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The potential of lands under coconut trees for the integration of cattle-coconut farming in West Bolangitang, North Sulawesi Province, Indonesia

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Abstract : Coconut cultivation is a leading commodity in tropical countries. Land under coconut trees is being used by farmers for grazing cattle. The goal of this study was to analyze the potential of land under coconut trees through the integration of cattle-coconut farming. Research samples were determined by purposive sampling and obtained 32 farmers who graze cattle on land under coconut trees in West Bolangitang, Indonesia. The results showed that the maximum potential of animals units was 4,744, the capacity increase in the cattle population based on land resources was 2,700, the maximum potential based on the head of farmers' family was 7,851.51, and the improvement of cattle population capacity was 5,808. The carrying capacity index of 16.86 indicated that the carrying capacity of the land area in the West Bolangitang is fairly high. This means that the maximum potential of the land resource is still greater than the feed requirements. Based on the potential of existing land under coconut trees, the real cattle population could be increased up to 16.86 times. The results suggested the forage introduction is necessary to support beef cattle farming. Based on the results of this study, if land under coconut trees is used as a source of forage, the cattle population can be increased, and this potential can be enhanced through the cattle-coconut integration approach that is environmentally friendly and sustainable, and this study suggests to farmers and the government that it is necessary to introduce qualified forage fodder to use the land under coconut trees.

Keywords : forage fodder, integrated crop-livestock systems, rangeland.

Introduction

Coconut (*Cocos nucifera*) is one of the chief crops grown across the world. Coconut is one of the favorite tropical fruits and that everyone loves to eat. From its coconut milk or its juice to the pulp it's used in the different tropical cuisines and mainly in desserts, and which can be processed into cooking oil and other derivatives. Indonesia is one of the top 10 coconut producing countries in the world, located between the Indian and Pacific ocean. The climate of this country is tropical which is ideal for the growth of coconuts. According to the Food and Agricultural organization of the UN it produces about 21,565,700 tonnes of coconuts in 2009[1].

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Coconut land can be utilized as integrated crop and livestock farming system. Cattle farming under coconut trees has potential to be developed as a profitable farming for rural smallholder farmers. Cattle livestock farming in West Bolangitang, North Sulawesi Province, Indonesia is still a traditional system and mostly uses the land under coconut trees for grazing or as rangeland. Meanwhile, cattle in this area is featured cattle that has been developed to meet the increased demands, so local governments have responded by increasing the cattle population, which is now considered slow growth.

The problem is determining whether there is enough forage available to meet the needs of cattle. The indications are that the program increasing the cattle population must be supported by the provision of livestock feed is mainly forage. Small-scale cattle farmers generally have the problem of limited land for forage plants, and by several studies indicated that availability of forage is still a problem for livestock farming in different regions in Indonesia[2,3,4].

The environmentally friendly farming approach is an approach that starts with the ecosystem approach. An ecosystem is an ecological system formed by the mutual relationship between the living and its environment[3]. Integration system of cattle and plantation is often considered as a step forward in farming practices that are environmentally friendly and sustainable, and an alternative approach to diversify sustainable agricultural production is to integrate cash grain cropping with ruminant livestock production[5]. Integrated crop-livestock systems for sustainable development, and integrated crop-livestock systems (IC-LS) implying a diverse range of integrated ecological, biophysical, socio-economic conditions, have been a foundation of agriculture for hundreds of years[6].

Coconut is a leading commodity and has dominated the plantation area in the district of West Bolangitang, so the land area of coconut can be utilized for the pastures and forages fodder cultivation as a source of cattle feed. The area under coconut trees have the large potential for the development of cattle, because in the land can be used for planting forage grass and legumes[7]. This situation shows that the cattle farmers in the study area use mostly cattle farming integrated with coconut plantation farming.

The economic dimension is the dimension that greatly contributes to the sustainability of agriculture, whether mono-cultured, mixed and integrated farming[8]. The question is what extent the economic potential of land under coconut trees to support cattle-coconut integration system. Based on these ideas, the research have been conducted that aimed to analyze the potential development of land under coconut trees through the integration of cattle-coconut farming in West Bolangitang, North Sulawesi, Indonesia.

Materials and Methods

The study was conducted in West Bolangitang using the survey method. The sample villages were determined by purposive sampling method, and there are villages which have the largest cattle population and have coconut plantations in North Sulawesi. Sample respondents are farmers who have been selling cattle, and have grazing or herding the cattle on the land under coconut trees, so the farmer respondents who raise cattle grazing under coconut trees. Cross section data and time series data presented the data used in this research, and the data collection techniques used were interviewing cattle farmers and direct field observation. The data in the research was analyzed according to formula with the Livestock Development Potential Effective equations (*1*), (*2*), (*3*), (*4*) and the index of Land Carrying Capacity equation (*5*)[9].

1) Maximum Potential of Land Resources*:*

$$PMSL = aLG + bPR + cR \qquad (1)$$

PMSL = The maximum potential in animal unit (AU) based on land resources:
adult cattle = 1.00 AU / Ha, veal = 0.60 AU / Ha, and calve = 0.25 AU / Ha

A = The coefficient is calculated based on the ratio of population to ruminants in animal units (AU) with an area of arable land (Ha), referred from the provincial standardized coefficients (East Java) in 1995 was 0.8 AU / Ha

LG = Coconut plantation area in the regency / sub-district studied (Ha)

B = Koefisien yang dihitung sebagai kapasitas tampung padang rumput alam Coefficient of carrying capacity of nature grasses (in 1995 = 0,5 AU/Ha)

PR = Nature grasses size (Ha)
C = The coefficient is calculated as the capacities of the swamp (1,2 AU/Ha)
R = Swamp size

2) Capacity Increased Cattle Population *based on land resources:*

$$KPPTR(SL) = PMSL - POPRIL \quad (2)$$

KPPTR(SL) = The capacity increase in the cattle population (AU) based on land resources
POPRIL = The real population of cattle (AU) in the Regency / Sub-District studied

3) Maximum Potential *based on head of farmers family:*

$$PMKK = dKK \quad (3)$$

PMKK = Maximum Potential (AU) based on head of family of farmer household
d = The coefficient is calculated based on the number of animal units (AU) of cattle kept by a family of farmers without having to hire labor from outside the family (in 1995=3 AU/KK)
KK = Head of Family

4) Improvement of Cattle Population Capacity *based on the maximum potentialdifference and real population selected years:*

$$KPPTR(KK) = PMKK - POPRIL \quad (4)$$

5) **Carrying capacity Index Analysis.**

Carrying capacity index is a number that indicates the status of carrying capacity in a region:

$$IDD = \frac{PMSL}{TK} \quad (5)$$

IDD = Carrying Capacity Index

TK = Total feed requirements (TK = k x POPRIL)

K = Constant of the need for digestible dry matter (BKC) by one animal unit: 1.14

Results and Discussion

Dry lands in West Bolangitang, North Sulawesi, Indonesia have the potential for development of agriculture in both food crops and plantations. Development of agricultural commodities in the drylands is one strategic option to increase the production and support national food security[10].

Coconut is a plantation type that dominates West Bolangitang. The area of coconut trees is 3,668 ha (23.39% of the total plantation area in North MongondowBolaang) with a production at 3,354.37 tons[11]. Farmers have used the land under coconut trees by planting food crops. In addition, the land under coconut trees planted forage for herding and grazing local cattle.

The success rate of local cattle farmer is determined by the characteristics of the farmer. Characteristics of the cattle farmer were based on the age, level of education, and number of family members. The results showed that 100% of cattle livestock farmers that responded in West Bolangitang were categorized as productive age. The age of farmers significantly influence the tendency of farmers to be positive about the success of his farming business[11].The level of education showed most are educated at Junior High School and High School educationlevel.The level of education is still categorized medium level, which can affect the success of cattle farming, because farmers with a higher education level can be expected to adopt the new technology[13,14].

Plantation areas owned by the respondents in the study site have an average area of 1.31 ha. Coconut land tenure is very supporting of food crops and forage crops farming in the study area. The indication of local beef cattle farms can be developed by utilizing the available feed in land under coconut trees. The development of local beef cattle in rural areas cannot be separated from the development of agricultural farming[13]. The local beef cattle are a strategic commodity with multiple functions for dryland farmers[15].

Cattle development research can be performed because of existing agro-ecosystems. Determination of the utilization of agro-ecosystem is based on the development of effective and livestock carrying capacity index. Table 1 shows the results of research on the potential for effective livestock development and land capacity index in the district of West Bolangitang.

Table 1. Effective livestock development potential and land Carrying Capacity Index in the District of West Bolangitang

Coefficients/Variables	Development potential value
PMSL	4,744
KPPTR (SL)	2,700
PMKK	7,852
KPPTR (KK)	5,808
IDD	16.86

Table 1 shows that the maximum potential of land resources under the coconut trees (PMSL) for the district of West Bolangitang amounted to 4,744 AU (animal unit). That is based on land resources in the district of West Bolangitang that can still accommodate the cattle population as much as the value of the PMSL.

The level of capacity increase in the cattle population by land resources KPPTR (SL) in the district of West Bolangitang amounted to 2,700 AU. This means that to meet the maximum potential of land resources, the cattle population in the district of West Bolangitang can be increased as much as the of KPPTR(SL)value. These efforts can be made to optimize the land under coconut trees. Optimizing the utilization of land resources in support of agricultural development in the future needs to be improved[16].

The maximum potential based on head of family of farmer household (PMKK) in the district of West Bolangitang amounted to 7,852 AU. That is based on the availability of labor, with each having 3 AU, the cattle population can increase to the amount of the PMKK. Since the results of analyzing the increase in the cattle population by the head of the family farmers (KPPTR (KK)) in the district of West Bolangitang still can be increased by up to 5,808 AU, the cattle population owned by families of farmers at the level of sub district could be increased to a value of that KPPTR (KK).

Forage fodder is a major feed ingredient for ruminant animal life. The important factor that must be considered in order to increase productivity is to provide quality and enough year-round fodder. In other words, fodder is the basis factor for the development of cattle farming business, in this case as much as 62 percent. Since the supply of forage is a limiting factor to cattle farming, management strategy of providing good forage grass and legume requires the ability of cattle farmers[14].

Value of Carrying Capacity Index (IDD) according to Table 1 is 16.86. This indicates that the carrying capacity of the land in the district of West Bolangitang is quite high. This means that the maximum potential of land resources is greater than the feeding needs. Based on the potential of existing land, the real population could be increased up to 16.86 times. In contrast, another study showed that the capacity is greater than the ruminant livestock population, which this condition is caused because the rainy season produces forage in large quantities[17]. Additionally, another study concluded that the cattle population exceeds existing capacity so that basic needs have not been met. However, the diminished fertile lands led to the development of livestock facing a tough challenge, especially the availability of land resources[18]. Likewise, the availability of forage land will determine the amount of forage fodder[19] and the strategies to achieve business success in cattle farming need appropriate technology[20].

The results of this analysis are based on the potential of effective land under coconut trees. However, this condition needs to be supported by increasing forage productivity with introduction of superior forage types. The results showed that the land under coconut trees is not fully utilized, so the cattle were consuming agricultural wastes and grasses that grow wild. This phenomenon occurred has also in other areas, which the utilization of vacant land estates is not maximized[21]. Lands under the coconut trees in the district of West Bolangitang have the potential to be utilized for the development of forage. This approach shows the development of cattle farming through the integration of cattle-coconut in the study area. Integrated farming systems approach can improve productivity and profitability compared to conventional farming[22]. Integrated farming systems approach provides the results of an increase in household nutrition, income and employment[23].

An Integrated farming management system with crop-livestock integration needs to be developed[24]. The systems generate additional employment opportunities for family labor, as well as minimize the risk associated with conventional farming systems. Integrated management apparently has shown livestock development that leads to the concept of sustainable farming which constitutes an essential component of social, economic and environmental systems. Studies have been done on an ongoing assessment of integrated farming according to quantitative standards of environmental and socio-economic benchmarks[25].

Cattle farming development can be done with the approach of integrated farming system through cattle-coconut. The integration of livestock with trees and others crops is seen as the most appropriate way to use the natural resources in a system that is productive and sustainable in the long term[26]. This is done because cattle farming is regarded as one of the causes of CO_2, CH_4 and others emissions that lead to global warming[27,28]. Developments can be performed with the approach of an integration model of a local environmentally friendly cattle-crop[29]. Furthermore, a model of sustainable dairy cattle-horticultural crops integrated farming system has been developed in Nongkojajar, Pasuruan Regency[5]. Likewise, a model of sustainable livestock and tourism development has been developed in Bali[30].

Conclusions

The results of this study show that the cattle population can still be increased if land under coconut trees used as a source of forage fodder. This potential can be enhanced through an environmentally friendly and sustainable coconut-cattle integration approach. The results also show that it is necessary for high productivity forage to be planted on land under coconut trees as a source of fodder for cattle in the context of improving the food security and the farmers' family income.

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