ministry of Agriculture: Jakarta; 2006. 17 p.

[43] Yuliani D. Animal rice integration system to achieve food sovereignty. J. Agrotechnology. 2014; 4(2): 15-26.

[44] Harli Integration system of goat-crops for resilient cocoa production. Agrovital. J. Agricultural Science. 2017; 2(1): 1-7.

[45] Wisri P, Susana IWR. The Potential and Utilization of Cocoa Fruit Skins as Alternative Feed for Ruminants. Wartazoa. 2014; 24(3): 151-159.

[46] Makka D. Prospects for the Development of a Competitive Livestock Integration System. Proceedings. National Seminar on Plant-Livestock Integration System. Center for Livestock Research and Development Collaborates with BPTP Bali and Casren: Denpasar; 2004. 18-31 p.

[47] Ickowicz A. Crop–Livestock Production Systems in the Sahel–Increasing Resilience for Adaptation to Climate Change and Preserving Food Security. Proceedings of a Joint FAO / OECD Workshop 23-24 April 2012.

[48] Director General of Livestock and Animal Health. Beef Cattle Population and National Meat Consumption in Indonesia. Director General of Livestock and Animal Health. Ministry of Agriculture: Jakarta; 2017.

[49] Umar S. Potential of Oil Palm Plantation as Center for Beef Cattle Development in Revitalizing and Accelerating Sustainable Livestock Development. Inauguration Speech for the Permanent Professor of Animal Reproduction at the Faculty of Agriculture. University of North Sumatra : Medan; 2009.

[50] Mathius IW, Sinurat AP, Tresnawati DP, Manurung BP. A study of Ready-to-Eat Feed Based on Oil Palm Industry By-Products for Pregnant Cows. [Internet]. 2007. Avalaible from: https://docplayer.info/33652661-Suatu-kajian-pakan-siap-saji-berbasis-produk-samping-industri-kelapa-sawit-untuk-sapi-bunting.html. [Accessed: 2020-11-24]

[51] Directorate of Animal Feed. General Guidelines for Animal Integration Development. Director General of Livestock and Animal Health. Ministry of Agriculture: Jakarta; 2011.

[52] Aritonang D. Oil palm plantations. Source of animal feed in Indonesia. J. Agricultural Research and Development Agency. 1986; 4: 93.

[53] Diwyanto K, Sitompul D, Manti I, Mathius I-W, Soentoro. Assessment of Business Development System Integration of Oil Palm-Cattle. In: Proceedings of the National Workshop on Oil Palm-Cattle Integration System. Ministry of Agriculture In cooperation with the Provincial Government of Bengkulu and PT. Agricinal: Jakarta; 2004.

[54] Setiawan BD, Arfa'i, Nur YS. Evaluation of the integrated Bali cattle breeding business management system with oil palm plantations in West Pasaman Regency, West Sumatra Province. Integrated Livestock Scientific Journal. 2019; 7(3): 276-286. DOI: http://dx.doi.org/10.23960/jipt.v7i3.p276-286

[55] Saragih B. Livestock Based Agribusiness. 2nd .Ed. USESE Foundation and Center for Development. Bogor Agricultural Institute: Bogor; 2000.

[56] Arfa'i. Potentials and Strategies for Developing Beef Cattle Business In Lima Puluh Kota Regency, West Sumatra. Dissertation. Postgraduate Program. Bogor Agricultural University: Bogor; 2009.

[57] FAO. World Agriculture. [Internet]. 2011. Avalaible from: http://www.world-agriculture.net/ [Accessed: 2020-11-24].

[58] BPS. Statistical Yearbook of Indonesia 2012. BPS-Statistics Indonesia: Jakarta; 2012.

[59] Radjit BS, Widodo Y, Saleh N, Prasetiaswati N. Technology to increase productivity and profits of cassava farming in ultisol dry land. Food Crop Science and Technology. 2014; 9(1): 51-62.

[60] Ramli N, Rismawati. Integration of cassava plants and poultry. Feed Commission Meeting Paper. 13-15 June 2007; Surabaya; 2007.

[61] Siswati L, Nizar R. Integrated agricultural model of horticulture and cows to increase farmers' income.

Indonesian Livestock Journal. 2012; 14(2): 379-384.

[62] Hutabarat TSPN. Regional Approach in Livestock Development. Directorate General of Livestock Production, Ministry of Agriculture: Jakarta; 2002. p.1-13.

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