POTENCY OF FOOD PRODUCTION BASED ON INTEGRATED FARMING TO SUPPORT FOOD SUFFICIENCY

Rahayu Relawati[1]

Abstract

Food production is important to support food sufficiency. Meanwhile integrated farming is a farming system purposed to optimize production factors in increasing yield and also to eliminate agricultural waste, ideally it becomes zero waste. The research purpose was to measure food production from farm management which applied integrated farming. This research result is used to predict food sufficiency in the region level. The research was done at Batu and Malang Regency, East Java. The research subjects are farmers who applied integrated farming, namely applying cultivation of crops and livestock in one management and they use the waste from livestock as input of farming, vice versa. Primary data was taken by structured and indepth interview. The research showed that integrated farming can produce high yield of vegetable and dairy cattle. Meanwhile their usage of each farm waste can reduce (save) the farm cost. The success of integrated farming to increase yield at farm level can be used to predict food sufficiency at the region level. If the implementation is getting wider at the region, they also can increase their food production. By using simulation, data of food production at farm level can be used as prediction of food production map at region level.

Key words: *integrated farming, food production map, vegetables, dairy cattle.*

Introduction

Food security is an important part of fulfilling the right to food, at the same time it is one of the main pillars of human rights. Therefore food security is important to be realized, starting from level of household, village, district and national. Farmer has a strategic position in the food security: farmers are food producers, but they are also the largest consumer group.

Food safety is also an important part of food security. Farmer's behavior in cultivation that aware of environmental sustainability and use chemicals wisely (even without chemicals) will produce healthy food, free of pesticide residues. Similarly, the behavior of healthy cattle with good sanitation will produce healthy milk or meat which is more safe for consumption.

Integrated farming is defined as the integration of all components of agriculture in one system or management. This system emphasizes on the economic based on

[1] Faculty of Agriculture and Animal Husbandry, University of Muhammadiyah Malang, Malang, Indonesia, email: rrelawati@yahoo.com.

environmental friendly technology and optimizing of all sources of energy produced. Integrated farming involves more than one sub-sector in an integrated system. Integrated farming can be a combination of crop-livestock; crop-fish; livestock-fish, or integration of the three sub-sector (crop-livestock-fish). The main benefits of integrated farming is to optimize usage of agricultural resources, costs efficiency and minimizing waste (zero waste).

The realization of food security as well as the application of integrated farming is important to realize and adopt at the level of agribusiness actors (farmers). The environmental friendly cultivation is important to apply.

Integrated farming is an ideal concept of agriculture, however, the implementation in Indonesia is still a discourse. It is because the community's knowledge and awareness is still low. Moreover it needs a relative high capital. Although integrated farming is very suitable to apply in Indonesia which has a tropical climate, sunshine is available along the year and high rainfall is available almost half of the year. Several methods such as integration of rice and fish (Indonesia: minapadi) and integration of chicken and fish (Indonesia: longyam) adopted this model.

Behera, U.K. and A.R. Sharma (2007) stated that farming systems research is considered a powerful tool for natural and human resource management in developing countries such as India. This is a multidisciplinary whole-farm approach and very effective in solving the problems of small and marginal farmers. The approach aims at increasing income and employment from small-holdings by integrating various farm enterprises and recycling crop residues and by-products within the farm itself. Moreover, Behera and Sharma mentioned that farming system focuses on:

- The interdependencies between components under the control of household and,
- How these components interact with the physical, biological and socio-economic factors, which is not under the control of household.
- Farm household is the basic unit of farming system and interdependent farming enterprises carried out on the farm.
- Farmers are subjected to many socio-economic, bio-physical, institutional, administrative and technological constraints.
- The operator of the farming system is farmer or the farming family.

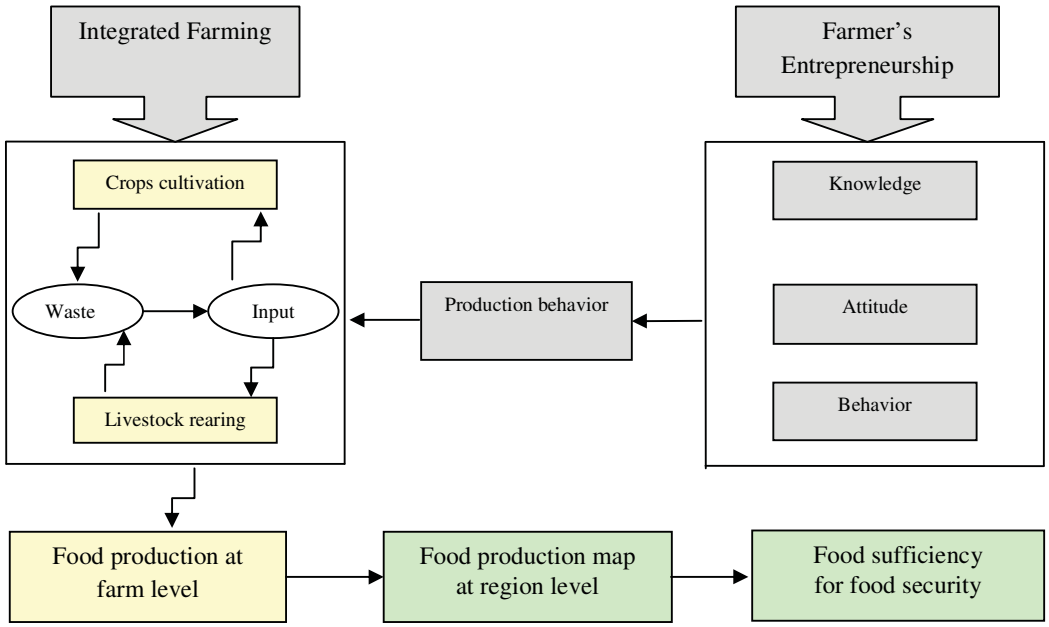

Figure 1. Conceptual framework of integrated farming to support food sufficiency

The realization of integrated farming in Indonesia needs support of entrepreneurship attitudes of agribusiness actors at the level of on farm (farmer). If the adoption of integrated farming with spirit of entrepreneurship is succeed to increase farm production, and the implementation is widespread at the regional level, conceptually it will realize food security in the region level, mainly focusing on food sufficiency. This concept has not been a serious study at the research level and at the level of agricultural development policy. Therefore, it is very important to do research aimed to analyze potency of food production based on integrated farming to support food sufficiency.The research purpose was to measure food production from farm management which applied integrated farming.

Method

The research was done at at Batu and Malang Regency, East Java. Sample from Batu Regency were Village of Torongrejo, Tlekung and Toyomarto, they are from Junrejo District. Sample from Malang Regency were Village of Banturejo, Waturejo and Tulungrejo, they are from Ngantang District. The research subjects were farmers who applied integrated farming, in which the farm waste are recycled for productive purposes.

Farmers applied crops cultivation and livestock rearing in one management. Primary data was taken by structured and in-depth interview.

Quantitative descriptive analysis was used to analyze data of the integrated farming based on food crops and livestock. It also compiled primary data and the secondary one, to predict the potency of food production at the region level. Meanwhile, the qualitative descriptive analysis was used to provide a detailed description of the implementation of integrated farming.

Research Result and Discussion

Integrated Farming (IF)

Integrated Farming is farming systems introduces a change in the farming techniques for maximum production in the cropping pattern and takes care of optimal resource utilization. There are several types of implementation of IF at the research location, ranging from the full integrated and semi-integrated. The most ideal IF is the cultivation in which farm wastes are better recycled for productive purposes. There are inter-related and interdependent between crops and livestock, involves the utilization of primary produce and secondary produce of one system as basic input of the other system. Thus, there is mutually integrated as one whole unit of farming.

Biogas

We also found there was an important process at IF, namely biogas processing. A biogas unit is an asset to a farming family. It produces good manure and clean fuel and improves sanitation. Biogas is a clean, unpolluted and cheap source of energy, which can be obtained by a simple mechanism and little investment. The gas is generated from the cow feces during anaerobic decomposition. Biogas generation is a complex biochemical process. The cellulolitic material is broken down to methane and carbondioxide by different groups of microorganisms. It can be used for cooking purpose and burning lamps. Benefit for environment and health is also obtained from waste processing. Usually the feces contaminate river, in which villagers usually take a bath and wash cloth and dishes.

Site Selection and Management of Biogas

The site should be close to the kitchen or the place of use. It will reduce the cost of gas distribution system. It should also be nearer to the cattle shed to reduce the cost of

transport of cattle feces. Land should be leveled and slightly above the ground level to avoid inflow or run-off of water. Plant should get clear sunshine during most part of the day. Generation of feces has a direct bearing on the quantity of gas generated. Gas production would be maximum at a temperature between 30 to 35oC. If the ambient temperature falls below 10oC gas production is reduced drastically (Behera and Sharma, 2009).

Cost and Benefit of Biogas

The construction cost of biogas reactor which size 6 cubic metre were Rp 5,822,000. This cost was subsidized by PT Nestle as much as Rp 2,000,000. (PT Nestle is a milk company that buy milk from dairy cattle farmers). For the other farmer group, cost of biogas reactor was subsidized by HIVOS, a Nedherland institution who supported program of environmental health in Indonesia. The other cost as much as Rp 3,822,000 was lent by cooperative for 3 years by annuity payment. The next program for the other farmers who want to construct biogas will include the lump that the price is Rp 170,000. Thus, the total loan from cooperative was Rp 4,000,000. Actually many farmers want to construct biogas reactor with capacity of 10 to 12 cubic metre, because they think that this size of biogas is more efficient. However, the program is for the size of 6 cubic metre.

The size of the biogas reactor is decided by the number of family members and the availability of feces. Ten cubic metre capacity reactor will need seven to ten animals (cow) and 80 kg of feces. The gas produced will meet the requirement of 3-4 families with average of 4-5 members. Each ten cubic metre of biogas reactor produce 4 to 6 tubes of 3 kg biogas (total 12-15 kg) per day. If it is compared with the price of subsidized LPG of 3 kg (Rp 15,000), so the production value of biogas is Rp 60,000-Rp75,000 per day.

Biogas Slurry

Beside produce biogas, the byproduct is slurry. Slurry is obtained after the production of biogas. It is enriched manure. Another positive aspect of this manure is that even after weeks of exposure to the atmosphere, the slurry does not attract fleas and worms. In the integrated farming system, slurry is used as manure that can reduce using of chemical fertilizer, even no chemical. Using slurry has three benefits: reducing chemical usage for sustainability agriculture, producing organic product (at least eliminating chemical residue), and reducing waste to minimize environmental pollution.

In practice, we found that using slurry as manure is still very low. The potency is high enough. In case of Ngantang District, there are 749 biogas plant owned by the member of the Cooperative of Sumber Makmur, it can be personal or group. However, we still hard to find farmers who use slurry as manure of their farm, the number is less than 10%. The constraints is the farmer's attitude that they lazy to bring slurry from the biogas plant to the farm. A few people enthusiastic to use slurry for their farm, because they have proved that the crop production is increased. The other constraints is that not all farmer has livestock and crop at once. Actually it could be solved with cooperation between farmers who have slurry but have not crops and them who have crops but have not slurry. Thus, the integrated farming is implemented not in one individual farm, but in one farmer group.

A better condition was found at village of Tlekung that we found 23 farmers who use their own slurry as manure of their crop, mustard meat. This is a one way IF, because they sell all product, so there is not crop's waste used for livestock.

Manure

The other process of livestock waste is using feces for manure. The process is fermenting feces by using EM4 as starter. It is implemented by more farmers, they are from almost all of the study location (including Torongrejo). The wider implementation of making manure is because of the simple process. Farmer who have chicken, rabbit, and cow in small number also can make manure from their livestock feces.

Feeding

A few number of farmers used the crop's waste as livestock feed, but this is a very limited application in the field. Only farmers who plant corn can use the waste for feeding. An interesting implementation was found in this case. A farmer at Toyomarto did corn harvesting step by step. Each 2 or 3 days he harvest the corn, dried the corn and give the corn crop waste to the dairy cattle. He does like this so that the crop waste (corn stem) for feeding will always fresh. In this village the farmers have not had silo for feeding. Other farmers who do not have corn crops often buy it from their neighbors, the price is about Rp 5,000 for one bundle with 7 corn stems.

The implementation of the most ideal IF is still rare in the research location. We categorized the implementation of IF as two levels, cyclic-integrated and one way-integrated IF. Cyclic integrated farming is the system in which waste of livestock is used as

input of crops and also waste of crops is used as input of livestock. Meanwhile, "one way" integrated farming is the system in which only waste of livestock is used as input of crops or only waste of crops is used as input of livestock. In the following part we describe each type of IF as we found from the study places. At each type we describe the IF system, farm production and income. Special for dairy cattle, we counted the average production and income at once for all types of IF, because we do not need to describe the same thing frequently.

1)Dairy cattle – Biogas – Corn

This is one type of cyclic integrated farming. Farmers grow dairy cattle, process its waste as biogas, use biogas slurry as manure and organic pesticide of corn, use corn plant (after harvesting) as feed of dairy cattle. We found only three farmers who applied this type of IF, they are from Ngantang District and from Toyomarto - Junrejo District.

In this type of IF, the average production was 12 litres milk per day. Farmer who has 6 cows and all are in productive period, the total production was 72 litres per day; 504 litres per week; 2160 litres per month. This production is lower than the average of Indonesia, 15 litres per cow per day. Actually the other farmers who have better cows can get 20-30 litre per cow per day.

Production of corn for 0.25 hectare was 2 tons, so the conversion of production per hectare was 8 ton per hectare. This is much higher than the average of Indonesia, productivity of corn per hectare is 3.3 tons. If it is compared with corn productivity in East Java is much higher, because in average of East Java corn productivity is only 3.99 tons per hectare (BPS, 2011). If it is compared with the research result in Blora (Warsana, 2007) is almost the same. Warsana found that corn productivity per hectare in Blora was 8.30 tons for sample farmers; 8.54 tons for small farm; and 8.06 tons for large farm. A qualitative information from the farmer at Ngantang and Junrejo that the corn plant which use biogas slurry perform the growth, physical performance and production much better than those which do not use biogas slurry.

2)Dairy cattle – Biogas – Tomato

This is a type of one-way integrated farming. Farmers grow dairy cattle, process its waste as biogas, use biogas slurry as manure and organic pesticide of tomato. However,

they cannot use tomato plant as feed of dairy cattle. We found only two farmers from Ngantang District who applied this type of IF. The production of tomato at this IF is 6 tons for 2000m^2 land, so the conversion per hectare is 30 tons. Before using slurry as manure, he got only 5 tons tomato from the same land (20% increased). The other advantage using slurry for tomato crops is that he did not need to use chemical fertilizer anymore. So, the product becomes organic, actually, but he sold the product as usual, the price was same with the other farmer. This is a weakness that farmer do not have any strategy to sell health product to get higher price.

3)Dairy cattle – Biogas – Chili

This is a type of one-way integrated farming. Farmers grow dairy cattle, process its waste as biogas, use biogas slurry as manure and organic pesticide of chili. However, they cannot use chili plant as feed of dairy cattle. We found two farmers from Ngantang District who applied this type of IF. Production of chili before using slurry was 9 quintals for 1000 m^2. This farmer has not harvest chili after using slurry, but he predicted that the production will increase, at least 20%. The production will be approximately 10.8 quintals for 1000 m^2, so the conversion for 1 hectare will be 10.8 tons/hectare. This productivity is good enough, although it is still lower than those of chili cluster at Kepung District, a production center in Kediri District that reached the amount of 13 tons/hectare.

4)Dairy cattle – Biogas – Cabbage

This is a type of one-way integrated farming. Farmers grow dairy cattle, process its waste as biogas, use biogas slurry as manure and organic pesticide of cabbage. However, he did not use any plant as feed of dairy cattle, because he sells all cabbage crops. If there is a sort of cabbage, it is not for cow feed. We found one farmer from Ngantang District who applied this type of IF.

The farmer who applied this type of IF did not know exactly how many physically volume of the product because he sell all the product at land based on negotiation with the middleman. However, he can explain from the increasing number of return and the performance of the crops. Before using slurry, he sold Rp 6,000,000 up to Rp 7,000,000 for 0.25 hectares of land; after using slurry he sold Rp 11,500,000 for the same land and the

same price in general. It means that the return almost double after using slurry. The farmer seen enthusiastic when he explain about this, a prove that he was very happy of the achievement. Assuming that the price is Rp 1,500/kg, the estimation of production is 7 tons for 0.25 hectares, so the productivity is 28 tons/hectare. This productivity is higher than the national average of cabbage productivity, 20.51 tons/hectare (BPS, 2010).

5)Dairy cattle – Biogas – Mustard Meat

This is a type of one-way integrated farming. Farmers grow dairy cattle, process its waste as biogas, use biogas slurry as manure of mustard meat. However, they did not use any plant as feed of dairy cattle, because they sell all mustard mead crops. If there is a sort of mustard meat, it is not for cow feed. We found 20 farmers from Desa Tlekung Junrejo District who applied this type of IF. Production of mustard meat was 14.52 tons per hectare, meanwhile the farm income per hectare was Rp 6,032,000. This is high enough, it can be proved from the R/C ratio of 1,71 that means efficient. Similarly for three months farmers got 71% from the capital.

6)Cow – manure – Tomato

This is a type of one-way integrated farming. Farmers grow cow, process its waste as manure, for tomato crops. However, they did not use any plant as feed of cow, because tomato crops after harvesting is dry and not for cow feed. We found 3 farmers from Desa Torongrejo Junrejo District who applied this type of IF.

The average production of tomato was 5 tons per hectare. This productivity was counted from 2 farmers only, who process waste of cow and rabbit become manure and use it to fertilize tomato crop. This average production is below the average of Indonesia, 10 tons per hectare.

7)Rabbit – manure – tomato

This is a type of one-way integrated farming. Farmers grow rabbit, process its waste as manure, for tomato crops. We found 1 farmer from Desa Torongrejo Junrejo District who applied this type of IF. Production of tomato was 5 tons per hectare. The

production and farm income of tomato was counted together with the previous farmer from Torongrejo as the average data. Meanwhile, the income of rearing rabbit was Rp 306,250 for three month, with the R/C ratio of 1.54. This performance was not interesting anymore at Torongrejo Village, so that the farmer tends to reduce rearing rabbit.

8)Goat – manure – mustard - chilli

This is a type of one-way integrated farming. Farmers grow goat, process its waste as manure, for mustard and chili crops. They do not use any crop for goat feed. We found 1 farmer from Desa Torongrejo Junrejo District who applied this type of IF. The production mustard was 12.5 tons per hectare, but the income was very low, it was only Rp 1,011,400 and the R/C ratio 1.13. Although the R/C is more than 1, it was too low according to the farmer. Meanwhile the income of goat was Rp 4.800,000 with the R/C ratio of 1.67. It was taken from 8 goats, rearing period of 1 year.

Income of Dairy Cattle

The average of milk production was 15.83 liters per day. The price is Rp 3,300 per liter. Thus, the average of revenue per cattle is Rp 52,239. If it is reduced by the average cost Rp 24,875 the income will be Rp 27,364. From this analysis, the R/C ratio is 2.1 indicated that is efficient.

Table 1. Farm's Yield per Hectare

No	Type of IF	Crop's Yield (ton/Ha)	Milk yield per cattle (litre/day)	Increasing livestock value (Rp/year)
1	Dairy cattle – Biogas – Corn	8.0	12	-
2	Dairy cattle – Biogas – Tomato	30	20	-
3	Dairy cattle – Biogas – Chili	10.8	18	-
4	Dairy cattle – Biogas – Cabbage	28	16	-
5	Dairy cattle – Biogas – Mustard Meat	14.52	15	-
6	Dairy cattle – manure- Tomato	5.0	14	-
7	Rabbit – manure –Tomato	5.0	-	8,750
8	Goat – manure – mustard	12.5	-	600,000

Discussion

The research result showed that integrated farming have a better performance comparing with the conventional, especially for the crops farm. Moreover, we also found that the productivity of crops which use biogas slurry is better than those that use manure from fermented feces. Livestock did not show a better productivity because it is not related with the crops farm. There are three advantages obtained from the IF. First, farmers get higher income because of higher productivity and lower cost. The lower cost is due to reducing chemical fertilizer. Second, there is a better environment because the livestock waste is processed to be a beneficial input of farm. Third, it produces health food because of the minimum residue of chemical material.

A similar finding in Indonesia was found from the research of Alamsyah, et al (2009), although the analysis is different. Alamsyah did research about Financial Analysis of Cattle Based Integrated Farming System in Ogan Ilir. The research obtained that the investment of five billion Rupiahs obtained the Net Present Value more than four billion Rupiahs, Net B/C ratio of 2.59 and the Internal Rate of Return (IRR) of 30%. These financial figures show high profits in integrated farming. If it compared with the bank deposit rate that only about 6% per year, the IRR is very high.

Moreover in India, research on IF obtained a similar information. Channabasavanna, et.al. (2009) did research of integrated farming systems for small and medium farmers in Karnataka, India during the wet and dry seasons of 2003-04 and 2005-06. It recorded 26.3 and 32.3 per cent higher productivity and profitability, respectively over conventional rice-rice system. Among the components evaluated, the highest net returns was obtained from crop (63.8 %), followed by goat (30.9 %), fish (4.0 %) and poultry (1.3 %), respectively. Employment generation and water requirement was 275 Man days/ha/year and 1247 mm, respectively under the integrated farming system. Specific energy was low in IFS (3.09 MJ/kg).

From the three existing research on integrated farming, in Malang and Batu, in Ogan Ilir (Indonesia) and in Karnataka (India) showed that the productivity and financial results of IF were better than the conventional farming. We are optimistic that if most farmers implement this system, it will support food security and food sufficiency.

Now days, it still rare farmers who implement IF. There are many constraints. It often happens that farmers do not have crops farm and livestock at once. Sometimes farmers only want to focus only at one field (livestock only or crop only). Farmers who

have livestock and crop at once, sometimes, they only rent the land. Thus, they do not want to maintain land owned by other people/institution, since IF process is for the long term purpose of sustainability agriculture. Farmer's awareness of the sustainability environment for the future generation is needed. It takes a long time to reach, but we have to start right now.

Let us do a simulation. Each region should identify the potency of land. Each land should be assessed base on the agro-climate condition. It is also should be categorized to low, medium and highland. If the condition is appropriate for the integrated farming it will be categorized as potential land. Each potential land should be identified what are the livestock and crops suitable to grow there.

It is still hard to find the implementation of IF at medium and low land. That is why the implementation of IF is still dominated by vegetable crops. We have just found corn crops as part of IF. In the future we hope that the crop variation will be more from cereal plant category.

After finding potential land, each region should determine the target. If the target is 5 years, at first year there are 20% farmers should implement IF, second year 40% and so on. This is should be managed continuously, so that farmers who already implement IF will not escape from the system.

In case of there is limitation of farmer's land and capital, IF system can be implemented in a group. It needs cooperation between farmers who have crops and them who have livestock. We still found in the field that some farmers trough away biogas slurry to the river. They do not use it because they do not have any crop. In contrary, we also found that other farmer who the distance less than 1 km cannot use slurry routinely because he did not have any livestock. So far he use slurry given by his brother, if there is a rest. This fact indicated that there is no cooperation between farmers in implementing IF. Of course, it need to be coordinated in one region. It can be start from one village, continuing to one district, and so on.

Conclusion

Crop's productivity from integrated farming were much higher than those from the conventional one. Besides, the farmer's income also increased. If there are more cereal farmers who implement IF, it will increase food production in the region level. With the

simulation, we can predict that if we add 20% farmers who implement IF each year, food sufficiency will be easier to reach in the next five years.

References

Alamsyah Idham, T. Lestari, D. Andriani. Analisis Finansial Sistem Usahatani Terpadu (Integrated Farming) Berbasis Ternak Sapi di Kabupaten Ogan Ilir, *Jurnal Pembangunan Manusia*, Edisi 6, Balitbangda Sumsel. Diakses di internet pada: 20 April 2011.

Anonim. 2002. *Peraturan Pemerintah Republik Indonesia Nomor 68 Tahun 2000 Tentang Ketahanan Pangan.* Jakarta: Sekretaris Negara RI.

Behera, U.K. and A.R. Sharma, 2007. *Modern Concepts of Agriculture*. Indian Agricultural Research Institute, New Delhi.

BPS, 2010. *Data Produktivitas Nasional Tanaman Sayur.* Browsing at internet www.bps.go.id

Channabasavanna, et.al. (2009). Development of profitable integrated farming system model for small and medium farmers of Tungabhadra project area of Karnataka. *Karnataka J. Agric. Sci*. 22(1): 25-27 2009.

FAO. 1996. *World Food Summit,* 13-17 November 1996. Rome, Italy: Food and Agriculture Organisation of the United Nations.

Insani, G. Adi, 2010. Integrated Farming System: Mungkinkah? http://chickaholic.wordpress.com/2010/07/09/integrated-farming-system-mungkinkah

Krisnamurthi, Bayu, 2003. Agenda Pemberdayaan Petani Dalam Rangka Pemantapan Ketahanan Pangan Nasional. Jurnal Ekonomi Rakyat. Artikel - Th. II - No. 7 - Oktober 2003. At internet http:// www.ekonomirakyat.org/edisi_19/artikel

Macionis, John J., 1996. *Society The Basics*, Third Edition. Prentice-Hall, New Jersey, USA.

Mubyarto dan Awan Santosa, 2003. Pembangunan Pertanian Berkelanjutan (Kritik Terhadap Paradigma Agribisnis). Jurnal Ekonomi Rakyat, Artikel - Th. II - No. 3 - Mei 2003]

Mulyana, Deddy, 2003. *Metodologi Penelitian Kualitatif.* Paradigma Baru Ilmu Komunikasi dan Ilmu Sosial Lainnya. Penerbit PT Remaja Rosdakarya, Bandung.

Plog, Fred and D.G.Bates, 1979. *Cultural Anthropology*. Second Edition. Alfred A.Knoff, Inc. USA.

Relawati Rahayu, 2003b. *Analisis Ketahanan Pangan Masyarakat Desa, Studi Kasus di Desa Jambuwer Kabupaten Malang.* Laporan Penelitian DPP UMM.

Warsana, 2007. Analisis Efisiensi dan Keuntungan Usahatani Jagung (Studi di Kecamatan Randublatung Kabupaten Blora). Tesis Pascasarjana, Universitas Diponegoro, Semarang. At Internet: http://eprints.undip.ac.id/17660/1/WARSANA.pdf, browsing 22 Juni 2012.