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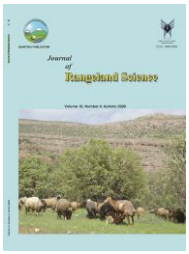

Short Communication:

Evaluation and Development of Crop and Cattle Integration Model in the Rural Area of Sekotong Sub-district, West Lombok District, Indonesia

Suhartini Suhartini[A]*, Herly Evanuarini[B], Reza Safitri[C], Aldyon Restu Azkarahman[B]
[A]Faculty of Agriculture, University of Brawijaya, Malang, Indonesia*(Corresponding author), Email: suhartini.fp@ub.ac.id
[B]Faculty of Animal Science, University of Brawijaya, Malang, Indonesia
[C]Faculty of Social and Politics Sciences, University of Brawijaya, Malang, Indonesia

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Abstract. The Artisanal and Small-scale Gold Mining (ASGM) activities have become the main source of income for the local people in Sekotong sub-district since 2008. However, the decreasing gold production enforces them to leave the ASGM activities and work back to the agricultural sector. The study aims to evaluate and develop a crop and beef cattle integration model in Sekotong sub-district, West Lombok district, Indonesia. The area was chosen purposively considering that Sekotong sub-district is the rural area of the district and had decreasing ASGM activities. The study was conducted with field research method consisted of case study, survey, in-depth interview and field observation to collect the data. In addition, the soil characteristics of Sekotong sub-district were also analyzed to determine the suitable crop in the proposed integrated system. The demographic, cattle population, crops availability, and farmer characteristics data were collected and potential crop and livestock integration model is proposed. The result showed that an integrated cattle and corn farming system under farmers group is recommended in order to increase cattle production and better farming management. In addition, other supporting farming practices which positively contribute to the system should be implemented in the model. The study concludes that an integrated cattle and corn farming model under guided farmer groups is recommended to support the farming practice by the local people who transitioned back from unsustainable ASGM into agricultural sector.

Key words: Artisanal Small-scale Gold Mining (ASGM), Integrated Farming System, Livestock

Introduction

The artisanal small-scale gold mining (ASGM) activities at Sekotong had improved the income of farmers/miners and created job opportunities. Sekotong and Lembar sub-district has been known as the centre for beef production in West Lombok district. At its peak activities in 2012, the ASGM in Sekotong, West Lombok contribute 76.01% of the farmers'/miner's income, while the agriculture contributes 23.99% of total income (Suhartini *et al*., 2017). The ASGM miners are mostly local people, the others were migrants who came to the sub-district to work. The ASGM local miners were previously farmers, and learned to work as ASGM miners from migrants who came from Tasikmalaya, West Java province. The ASGM activities in Sekotong still exist until today, but the number has been greatly decreasing, which is valued only about 10% compared to its peak production in 2012. The declining gold production and income, as well as the unsustainability of ASGM, thus enforce local people to seek for alternative sources of income such as by going to work in agricultural sector.

The agricultural background of the local people who go back to work as a farmer due to the declining gold production has provided them with the basic skills capital. However, due to the dry climate in Sekotong sub-district and increased lifestyle during their work as miner, a certain farming model is required to guide them during the transition. One of the approaches is to introduce an integrated crop and cattle farming system. The integrated farming would provide a decent and more sustainable income to them as well as to tackle the risks originated from the environmental factors by providing diverse farming products and land optimization (Esteves *et al*., 2018).

The West Lombok district, especially in Sekotong and Lembar sub-district, has been known as the centre for beef production in West Nusa Tenggara province. Moreover, almost 25% of cattle in West Lombok district are reared in Sekotong sub-district, which amounted for 38,941 cattle in 2015. However, our initial observation showed that the cattle farming in Sekotong sub-district was still practiced in a traditional system, where the cattle were grazed in a dryland without proper feeding management and technological inputs to support the production. According to Pamungkas and Hartati (2004), the integrated farming system could improve the traditional farming practice and provide higher productivity and income for the farmer. In the integrated farming system, the land usage is optimized, the production is minimized, and soil fertility is maintained through organic waste management from the livestock. Research by Bustami*et al*. (2006), showed that the introduction of integrated cattle and corn farming system provide better production with organic fertilizer and biogas production as the added value. In this study, we evaluate the possible integrated crop and cattle farming system to be applied in Sekotong sub-district by assessing the available data. The result is expected to help local farmer as well as the local government in conducting suitable integrated farming program.

Materials and Methods

Study area

The research was conducted in Sekotong sub-district, West Lombok District, Nusa Tenggara Barat Province, Indonesia (115º46'to 116º20' E and 8º 25' to 8º 55' S) comprises of 330.45 Km^2land area. The location was selected purposively based on the area was an ASGM location which most of the miners need alternative livelihood due to they have left the ASGM activities. The agricuture and livestock activities are the main sector in Sekotong as an alternative to

the unstainable ASGM gold mining sector. The Sekotong sub-district covered nine villages, which are West Sekotong, Pelangan, Central Sekotong, Buwun Mas, Kedaro, BatuPutih, CendiManik, Gili Gede Indah, and Tamansari village (Fig. 1).

Fig. 1. The map of Sekotong sub-district marked with a blue circle (Portal Informasi Indonesia 2017, with modification)

Methods

The study was conducted through field research by collecting the demographic, cattle population, crops availability, and farmer characteristics data through case study, survey, field observation and in-depth interview with 50 respondents consisted of Department of Agriculture and Livestock officers and head of farmer groups in Sekotong sub-district. Moreover, the soil characteristics from different villages in Sekotong sub-district were also analyzed in the Laboratory of Soil, Faculty of Agriculture, University of Mataram to help determine the suitable crop for the integrated farming system. The soil pH was measured by using pH meter by following Motsara and Roy (2008), the soil organic carbon (Organic-C) was measured by using colorimetric method with the help of spectrophotometer (Datta *et al*., 1962), the total nitrogen (N-Total) in soil was measured with Kjeldahl (Motsara and Roy,2008), available potassium (K) in soil was measured with the help of flame photometer (Toth and Prince, 1949), and exchangeable calcium (Ca) and magnesium (Mg) in soil were measured with EDTA titration method (Cheng and Bray, 1951). The obtained data was then analyzed descriptively to conduct and propose the suitable integrated farming system.

Results

Sekotong sub-district is one of the rural sub-districts in West Lombok District. The sub-district covered 330.45 Km^2 land which mostly dominated with dryland. The map of Sekotong sub-district is presented in Fig. 1, while overview of the Sekotong sub-district is presented in Fig. 2. The farmers' characteristics in this study were collected through in-depth interview, and the results are as follow: (1) Paddy rice and corn were the most favorable crops by the farmer; (2) farmers had 0.7-2 ha land for crop farming, and reared 3-4 cattle as their secondary source of income (smallholders); (3) most of the farmers were previously worked as gold miner; and (4) lack of farming management knowledge and technology input.

Fig. 2. Overview of the Sekotong sub-district

Assessment from Statistics Indonesia (2016) showed that the crops produced in West Lombok district consisted of corn, cassava, peanut, soybean, and paddy rice with paddy rice that occupied the most land area (35,000 ha) and followed with maize (5,043 ha). In livestock farming, beef cattle were the most reared animal by the local people, followed by goat, and small amount of poultry. Moreover, the amount of reared cattle in Sekotong sub-district showed a continuous increase from 2013 to 2017 (Table 1).

Table 1. Beef cattle population in Sekotongsub-district in 2013 - 2017

Year	Total cattle (heads)	Growth (%)
2013	21,802	-
2014	22,272	2.11
2015	23,721	6.11
2016	24,415	2.84
2017	27,040	9.71

Source: Department of Livestock and Animal Health West Lombok district (2017)

Moreover, we also observe the feed diets of the cattle reared in the Sekotong sub-district. The result showed that season plays a major role in determining the cattle diet, as the cattle were reared extensively and their diets would be solely determined by the available forage in the grazing area. Indonesia has only two seasons, that are dry season and rainy season. The cattle diet composition in Sekotong sub-district during both seasons is presented in Table 2.

Table 2. Feed diets of reared cattle in Sekotong sub-district

Feed	Raining season	Dry season
Signal grass (%)	20	8
Elephant grass (%)	33	18
Fresh corn straw (%)	10	10
Dry corn straw (%)	0	12
Fresh paddy straw (%)	20	0
Dry paddy straw (%)	17	40
Husk (%)	0	12
Total (%)	100	100

In this study, we have also collected the climate characteristics as well as analyze the soil characteristics from 10 different areas across Sekotong sub-district to provide data for suitable crop determination. The climate and soil characteristics in Sekotong sub-district is presented in Table 3. The annual rainfall data showed that there was 2014 mm rainfall in 2018, with a long dry season. The local people in Sekotong sub-district used a rain catcher system called *Embung* which is a form of moderate individual water reservoir made from brick placed in several spots across the district. The collected water is then used for daily usage as well as farm irrigation, noting that soil water is rarely found and some areas in the district is located near the coast thus the water would have high salinity.

Table 3. Climate and soil characteristics in Sekotong sub-district

Variables	Score
Climate characteristics	
Annual temperature	27 – 29^{o}C
Annual rainfall	2014 mm
Soil characteristics	
pH	7.1
Potassium (K)	0.49%
Calcium (Ca)	0.54%
Magnesium (Mg)	4.25%
C-Organic	0.75%
N-Total	0.04%
C/N Ratio	18.75

Discussion

Based on the demographic assessment in this study, an integrated crop and livestock farming system is recommended to optimize the current agricultural practices by the farmer, preferably positively affect each practice in a sustainable farming system, as well as people-centered, participatory, and empowering (Mardikanto, 2010). The data showed that cattle population reared in Sekotong sub-district showed an increase, however the dry environment in Sekotong

sub-district was the major problem faced by the farmers. An effort to adapt to the dry condition, local people were mainly depended on the traditional rain catcher system called *Embung*. The traditional rain catcher system is labour intensive, and affect their livestock rearing practice as well. The livestock farming is then regarded as secondary source income and the labour mainly went into crop farming. This resultin the commonly found extensive livestock farming by letting the cattle graze in the dryland without proper feeding and rearing management.The condition proposed for a technological approach to whether to improve its nutritional value or prolonging the storability so the livestock farmers could have had sustainable production throughout the seasons. Research by Liu *et al*. (2015) proposed a solution through straw fermentation to support livestock feeding availability in the dry area.

Most of the area in Sekotong sub-district is a marginalized dryland (Fig.2) without any efforts to improve soil quality by the local people. The application of organic fertilizer from cattle faeces offers an alternative way to improve the soil quality. However, the poor efforts and lack of technological knowledge and application inhibit the integrated farming approach. The most common cattle farming problems found in this research were poor feeding, breeding and rearing management. The poor feeding management resulted in poor cattle production performance, while the poor breeding management resulted in high calf mortality, uncontrolled genetic pools, and failed pregnancies.In this study, we found that in average beef cattle produced 4-5 kg of faeces, and with the total of 27,040 cattle(Department of Livestock and Animal Health West Lombok district, 2017)we calculate that 108-135 tons of cattle faeces were produced daily. The massive amount of the produced cattle faeces showed the potential to be utilized whether through biogas technology (Hasnudi, 1991) or organic fertilizer (Bamualim*et al*., 2004) which aside from increase the farming profit, could also improve the soil fertility as well.

On average, cattle farmers in Sekotong sub-district were smallholders (owned 3 to 4 cattle each) with mostly were Bali cattle breed. The small cattle population is then expected to cause difficulties in technology adoption and cattle farming improvement. In order to solve the problem, we propose to initiate a guided farmer group with intensive farming system. Research by Lisson*et al*. (2010), showed that the application of integrated Bali cattle and crop farming system under farming group management resulted in positive production, socio-economic, and technology adoption in Eastern Indonesia. However, the interview in this study showed that previous cattle farmer groups scheme in Sekotong sub-district showed unsatisfying result due to lack of knowledge by the farmers. An expert-guided farmer group system is then proposed to control the rearing management and continuous cattle farming improvement.

In order to determine the suitable crop in the integrated cattle and crop farming system, we observe the data of commonly planted crops in Sekotong sub-district. The data (Statistics Indonesia, 2016) showed that paddy rice and corn are the most planted and preferred crops in Sekotong sub-district. The result is mainly due to both crops are the main consumed food in the area. Both crops are then assessed for the integrated crop and cattle farming system. The integration between both crops and cattle farming has been widely observed and applied. Research by Kato *et al*. (2009), showed that paddy rice required higher water efficiency, compared to corn (Howell *et al*., 1997). In addition, research by Deng *et al*. (2020), showed that corn had higher N usage efficiency increase (48%) compared to the paddy rice (16%) when cattle manure was applied as the fertilizer. By taking into

accounts of the dry climate of Sekotong sub-district as well as the N usage efficiency, we thus proposed the integrated corn and cattle farming system. The effort to integrate crop and livestock farming aims to suppress the farming cost and give added value to the produced waste simultaneously. The produced waste in corn farming could be utilized as cattle feed by applying fermentation technology so that it would have better nutritional and storability value. On the other hand, composting the Bali cattle feces into organic fertilizer will suppress the cost of corn farming while also improve soil qualities. After assessing the demographic, farmers' characteristics, cattle population, crop availability, as well as climate and soil characteristics in Sekotong sub-district, we propose an integrated farming models is presented Figure 3.

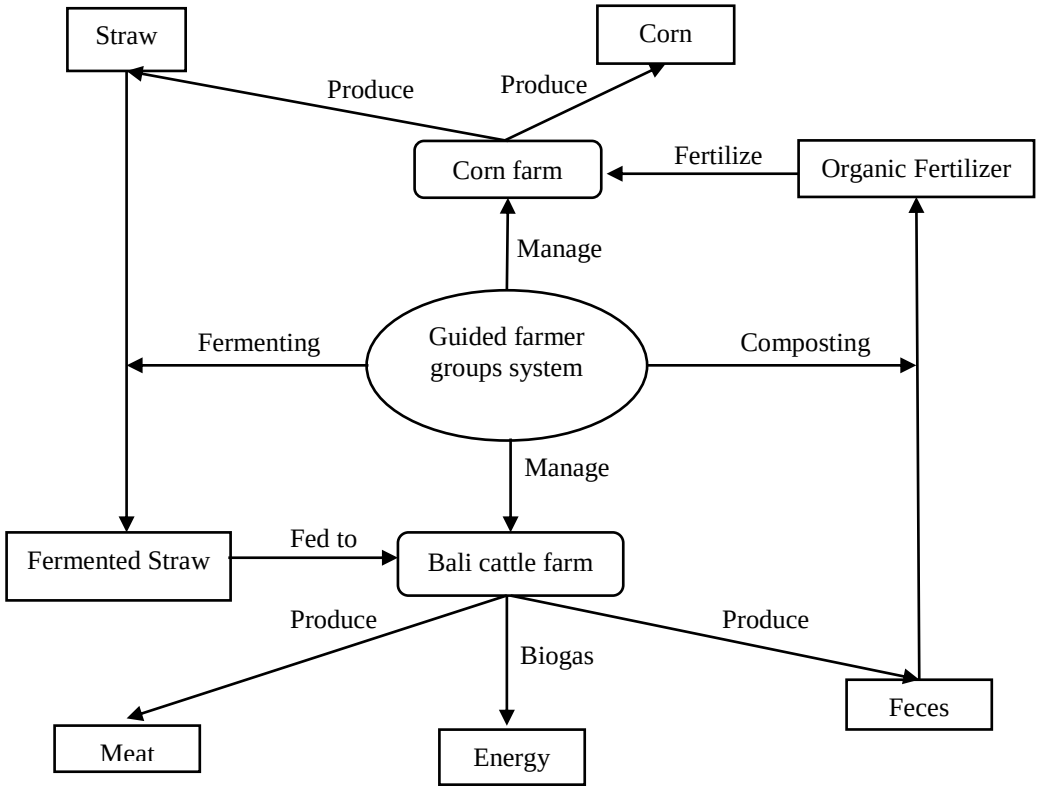

Figure 3. Proposed integrated corn and cattle farming model

The reared cattle (Bali cattle) in the farming system is indigenous cattle breed which have adapted to the environment. Research in Bali cattle farming integration by Lisson *et al*. (2010), showed that the breed had good environmental adaptation in Indonesia, and would conserve the indigenous breed as well. The transition from extensive into intensive farming system aims for better control and rearing management. An expert to guide in each farmer group would also help them to maintain and develop their farm. Kusumayana and Arlina (2017) mentioned that the integrated farming system would help farmer to reduce the economic risk, as it has more diverse product. In addition, the supporting farming practice (fermentation, composting and biogas production) would give added value to the produced waste, and had positive impact to the environment as well.

Conclusion

The integrated corn and cattle farming system under guided farmer groups is proposed to improve the current farming system in Sekotong sub-district. Corn farming is chosen as the crop is favorable and is one of the main consumed food for the local people, as well as it suits the climate and soil characteristics and had water and nitrogen usage efficiency compared to the paddy rice. Intensive cattle rearing is chosen as the livestock has already had high population in the district and the intensive farming system under farmer groups would help smallholder farmers in adopting technology as well as farming management. Moreover, cattle face composting, corn straw fermentation and biogas technology are also recommended to improve the farming profit and empowering the farming practice as well.

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