Journal of Economics and Sustainable Development
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.5, No.1, 2014

Optimizing Crop and Livestock Integration Using the Analysis Approach of *Goal Programming* (a case study in Tanah Laut Subdistrict, South Kalimantan, Indonesia)

Eni Siti Rohaeni[1,2], Budi Hartono[3], Zaenal Fanani[3], Bambang Ali Nugroho[3]

1. Post-graduate Program, Faculty of Animal Husbandry, University of Brawijaya, Malang, Indonesia

2. The Assessment Institute of Agricultural Technology South Kalimantan, Jl. Panglima Batur Barat No. 4 Banjarbaru, Kalimantan Selatan, Indonesia

3. Animal Husbandry Faculty, University of Brawijaya, Jl. Veteran, Malang, Indonesia

E-mail of the corresponding author : eni_najib@yahoo.co.id

Abstract

Farming done by most farmers in Indonesia is an integrated farming system or integration with the aim to increase income through several commodities made either from crops, plantations and livestock. Farming done using both an integrated system and diversification leads to integrated business making one farming to another farming mutually beneficial. This study aims to examine the optimization of the sustainable integration of crops and beef cattle (economic, environmental and social aspects) using an analysis approach of goal programming which is the case in the dry land, Tanah Laut Regency, South Kalimantan, Indonesia. The data analysis employed was Goal Programming (GP) analysis for optimization testing. The GP data completion using WinQSB software. In this GP analysis, the objective of optimization to be achieved is a constraint, therefore the the objective of the optimization in this study is treated as a goal constraint. GP designed to achieve several objectives consists of several alternative activities and resource constraints analyzed at the farm level. The result show that on the first optimization results are recommended for planting 0.20 ha of rice, 0.30 ha of rubber, 0.28 ha of groundnut and 0.22 ha of sweetcorn and they were not recommended for soybeans. The income generated from the results of the first optimization has meet the applicable minimum wage of 128,03 % with a cultivated land area of 1.59 ha. The second optimization included constraints in order that soybean commodities could be cultivated which resulted in the recommendation for planting 0.20 ha of rice, 0.21 ha of rubber, 0.18 ha of soybean, 0.21 ha of groundnuts and 0.20 ha of sweetcorn. The income generated from the results of the second optimization has meet the applicable minimum wage of 107.72 % with a cultivated land area of 1.59 ha.

Keywords: beef cattle, farming system, sustainability

1. Introduction

Farming done by most farmers in Indonesia is an integrated farming system or integration with the aim to increase income through several commodities made either from crops, plantations and livestock. Farming done using both an integrated system and diversification leads to integrated business making one farming to another farming mutually beneficial. At first, farmers diversify farming to meet a variety of needs of family consumption (Rusastra *et al.*, 2004).

Integrated/combined farming is one good way to optimize the use of resources and to maximize income (Faridah, 2001). Ruminant livestock is a type of other livestock types that plays an important role in sustainable agricultural systems because this type of livestock produces fertilizers and can utilize agricultural waste as their fodder.

South Kalimantan is a province in Indonesia which is included in the eastern part of Indonesia where the agricultural sector is one of the important livelihood for the population as indicated by 22.34 % of the population work as farmers (Central Agency on Statistics of South Kalimantan, 2010). Tanah Laut is one of the subdistricts in the province of South Kalimantan which is an agricultural area with most of its agroecosystems consist of dry land. Farming carried out in this area generally are food crops (rice, corn, beans, potatoes), plantations (rubber, palm oil) and livestock.

Munasinghe (1993) describes that the definition of sustainable development must meet three dimensions, namely economically efficient and viable, socially equitable and ecologically sustainable (environmentally friendly). The concept of sustainable agriculture suggested by Devendra (2011) was initially focused on environmental aspects,

but it currently has been expanded including socio-economic and broader political elements: the ecological aspects focus on environmental protection to improve ecosystem resources and biodiversity conservation; the socio-economic aspects: limitations of the resources, which are socially nd technologically acceptable, farmers' organizations and cooperatives (institutional), and improved livelihoods of poor farmers (economics). The research findings reported by Khan and Iqubal (2010) state that the integrated crop-livestock enterprise is economically viable, environmentally friendly and socially acceptable within in a region. Based on the description, it is necessary to optimize patterns of sustainable crops and beef cattle in dry land by considering ecological, economic and socio-cultural aspects as well as the direction of the development of sustainable beef cattle business in dry land.

Goal programming (GP) was introduced by Charnes and Cooper in the early of 1960s. GP is a technique widely used for decision making with multiple objectives. GP is considered as the best way to allocate resources in Nigeria, especially in the agricultural sector with several conflicting goals. According to Lieberman (1997), GP is a linear programming used to obtain a variety of specific purposes simultaneously. The basic approach of GP is to set a goal where each goal is expressed in figures, to formulate an objective function for each objective and to find a solution by minimizing the deviation from the objective function to each objective.

Several studies made using the analysis of GP among others are a study by Sen and Nandi (2012a) in Tripura on rubber plantations; and a study by Otomeso and M-Lawal (2010) to optimize food consumption for households in the context of food resistence in Negeria. The GP technique can be used to overcome problems in determining optimal cropping patterns by considering multiple objectives in the agricultural planning and management (Sen and Nandi, 2012b). Fibrian *et al*. (2011) concerning the optimization of the utilization of palm oil waste intended for reasonable costs can minimize the level of environmental pollution and bring maximum profits. Hendriwan *et al*. (2008) conducted a study to determine the optimal allocation of fishing units in accordance with the supporting capacity that is socially acceptable using goal programming analysis. Purba *et al*. (2008) conducted a study to optimize the role of credit/financing/ financial institutions in supporting capture fishery business declared eligible. A study on optimization using GP is reported by Kastaman *et al*. (2007) that the optimization results in vegetable cropping in Garut generated income growth of 58.39 % while another study on optimization by Basuki (2000) reports increased income of vegetable intercropping in pine lands at 136.47%. GP analysis is also performed to analyze the costs used for consumption of children under five, to analyze food consumption habits of children under five and to plan menus for children under five in the attempts to improve nutrition of fishermen family (Tanziha, 2009). Other studies on optimalization are reported by Budiasa *et al*. (2012) and Januartha *et al*. (2012) in Bali.

This study aims to examine the optimization of the sustainable integration of crops and beef cattle (economic, environmental and social aspects) using an analysis approach of goal programming which is the case in the dry land, Tanah Laut Regency, South Kalimantan, Indonesia.

2. Methodology

2.1 Location and Time of the Research

The study was conducted in Sumber Makmur Village, Takisung Subdistrict, South Kalimantan. The study was conducted as long as four months from September to December 2012.

2.2 Sampling Techniques and Data Collection

The technique to determine the respondents to seek information and knowledge examined employed particular consideration (*purposive*). The selected respondents are the one having or running a business in beef cattle and doing other types of farming, i.e. crops and plantations following the general pattern of farming commonly done in the research area. The types of beef cattle raised by the farmers generally are local cattles, especially Bali cattle and Peranakan Ongole (PO). The number of the respondents in this study were 39 people.

The method used in this study was a survey method. The primary data were obtained from interviews with farmers. The secondary data were collected from related offices/agencies. The variables examined for the analysis of Goal Programming included economics, environment and social. Economic variables consisted of farmers' income, population growth and the number of cattle raised. Environment variables consisted of the use of fecal waste as a fertilizer and the use of agricultural waste as fodder. Meanwhile, the social variables consisted of the absorption of agricultural labor.

2.3 Data Analysis

The data analysis employed was Goal Programming (GP) analysis for optimization testing. The GP data completion using WinQSB software. In this GP analysis, the objective of optimization to be achieved is a constraint, therefore the the objective of the optimization in this study is treated as a goal constraint. GP designed to achieve several objectives consists of several alternative activities and resource constraints analyzed at the farm level. There are six objectives/targets to be achieved in this study, namely:

1. to increase farmers' income,
2. to increase the cattle population growth
3. to increase the number of cattle raised
4. to increase the utilization of fecal waste as fertilizers
5. to increase the utilization of agricultural waste as fodder
6. to increase the absorption of agricultural labor

Functional constraints are constraints limiting the realizations of the goals, in this study, there are several functional constraints, they are :

1. the area of land (rice fields, gardens and fields) available for crop and livestock farming
2. capital owned by farmers to run their farming
3. family labor owned
4. forage availability

The mathematical equation of the objective function in Multiple Goal Programming (MGP) model for sustainable cattle business is formulated as follows:

$$\text{Min } Z = W_1 (d_1^+ + d_1^-) + W_2 (d_2^+ + d_2^-) + W_3 (d_3^+ + d_3^-) + W_4 (d_4^+ + d_4^-) + W_5 (d_5^+ + d_2^-) + W_6 (d_6^+ + d_6^-)$$

Description:

W1 : weight increases farmers' net income as the 1st goal
W2 : weight increases cattle population growth as the 2nd goal
W3 : weight increases the number of cattle raised as the 3rd goal
W4 : weight increases the utilization of fecal waste as fertilizer as the 4th goal
W5 : weight increases the utilization of agricultural wastes for fodder as the 5th goal
W6 : weight increases the absorption of agricultural labor as the 6th goal

3. Result and Discussions

3.1 Description of Research Variables

Survey results reveal that there are six patterns of farming that are quite dominantly done farmers in Sumber Makmur Village, Takisung Subdistrict, Tanah Laut Regency, South Kalimantan, Indonesia. The six common patterns of farming consisted of : (1) rice and cattle, (2) rice, rubber and cattle, (3) rice, soybeans, rubber and cattle, (4) rice, soybeans, and cattle, (5) rice, soybeans, groundnuts and cattle, (6) rice, sweetcorn and cattle. These patterns indicate the existence of an integrated business between crop and cattle done by farmers in the region where the research was conducted.

Based on the results of the survey given to the respondents, the characteristics of the farmers are shown in Table 1. The age of farmer respondents in this study was 42.6 years in average, where the youngest age was 39.7 years found in the farming pattern of group (2), i.e. rice, rubber and cattle, and the oldest age was 45.1 years found in the farming pattern of group (4), i.e. rice, soybeans and cattle. Based on their age, the farmers are classified into the productive age where in this age farmers still have the desire, abilities and ideas that are quite open to change.

Tabel 1: Characteristics of respondent farmers and farming system on research location with a land area of 1.59 ha

No	Commentary	Mean value
1	Age (years)	42.6
2	Education (years)	7.8
3	Experience (years)	13.8
4	Extensive land ownership (ha)	2.66
5	Extensive agricultural land use (ha)	1.59
6	Land use for HMT (ha)	0.20
7	Household Members (pearsons)	4.00
8	Utilization of livestock manure for fertilizer (kg/years)	4,517
9	Utilization of agricultural wastes for animal feed (kg/years)	2,898
10	Total cattle (AU)	3.60

The educational background of farmers in the study was 7.8 years, where the shortest education was 5.5 years found in the farming pattern of group (4), i.e. rice, soybean and cattle meanwhile the longest education was 9 years found in the farming pattern of group (2), i.e. rice, rubber, and cattle and in the farming pattern of group (1), i.e. rice and cattle. In this research, the educational background of the farmers can be assumed low, i.e. elementary school (SD) graduates who did not graduate from Junior High School (SMP). The educational background of the farmers generally affect their mindset in managing farming, a relatively high educational background makes farmers more dynamic. This suggests that education is one of other important factors to think about and to decide a certain activity. Education is assumed as having a positive correlation with the adoption of technology. It will be easier for farmers who have a higher level of education to be advanced and accept the technology.

The experience of farmers in this study was 13.8 years in average, with the shortest experience was 9.6 years found in the farming pattern of group (3), i.e. rice, soybean and rubber, while the longest experience was 18.4 years found in the farming pattern of group (6), i.e. rice, corn, beef. The experience of the farmers was quite long over10 years, experience affects one's learning process, whether it is a pleasant one or not.

The area of the land possession of the farmers in this study was 2.66 ha in average, with the smallest land area was 1.59 ha found in the farming pattern of group (1), i.e. rice, and cattle, while the largest land area was 3.2 ha found in the farming pattern of group (6), i.e. rice, corn, and cattle. The average land possession in the area of this study is high because the research site was located on the island that is still sparsely populated, unlike the island of Java. Narrow farm land is one of the obstacles in the application of intensive farming systems, which can make farmers less capable of implementing agricultural technology done commercially.

From the view point of land use, it is revealed that the average land use was 1.59 ha, with the smallest level of land use was 0.75 ha found in the farming pattern of group (1), i.e. rice and cattle while the largest level of land use was 2.43 ha found in the farming pattern of group (3), i.e. rice, soybean and rubber. Not all areas of land owned by farmers had been used, the average land use was 1.59 ha or about 59.77 % of the land owned. Some of the reasons given why farmers dis not utilize all of their land is due to the lack of capital, limited manpower and the conversion of land use from seasonal crops to plantation crops which had not produced/ harvested (had been planted for 1 year) such as rubber.

Agricultural land owned by farmers, a small part of the land was used to grow forage, the average area for planting forage in this study was 0.20 ha, with the largest areas found only in the farming pattern of group (5), i.e. rice, soybean, ground nuts and cattle by 0.30 hectares while the area used to grow forage on other groups was equal, i.e. by 0.20 ha. Land use for forage is generally given priority although the land used is not large because if a farmer has his own forage, therefore fodder availability can be assured making him not depend entirely on natural grass or able to overcome the shortcomings of fodder in a long dry season.

The average number of the household members of a farmer in this study was 4 people, with the smallest number of family members (3 persons) found in the farming pattern of group (2), i.e. rice, rubber and cattle, while the highest number of household (5 persons) found in the farming pattern of group (1), i.e. rice and cattle and in the

farming pattern of group (5), i.e. rice, soybeans, groundnut and cattle. Members of the household that were commonly used as farm labor are the head of the family (husband/ father), most female workers are wives or mothers, meanwhile, children are almost never instructed to help their parent except for adults and have not married.

Farmers generally utilized fecal waste produced by cattle for fertilizer. The average utilization of fecal waste in the study was 4,517 kg/year, with the lowest level of use was 2,102 kg/year found in the farming pattern of group (4), i.e. rice, soybeans and cattle while the highest level of use was 7,700 kg/year found in the farming pattern of group (1), i.e. rice and cattle. The manure used for fertilizer was generally not processed into *bokashi* (fermented organic matter) but left for only 1-3 months, then used for farming such as rice, corn, soybeans, groundnuts, rubber, forage or fruit and vegetable plants.

In addition to manure used for fertilizer, farmers also utilized agricultural wastes for animal fodder such as rice straw, corn straw or other waste. The average utilization of waste to feed animals in this study was 2,898 kg/year, with the lowest level of the waste utilization was 1,100 kg/year found in the farming pattern of group (3), i.e. rice, soybean dan rubber while the highest level of the waste utilization was 10,350 kg/year found in the farming pattern of group (1), i.e. rice and cattle.

These results indicate the integration between crops and livestock made by farmers where fecal waste was used as organic fertilizer and agricultural waste was used to feed animals and therefore it is expected that the farming done integratedly can reduce production costs, solve the problem of shortage of chemical fertilizers, improve profits and are sustainable (Priyanti *et al*., 2001; Rohaeni *et al*., 2006; Basuni *et al*., 2010). This statement was added by Gupta *et al*. (2012) saying that the integration system provides benefits such as reducing erosion, improving crop yields, intensifying land use, increasing profits, reducing poverty, improving the environment and making it sustainable. Sati and Sing (2010) state that the recommended measures for sustainable farms are increasing the planting of fodder crops both on marginal land and other land that help to reduce erosion, encouraging the management of natural resources for the supply of animal fodder such as public lands, forests and grasslands that are managed under the control of a department, socialization on good management of livestock keepers, and improved quality of livestock in order to increase production.

Beef cattle raised by farmer respondents was between 2-6 Livestock Unit (Animal Unit/AU) with an average of 3.6 AU, with the smallest number of cattle was 3.3 AU found in the farming pattern of group (5), i.e. rice, soybeans, groundnuts and cattle, while the largest number of cattle was 4.1 AU found in the farming pattern of group (2), i.e. rice, rubber and cattle. Cattle maintained by farmers played important roles as a source of fertilizer and a source of capital that could be exchanged with money when the farmers need it.

The survey results (existing conditions) show that the average income of farmers participating in this study was Rp 17,270,166/year, with the smalest incomes of Rp 5,672,502 found in the farming pattern of group (1), i.e. rice and cattle, and the highest income of Rp 42,792,773/year found in the farming pattern of group (2), i.e. rice, rubber and cattle. Regional Minimum Wage applied in South Kalimantan in 2012 was Rp 1,225,000/month or Rp 14,700,000/year. Referring to the applicable minimum wage, the contribution of farmers' income in the existing conditions to the Regional Minimum Wage was between 38.59 to 291,11% (Table 2) from 6 patterns of farming, which meets the standard of the minimum wage of farming patterns 2 and 3 where the biggest income was contributed by rubber commodities. This condition indicates that most of the farmers' income has not fulfilled the Needs of Decent Living which refers to the applicable minimum wage. The findings of this research are consistent with the report by Rois (2011) in West Kalimantan and Nazam (2011) in West Nusa Tenggara that in the existing conditions, the income of farmers does not meet the needs of decent living.

Table 2: Farmers' income in the existing conditions in the research location

No	Farming patterns	The land area is cultivated (ha)	Income (Rp/year)	Contribution to Minimum Wage (%)
1	Rice and cattle	0.75	5,672,502	38.59
2	Rice, rubber and cattle	2.05	42,792,773	291.11
3	Rice, rubber, soybeans and cattle	2.43	27,056,800	184.06
4	Rice, soybeans and cattle	1.27	7,153,671	48.66
5	Rice, soybeans, peanuts and cattle	1.79	10,479,891	71.29
6	Rice, corn and cows	1.23	10,465,625	71.19
	Mean	1.59	17,270,210	117,48

3.2 Goal Programming Analysis

The six patterns of farming applied for optimization in this study were (1) rice and cattle, (2) rice, rubber and cattle, (3) rice, soybeans, rubber and cattle, (4) rice, soybeans, and cattle, (5) rice, soybeans, groundnuts and cattle, (6) rice, sweetcorn and cattle. Farming optimization with a wide selection of patterns is used to achieve several goals, namely (G1) to increase farmers' net income, (G2) to increase livestock population growth, (G3) to increase the number of livestock raised, (G4) to increase the use of fecal waste as fertilizer, (G5) to increase the use of agricultural wastes to feed livestock, and (G6) to increase the absorption of agricultural labor.

Table 3: The formulation of the objective functions and constraints of the study

Variable	X1	X2	X3	X4	X5	Direction	R.H.S.
G1	5,012.281	22,233,729	4,389,180	7,497,620	9,403,030		
G2	1.52	1.69	1.54	1.55	1.58		
G3	4.12	4.20	3.98	3.68	5.15		
G4	4,934	3,038	3,687	2,490	5,832		
G5	2.233,65	695,40	1.048,70	707,16	1.082,01		
G6	179,18	111,96	125,23	116,33	212,05		
C1	1.00	1.00	1.00	1.00	1.00	=	1.00
C2	11,599,392	8,784,834	8,882,805	8.181,960	11,550,295	=	9,799,857
C3	382,40	224,30	275,80	297,70	429,60	=	322,00
C4	23,947	14,420	17,730	17,907	32,030	=	21,207

To realize farming optimization, there were several constraints to be considered, namely (C1) the ownership of land areas, (C2) capital, (C3) family labor, and (C4) the availability of forage. Land is the constraint that occurred almost in everywhere both in terms of the area or the quality of the land and so did the availability of family labor which is getting increasingly smaller at present making the availability of family labor a constraint. Capital is an important factor in farming activities as without it, it will hard for farmers to develop the farming they run (Damihartini and Jahi 2005). Availability of capital for farming activities for farmers is closely linked to the success of farming management. This is due to the availability of farming capital is the main source of power for the production process. Based on interviews and analysis done, the following multiple goal programming (GP) formulation as shown in Table 3 is obtained with decision variables as follows:

X1 : the optimized rice areas (ha)
X2 : the optimized rubber areas (ha)
X3 : the optimized soybean areas (ha)
X4 : the optimized groundnut areas (ha)
X5 : the optimized corn areas (ha)

Based on the results of the optimization analysis, it is recommended to plant 0.20 hectare of rice, 0.30 hectare of rubber, 0.28 hectare of groundnut and 0.22 hectare of sweetcorn (Table 4). The optimization results in this study for the economic aspects generated an income by Rp 11,836,614/hectare/year. The applicable Regional Minimum Wage in South Kalimantan in 2012 was Rp 1,225,000/month or Rp 14,700,000/year, and therefore the income obtained from the above optimization results gave contribution at 80.52% to the applicable minimum wage if farmers cultivated a land area of only 1 ha. Based on the survey, it is revealed that the average utilization of land areas was 1.59 hectare (Table 1), by referring to the average cultivated land by 1.59 ha/family, therefore the net income earned by the farmers was Rp 18,820,216/year, this income gave contribution at 128,03% to the applicable minimum wage.

Table 4: The results of optimization of crops and beef cattle with a land area of 1 ha

Symbol	Solution
Decision (hectare) :	
Rice (X_1)	0.20
Rubber (X_2)	0.30
Soybeans (X_3)	-
Peanuts (X_4)	0.28
Sweetcorn (X_5)	0.22
Purpose :	
Net income (G1) Rp/year/ha	11.836.530
Livestock population growth (G2) AU/year	1.59
Number of livestock kept (G3) AU/year	4.25
Utilization of waste for fertilizer coop (G4) kg/year/ha	3.888
Utilization of agricultural wastes for animal feed (G5) kg/year/ha	1.095
Employment (G6) HOK/year/ha	148.91
Constraints :	
Land Area (C1) ha	1.00
Stock (C2) Rp/year	9.799.857
Family Labor (C3) PD/year	322
Availability HMT (C4) kg/year	21.207

Note : Rp : rupiah; AU : animal unit; PD : person days

In this study, the farming activities done are considered integrated with each other because the waste produced by livestock was used as fertilizers for the crops. And the agricultural waste generated at harvest was used to feed the livestock. The types of the agricultural waste used were rice straw, corn straw, groundnut leaves and soybean leaves. According to Hilimirea (2011), the integration between crops and livestock has several benefits: 1) nourishing the soil through the on- farm input in the form of organic fertilizer produced by cattle, 2) encouraging and enabling farmers to maintain semi-permanent pastures that can improve soil quality, 3) increasing crop yields, 4) improving on-farm biodiversity and related ecosystem services such as pollination and management of weeds/pests, 5) increasing economic benefits for farmers, and 6) providing social benefits to farmers and societies. The findings of the research conducted by Rohaeni *et al.* (2006) showed that the integration could increase income as many as Rp 8,559,600 or 78.2 % higher than the unintegrated system. Other research findings are reported by Priyanti *et al.* (2001) which showed that the integration system increased income by 69.5 %, also by Basuni (2010) that the availability of organic fertilizers were ensured and agricultural waste could be used and thereby reduced production costs. Latif and Mamat (2002) add that the integration system could reduce weeding costs by 17-38 % and increase livestock production, which in turn increased the income of farmers.

Other purposes of the economic aspects which are also the objectives of this study were obtained from the optimization results for the livestock population growth of 1.59 AU/year, based on the data on the average ownership of cattle (Table 1), o the resulting population growth became 5.19 AU. The optimization result of the number of cattle kept was 4.25 AU, so that there is a difference in the livestock population resulted from the optimization of livestock growth (5.19 AU) by 0.94 AU, this number refers to the number of cattle that can be sold per year to add the family income. The optimization result of the number of cattle raise has something to do with the utilization of fecal waste produced as fertilizer. If the populations declines, the source of fertilizer will decrease as well .

The goal of optimization for environmental aspects is, for example, the use of agricultural wastes for animal feed at 1,095 kg/ha, if it is assumed that the average farmers used an area of 1.59 ha, fodder from the agricultural

waste by 1,745 kg/year will be generated. The amount of the optimization results for the purpose of the utilization of agricultural wastes for animal feed is associated with the number of animals kept and cultivated land area as well as the availability of fodder. Fodder given to livestock in the research site was mostly grass, either the local one or the superior one, supplemented with agricultural wastes. The use of agricultural waste was not done throughout the year, based on the interviews, the utilization of agricultural wastes was conducted during the harvest season of rice, corn, soybeans, groundnuts and other commodities. The goal of optimization for the social aspects which is the absorption of agricultural labor generated a value of 148.91 PD/ha/year.

Table 5: The second formulation of the objective functions and alternative constraints of the research

Variabel	X1	X2	X3	X4	X5	Direction	R.H.S.
G1	5,012,281	22,233,729	4,389,180	7,497,620	9,403,030		
G2	1.52	1.69	1.54	1.55	1.58		
G3	4.12	4.20	3.98	3.68	5.15		
G4	4,934	3,038	3,687	2,490	5,832		
G5	2,234	695	1.049	707	1,082		
G6	179,18	111,96	125,23	116,33	212,05		
C1	1.00	1.00	1.00	1.00	1.00	=	1.00
C2	11,599,392	8,784,834	8,882,805	8.181,960	11,550,295	=	9,799,857
C3	382,40	224,30	275,80	297,70	429,60	=	322,00
C4	23,947	14,420	17,730	17,907	32,030	=	21,207
C5	0	0	0.10	0	0	≤	0.57
C6	0	0	0.57	0	0	≥	0.10

The optimization results above (the first alternative, Table 4) showed that soybean was neither cultivated nor recommended to support the government's the self-supported program (in Indonesian: *swasembada*) of soybeans, thus the constraint function was rearranged to make the soybean commodities recommended to be cultivated. Table 5 displays the reanalyzed formulation by adding constraints such as constraints in the areas for soybean planting by 0.10 ha minimally (C5) and 0.57 ha maximally (C6) in order to produce new optimization (Table 6). Constraints C5 and C6 are the data obtained in the research area, namely the average minimum area of soybean planting by 0.10 ha and the average area of soybean planting by 0.57 hectare.

The analysis results of the second alternative optimization is recommended for planting 0.20 ha of rice, 0.21 ha of rubber, 0.21 ha of groundnut and 0.20 ha of sweetcorn (Table 6). Optimization in the second alternative found that all commodities were cultivated in order to support the government's the self-supported program (in Indonesian: *swasembada*) of rice, soybeans and sweetcorn. The obtained optimization results generated a goal with the net income of Rp 9,969,075/ha/year, this value gave contribution at 67.75% to the minimum wage that applies to the land of only 1 ha. If converted to the average cultivated land, i.e. 1.59 ha /family (Table 1), the obtained net income of farmers was Rp 15,850,829/year, this value gave contribution at 107,72 % to the minimum wage.

Table 6: The second alternative optimization result between crops and beef cattle in an area of 1 hectare

Symbol	Solusi
Decision (hectare) :	
Rice (X_1)	0,20
Rubber (X_2)	0,21
Soybeans (X_3)	0,18
Peanuts (X_4)	0,21
Sweetcorn (X_5)	0,20
Purpose :	
Net Income (G1) Rp/year/hectare	9.958.995
Livestock population growth (G2) AU/year	1,58
Number of livestock kept (G3) AU/year	4,23
Utilization of waste for fertilizer coop (G4) kg/year/hectare	3.982
Utilization of agricultural wastes for animal feed (G5) kg/year/hectare	1.146
Employment (G6) PD/year/hectare	148,94

Note : Rp : rupiah; AU : animal unit; PD : person days

3. Conclusions

The first optimization results are recommended for planting 0.20 ha of rice, 0.30 ha of rubber, 0.28 ha of groundnut and 0.22 ha of sweetcorn and they were not recommended for soybeans with the goal obtained from :

a. Economic aspects in the form of an income by Rp11,836,614/ha/year, livestock population growth by 1.59 AU/year and an increased number of livestock raised by 4.25 AU/year
b. Environmental aspects in the form of fecal waste utilization as fertilizer by 3,888 kg/year and agricultural waste utilization for fodder by 1,096 kg/year/ha
c. Social aspects in the form of the absorption of agricultural labor by 148.91 PD/year
d. The income generated from the results of the optimization has meet the applicable minimum wage of 128.03 % with a cultivated land area of 1.59 ha

The second optimization included constraints in order that soybean commodities could be cultivated which resulted in the recommendation for planting 0.20 ha of rice, 0.21 ha of rubber, 0.18 ha of soybean, 0.21 ha of groundnuts and 0.20 ha of sweetcorn with the following obtained goal:

a. Economic aspects in the form of an income by Rp 9,969,075/ha/year, livestock population growth by 1.58 AU/year and an increased number of livestock raised by 4.23 AU/year
b. Environmental aspects in the form of fecal waste utilization as fertilizer by 3,983 kg/year and agricultural waste utilization for fodder by 1,146 kg/year/ha
c. Social aspects in the form of the absorption of agricultural labor by 148.94 PD/year
d. The income generated from the results of the optimization has meet the applicable minimum wage of 107.72 % with a cultivated land area of 1.59 ha

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