FARMER'S HOUSHOLDS FOOD SECURITY IN SUSTAINABLE AGRICULTURE CONTEXT[1]

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ABSTRAK

Tujuan penelitian ini adalah menentukan perbaikan sistem usahatani dengan simulasi programasi linier yang dapat memperbaiki aliran kas bersih (*net cash flow*) yang mencerminkan kesejahteraan finansial rumahtangga tani sekaligus produksi usahatani yang berkelanjutan.

Simulasi model programasi linier rumahtangga tani yang memenuhi persyaratan ketahanan pangan rumahtangga dan pertanian berkelanjutan (model FSSA-LP) digunakan untuk analisis penelitian. Data primer yang diperoleh dari 100 sampel rumahtangga tani untuk setiap daerah pedesaan di tiga provinsi di Indonesia, yakni Bali, Jawa Timur dan Daerah Istimewa Yogyakarta, digunakan untuk menetapkan parameter model. Penerapan efisiensi teknis yang lebih tinggi dan metode pertanian berkelanjutan dengan input eksternal rendah sekaligus pertanian berkelanjutan dengan informasi ekologi tinggi disimulasikan dalam model FSSA-LP yang valid.

Hasil penelitian menunjukkan bahwa penerapan secara simultan tingkat efisiensi teknis tertinggi yang menghasilkan output usahatani optimal dan metode pertanian berkelanjutan dengan input eksternal rendah sekaligus pertanian berkelanjutan dengan informasi ekologi tinggi yang menghasilkan usahatani lebih lestari pada model FSSA-LP tidak hanya meningkatkan aliran kas bersih rumahtangga tani tetapi juga mengatasi penurunan aliran kas bersih rumahtangga tani akibat perubahan faktor-faktor eksogen dari model FSSA-LP, seperti tingkat suku bunga kredit tinggi, harga input usahatani tinggi, harga output rendah, dan harga pangan tinggi secara simultan.

Kata kunci: Ketahanan Pangan Rumahtangga, Pertanian Berkelanjutan, Efisiensi Teknis.

INTRODUCTION

Low nutrition status caused by low amount and poor quality of food consumed as well as the conservative nature of farm production constrained for farm household in matches the requirements of household food security and sustainable agriculture. If food produced using conservative farm techniques failed to satisfy household food requirements, households meet their food needs by buying food from the market. If food prices remain constant, household food purchasing power can increase by improving the household total income. This study endeavored to determine reforms in the FSSA-LP model that can improve household net cash flow together with conservative farm production.

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By definition, household food security refers to access to food that is both quantitatively and qualitatively sufficient to satisfy consumption and nutritional requirements necessary for the household to carry out its daily activities and to lead a healthy life according to the local culture. Food availability necessary to satisfy food consumption can be obtained through farm production as well as buying it from the market. There are three dimensions of household food security. These are; food availability and distribution, food purchasing power and food habit (FAO, 1996; FAO, 1997).

Household food security situation in Indonesia is still far from satisfactory. This is clearly indicated by the aggregate food security index of households grouped as food insecure, especially as far as calorie and protein intake is concerned. This poor performance in household food security situation can be attributed to a number of factors like inequality in seasonal food availability and distribution, low food purchasing power and bad food habit caused by lack of knowledge about food. Many researchers have also found that the low level of household food security situation in Indonesia is intimately linked to the low level of sustainable agriculture.

The development and widespread adoption of modern agriculture practices over the last 30 years in Indonesia have led to a tremendous increase in agricultural production. Paradoxically, the same methods, processes and technologies that increased agricultural productive have also got some negative consequences. Among these are: soil erosion, loss of biological diversity, agrochemical pollution, increased farmer indebtedness, displacement and disempowerment, loss of indigenous knowledge and deterioration of quality of rural life (Zamora, 1996).

The growing awareness of problems associated with the mainstream approach to agricultural research and development and the changing situation in the agricultural environment during the 1980s, led to the development of institutions to search for a more sustainable system of agriculture at various levels.

There are many definitions of sustainable agriculture. Among others, the description of sustainable agriculture includes farming systems that are commonly referred to as organic, ecological, regenerative, biodynamic, permanent, alternative, natural, low external input sustainable agriculture (LI/SA) and high information ecological sustainable agriculture (HI/SA) (Sajise, 1995; Luna and House, 1990).

FAO (1991) defined sustainable agriculture as management and natural resources conservation (soil, water, germ plasmas, crops and livestock) and changes of technological orientation as well as institutions to satisfy human needs at present and for future generations. TAC/CGIAR (1988) defined sustainable agriculture as the successful management of resources for agricultural farming that can help meet the ever changing human needs and to conserve or improve the quality of the environment and also to sustain natural resources.

Compounding a single operational definition for sustainable agriculture may be difficult at the moment, but it can be expressed basing on the existing criteria. Criteria for sustainable agriculture are: economic viability, ecologically sound and friendly, socially just, culturally appropriate and systems/holistic approach (Zamora, 1996).

In all the initiatives and activities involving sustainable agriculture, it is clear that sustainable agricultural framework and its variations are essentially divergent from the current mainstream agricultural research and production practices and there are strong arguments for the need for new directions and approaches to agriculture.

THEORITICAL FRAMEWORK

The farm household model that satisfied the requirements of household food security and sustainable agriculture constitutes the intersection of three components i.e. (1) farm production from a sustainable farming system, (2) household food consumption that meets nutritional requirement according to the ideal national food pattern, and (3) food habit. The conceptual framework of this research is presented on Figure 1.

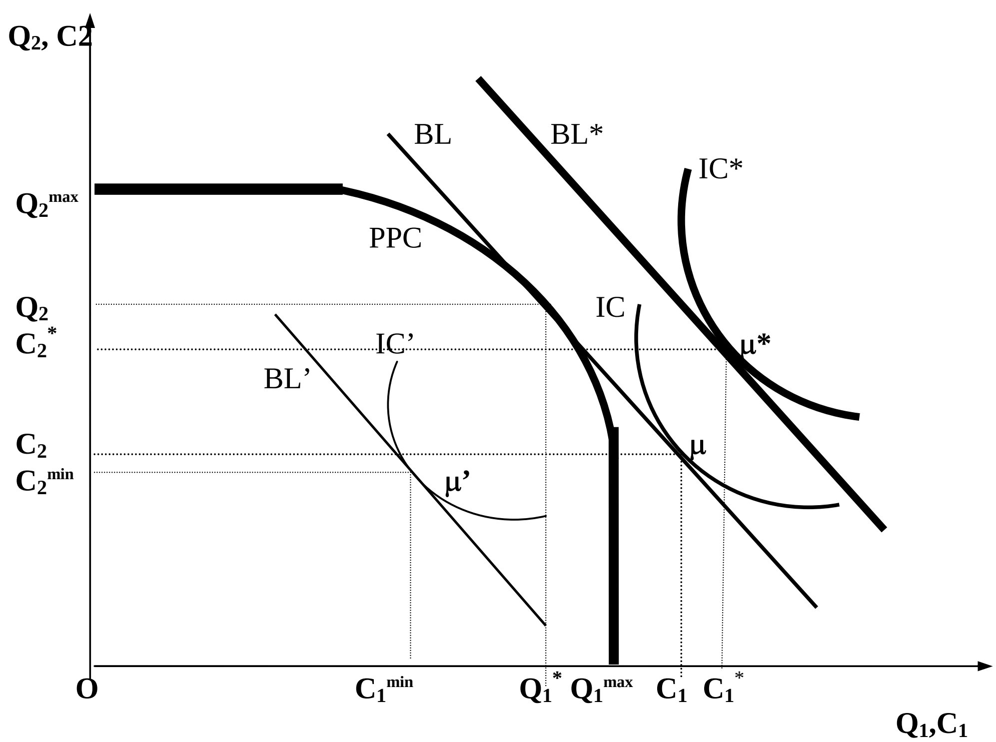

Figure 1. Farm Household Model that Satisfies the Requirements of Household Food Security and Sustainable Agriculture

The rational and knowledgeable farm households only consider every point along the production possibility curve (PPC). Every point below the curve represents the level of production that is below the production potential of available farm resources. Understanding the reason why farm households do not produce at the production possibility frontier (PPF) constitutes one level for determining the constraints to maximize net household's income.

Since threshold agricultural input usage in the process of production is highly considered in building the model of farm household that satisfies the requirements of household food security and sustainable agriculture, construction of the PPC is done by cutting the PPC at maximum level of production of a commodity produced using the conservative food production (use of agricultural inputs below the tolerable rating). Production activity of Q_1 that met the requirements of sustainable agriculture is located to the left of Q_1^{max} while for Q_2 is in below Q_2^{max}.

The problem often faced by households is the conservative food production that does not satisfy household consumption basing on the recommended health requirements. This means that food production does not balance with food consumption. When food production obtained through conservative farm techniques does not satisfy household food consumption, households can meet their food requirements by buying it from the market. If food prices remain constant, household food purchasing power can be increased by increasing household total income. In this situation, the equilibrium is achieved in theoretical terms because the conditions for household food security requirements and sustainable agriculture are satisfied.

RESEARCH METHODS

The FSSA-LP model was used to achieve the objectives of this study. Primary data was collected from a sample of 100 farm households in three villages of the three Indonesian provinces, i.e. (a) Penebel Village, Bali Province, (b) Pakisaji Village, East Java Province and (c) Wijimulyo Village, Yogyakarta Province. Secondary data was also gathered from relevant government offices, such as the provincial offices for Agriculture, Animal Husbandry, Health, Cooperative, and the BRI at each province to supplement the specified parameters of the model. Seasonal constraints and requirements are introduced in the model. Three seasons in 1996-1997, i.e. season 1 (November-February), season 2 (March-June) and season 3 (July-October) are considered to be a complete period for covering all activities of a rice farm yearly. The application of the highest technical efficiency rating (TER) and the methods of low external input sustainable agriculture (LI/SA) as well as high ecological information for sustainable agriculture (HI/SA) were simultaneously used to simulate and validate the FSSA-LP model.

Linear programming is a mathematical technique that can be used to allocate limited resources among competing activities to maximize the value of the objective function (Heady and Candler, 1973). The general model of linear programming problem is expressed as follows:

$$\text{Maximize } Z = \sum_{j=1}^{n} C_j X_j \qquad (1)$$

Subject to:

$$\sum_{j=1}^{n} a_j X_j \begin{smallmatrix} > \\ = \\ < \end{smallmatrix} b_i;\ i=1,2,\ldots,m \qquad (2)$$

$$\text{and} \quad X_j \geq 0 \qquad (3)$$

where Z is the objective function or function to br maximized; X_j's are the activities or decision variables; $C_{j's}$ are the contributions of jth activities to the value of the objective function; a_{ij}'s are the rate of use of (or contribution to) the b_ith constraint (or requirement) by a unit of jth activity; b_i's are the resource or requirement levels.

Equations (2) and (3) are the set of constraints and non negative conditions, respectively, which must be satisfied in optimization. More specifically, the farm households' linear programming model that matches the requirements of households' food security and sustainable agriculture (FSSA-LP model) can be illustrated as follows:

$$\text{Maximize: } z = c_1x_1 + \ldots + c_jx_j + \ldots + c_nx_n$$

Subject to:

$$a_{11}x_1 + \ldots + a_{1j}x_j + \ldots + a_{1n}x_n \begin{smallmatrix} > \\ = \\ < \end{smallmatrix} b_1$$

$$a_{i1}x_1 + \ldots + a_{ij}x_j + \ldots + a_{in}x_n \begin{smallmatrix} > \\ = \\ < \end{smallmatrix} b_i$$

$$a_{m1}x_1 + \ldots + a_{mj}x_j + \ldots + a_{mn}x_n \begin{smallmatrix} > \\ = \\ < \end{smallmatrix} b_m$$

$$a_{f1}x_1 + \ldots + a_{f}x_j + \ldots + a_{fn}x_n = \text{food security}$$

$$a_{s1}x_1 + \ldots + a_{sj}x_j + \ldots + a_{sn}x_n \leq \text{sustainable agriculture}$$

$$a_{u1}x_1 + \ldots + a_{uj}x_j + \ldots + a_{un}x_n + a_{uw}x_w = \text{capital}$$

$$a_{c1}x_1 + \ldots + a_{cj}x_j + \ldots + a_{cn}x_n + a_{cw}x_w \leq \text{credit limit}$$

$$a_{r1}x_1 + \ldots + a_{rj}x_j + \ldots + a_{rn}x_n + a_{rw}x_w \geq \text{cash reserve}$$

$$\text{and } x_j \geq 0$$

where z is the objective function (net cash flow); x_j's are the activity alternatives in production, consumption, marketing and finance; b_i's are the constraints: requirements (>), restrictions (<) and equalities (=); a_{ij}'s is an addition to (<0) or substraction from (>0) b_i by a unit of x_j; c_j is an addition to (>0) or subtraction from (<0) z by a unit of x_j; a_{fj} is the rate of households food security requirements decreases (>0) or increases (<0) by choices in production, consumption, marketing and finance; a_{sj} is the rate of sustainable agriculture requirements decreases (>0) or increases (<0) by choices in production, consumption, marketing and finance; a_{uj} is the rate at which cash reserve decreases (>0) or increases (<0) by choices in production, consumption, marketing and finance; a_{cj} is the rate at which credit limit decreases (>0) or increases (<0) by choices in production, consumption, marketing and finance.

The first m rows below the objective function (z) and the first n column specify a conventional linear programming matrix, including cash account and credit account rows. The n columns include activities for borrowing and repayment loan. To this matrix then, are added rows for household's food security and sustainable agriculture.

RESULTS AND DISCUSION

Farm households that satisfied the requirements for household food security and sustainable agriculture (model FSSA-LP) had the opportunity to increase household net cash flow by applying the highest technical efficiency rating (TER) that yielded optimal farm output and methods of low external input sustainable agriculture (LI/SA) and high information ecological input sustainable agriculture (HI/SA) that simultaneously resulted from sustainable farm production in the FSSA-LP model. These did not only increase household net cash flow but also offset the loss to household net cash flow that resulted from simultaneously changing the exogenous factors of the FSSA-LP model, such as high credit interest rate, high current input price, low farm output and high food prices. This is indicated by the significant increase in household's net cash flow in Penebel Village, Bali Province, Pakisaji Village, East Java Province, and Wijimulyo Village, Yogyakarta Province compared with the actual net cash flow (Table 1).

Table 1. The Application of the Higher TER and the Methods of LI/SA and HI/SA Without and With Changing the Exogenous Factors

Simulation	Village	Net Cash Flow (Rp.000)	Increase (Rp.000)
1. Application of the higher TER and the methods of LI/SA and HI/SA without changing the exogenous factors	Penebel, Bali	3.574	638
	Wijimulyo,Yogya	3.349	668
	Pakisaji, East Java	2.812	595
2. Application of the higher TER and the methods of LI/SA and HI/SA with changing the exogenous factors	Penebel, Bali	3.428	492
	Wijimulyo,Yogya	3.321	640
	Pakisaji, East Java	2.699	482

Farmer's household food security requirements at villages of Bali, Yogyakarta and East Java can be satisfied from the household's food availability. Table 2 shows the ways of the households satisfied the national ideal food pattern.

Table 2. Food Availability to Satisfy the National Ideal Food Pattern, 1997

Food material	PPH	Food from farm (kg)			Food from market (kg)		
	(kg)	Bali	Yogya	East Java	Bali	Yogya	East Java
Grains	221	211	211	211	0	0	0
Tuber roots	61	53	54	54	8	6	7
Meats	85	0	0	0	83	84	86
Beans	20	9	9	10	11	11	10
Oil and fats	22	0	0	0	22	22	22
Fruit/seed oils	53	49	45	18	3	8	34
Vegetables and fruits	166	112	107	97	48	61	73
Sugars	28	0	0	0	28	28	28

The household's purchasing powers for food were affected by household's income and market food price at all villages. Household's income its self provided from all cash supply. The household's food pattern variation was determinate by difference of the household's food habit.

Sustainable agriculture characteristics at farm level represented by soil erosion, external input uses, credit limit and households cash reserve. This research found that the sustainable agriculture requirements satisfied.

There is no one answer for sustainable agriculture systems. Whatever agriculture systems, whether solid chemical substance or natural, if referred to one point of views may be identified as resource conservation, but in different point of view may be identified as extravagant, no environmental sound or polluting. Often asked by experts in agriculture field that how long can we hold out energy inputs, nutrient supply, fuel, petrochemical and mineral fertilizers from outer part of farming system? Direct replacement of the external chemical inputs with non-chemical input, however, not produce results more sustainable agriculture yet. For instance, precise less use of organic fertilizer (manure) cause soil and water surface pollute as bad as pollution cause by excessive use of chemical fertilizer. It is analogue to bio pesticide use that proceeds same peril as excessive use of chemical pesticide (Dover and Talbot, 1987).

External input use, such as pesticide; artificial fertilizer and agricultural machines, in a mass manner caused damaged non-renewable resources and environment. Agriculture system that developed along several past decades put on large contribution indeed on decreasing of famine and increasing of farm household standard of living (Agarwal and Narain, 1989; Shepherd, 1998).

With observed the cases that threaten agriculture sustainability, no needed meticulous thinking to aware direct relationship between food security and sustainable agriculture. World food security not only depends on increasing of food production, but also on decreasing of distortion in world food market structure and shift of focus to resources based sustainable food production.

Focus of world agency project that connected on food and agriculture in elevation of poverty and malnutrition was maintained global food security, natural resources management and environment conservation. Nowadays, challenging for agricultural experts is to develop a strategy to outcome sustainable food security at the transition period of green revolution to green-green revolution.

CONCLUSION AND RECOMMENDATION

Conclusion

Low nutrition status due to low amount and quality of food consumption as well as less conservation in nature of farm production constrained for farm households in matches the requirements of households' food security and sustainable agriculture.

The application of highest technical efficiency that yielded optimal farm output and methods of low external input sustainable agriculture as well as high ecological information sustainable agriculture that resulted sustainable farm production in the FSSA-LP model simultaneosly, not only increase households net cash flow but also can offset the loss of the households net cash flow resulted by simultaneously changing of exogenous factors of the FSSA-LP model, such as high credit interest rate, high current input price, low farm output and high food price.

Recommendations

It is therefore recommended that the application of the higher TER and the methods of LI/SA and HI/SA in the FSSA-LP model be simultaneously applied in order to improve household net cash flow as well as the sustainable farm production.

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REFERENCES

Agarwal,A. and S.Narain (1989), *Toward Green Villages: A Strategy for Environmentally-sound and Participatory Rural Development,* CSE, New Delhi.

Devor, M and L.M. Talbot (1987), *To Feed the Earth: Agro ecology for Sustainable Development*, World Resource Institute, Washington DC.

FAO (1991), *Farming, Processing and Marketing Systems for Sustainable Agriculture and Rural Development*, Rome.

FAO (1996), Policy Statement and Plan of Action of the World Food Summit, Draft Working Paper at Inter-sessional Working Group of the Committee of World Food Security, Rome, July 29-August 2.

FAO (1997), Assessment of the Household Food Security Situation, Based on the Aggregate Household Food Security Index and the Sixth World Food Survey, Document CFS:97/4 SUP.1 at 23rd Session of the Committee on World Food Security, Rome, April 14-18.

Heady, Earl O. and Wilfred Candler (1973), *Linear Programming Methods,* Seventh Edition, The Iowa State University Press, Ames.

Luna, John M. and R.R. House (1990), ‘Pest Management in Sustainable Agricultural Systems’, in Edwards, Clive A. *et al.*(Eds.), *Sustainable Agricultural Systems,* Soil and Water Conservation Society, Ankeny, pp.157-73.

Sajise, Percy E. (1995), Sustainable Agriculture and Rural Development Concerns in Southeast Asia, Paper Presented at the Seminar ‘People-Based Sustainable Agricultural Development for a Global Tomorrow’, Yogyakarta, October 30-31.

Shepherd, Andrew (1998), *Sustainable Rural Development*, Macmillan Press Ltd., London.

TAC/CGIAR (1988), *Sustainable Agriculture Production: Implication for International Agriculture Research*, FAO, Rome.

Widodo, Sri (1998), 'Farming System Approach for Sustainable Agriculture', *Agro Ekonomi* 5, pp. 1-6.

Zamora, Oscar B. (1996), Contextualizing the Indicators for Sustainable Agriculture, in SEARCA, Working Paper on 'Sustainable Agriculture Indicators', SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA), College.