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Sustainable Rice-Cattle Integrated Farming System for Small Landholders in the Province of Bulacan

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Abstract. The escalating concerns regarding expanding population, pollution, desertification, depletion of energy reserves, and degradation of natural resources set forth sustainable development to become an important topic in social, political and scientific agenda in recent years. Sustainable agriculture with sustainable ecosystems ensures the socio-economic development for future generations. This paper presents a rice-cattle integrated farming system model for small landholders in the province of Bulacan. The results discuss the average annual expenditure and income in the rice, cattle and combined rice cattle farming system. The future directives of this work enfold development of agricultural machinery to support the integrated farming system, further improvement on socio-economic aspects of the farmers, environmental aspects such as significant sequestration of carbon as one of the agricultural by-products.

Keywords: sustainable, rice, cattle, integrated, farming

1. Introduction

The escalating concerns regarding expanding population, pollution, desertification, depletion of energy reserves and degradation of natural resources set forth sustainable development to become an important topic in the social, political and scientific agenda in recent years [1]. Sustainable development concept covers a broad range of fields and its impact can be assessed along multiple dimensions, such as ecological, economic and social dimensions [1]-[5]. Agricultural development is one of the areas where sustainable development questions needs to be addressed regularly.

Agriculture is the basis of the national economy [6], [7], and it is the basic conditions and foundation of other industries existence and development. Agricultural development is important, as agriculture provides the means for producing the food that the population needs. Furthermore, many economies are dependent on agriculture for generating wealth and its development in a sustainable way is essential to secure economic development for future generations.

The predominant activity of human interaction in the natural world is accounted to agriculture [8]. Sustainable agriculture with sustainable ecosystems certainly enhances the biodiversity. Thus, the greater the diversity results to greater stability. However, the system of industrial agriculture leads to highly specialized and intensive monoculture that is more and more dependent on chemical fertilizers, pesticides, and machine power. These allows dramatic increases in productivity and correspondingly cheap and abundant food, inevitably leads to soil compaction, top-soil erosion, pollution [9], loss of genetic diversity and ultimately the loss of fertility [9], [10]. Moreover, serious environmental degradations [11], [12] have a very close relationship with the predatory and high input and output of agriculture operation.

Currently, lots of land use problems we're facing, such as sharp decrease of cultivated land, disordered expansion of construction land, deterioration of ecological environment, are caused by improper land use

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structure [13]. Small diversified family farms, according to the ecological agrarians, are more likely to be ecologically sound. When diversified, farms wasted nothing, for farmers raise grain, feed it to livestock, and use the manure from the livestock to fertilize the field [14]. Small owners of farms, moreover, are better motivated to care their land and maintained soil fertility, not only because their next generations would depend on the land for their survival, but also because long-term occupation of a place allows the owner to develop emotional attachments [15].

1.1. Current situational analysis

Currently, majority of farmers in Bulacan are holding arable lands generally less than two and a half hectares. These farmers generally practice subsistence farming where they are confronted by multi-faceted challenges of producing a continuous, reliable and balanced supply of foods, as well as cash for basic needs and recurrent farming expenditure. Moreover, farmers are engaged to single crop production subjected to a high degree of risk and uncertainty [16] because of seasonal, irregular and uncertain income and employment to the farmers. Furthermore, the damages brought about by cyclical typhoons sets forth the farmers to face with the worst situation of few harvest or nothing at all.

Crop residues, on the other hand, such as rice stalks, hays and the likes are considered to be hurdle and non-value by-products during land tilling. These are immediately burned resulting to a thick white smoke, being inhaled by farmers for many hours sometimes due to wet residues and rotational wind directions. As a result, farmers with asthma incurred additional expenses for the medicine they need to take.

1.2. Motivations and objectives

Due to high risk and extreme level of uncertainty in income, farmers are faced with multi-faceted challenges in recovering their inputs loaned from private entities as well as to sustain their basic needs and succeeding farming expenditures. Marginal farmers tend to loss their rights to leasehold or even ownership with their ballooning debts. The concept of integrated farming system [17] can provide alternative approach to alleviate the economic conditions of farmers. The main trust of the study is to assess the field testing for the rice-cattle integrated farming system model for small landholders towards sustainable agriculture in the province of Bulacan.

2. Design Architecture

2.1. Rice-Cattle integrated farming system model

The rice-cattle integrated farming system [RCaIFS] concept presents the relationships among the different areas involved within the process as shown in Fig. 1. The model commences with the aggregate inputs comprising of rice farming [RF] inputs and cattle farming [CaF] inputs. These inputs are set forth directly and indirectly into the land. The output of each system are converted or given an equivalent in monetary values, and the combination is called aggregate outputs.

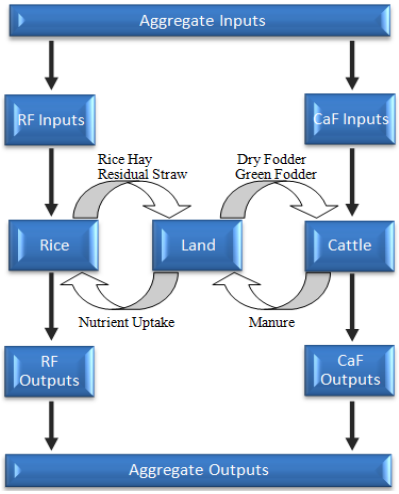

Fig. 1: Rice-Cattle Integrated Farming System Design Concept

The rice farming system provides rice hay and residual straw into the land. The by-products can be taken by cattle as dry matter during feeding and grazing respectively. Likewise, green fodder such as grasses and weeds serve as cattle food. In return, manures are spread back to the soil for nutrient uptake to rice plants.

2.2. Rice farming and cattle farming scheme

The rice farming scheme shown in Fig. 2 sequenced the activities which includes the input, processor, intermediate output, and the outputs products and by-products stages. The input stage consists of seeds, fertilizer as major soil amendment, water, and pesticides as other agro-chemicals. Moreover, operational and labor costs are considered to be input in the system. The land processes the available inputs and thus resulted to intermediate output such as palay, rice hays, grasses and weeds, and residual straw. The output product is the rice grains while the by-products available for cattle use are rice bran concentrate, stack hays and cut grass and weeds. The manures produced are sent back to rice land as organic soil amendment.

The cattle farming scheme shown in Fig. 3 progresses from various inputs, processor, intermediate output, to output products and by-products. The inputs consist of cattle, housing, medicines, breeding, operational cost and feeding materials. The land accommodates the inputs directly and indirectly in nature. The intermediate outputs are matured cattle and calves, and manures. The former intermediate outputs are the products for meat and for growing; whereas, the latter is the by-products for rice farming. This by-products when processed provides green and dry fodder as well as concentrate as feed material to the cattle.

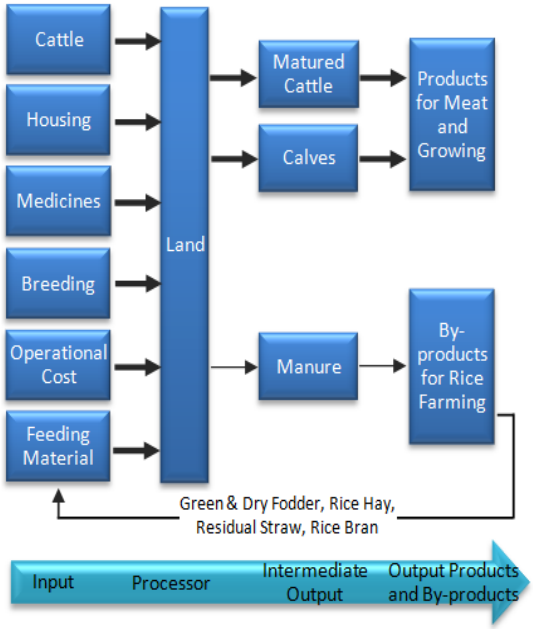

Fig. 2: Rice Farming System Concept

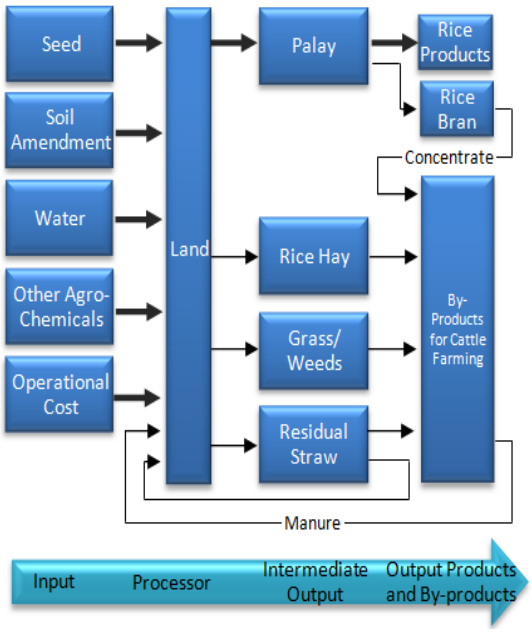

Fig. 3: Cattle Farming System Concept

3. Results and Analysis

3.1. Rice and cattle farming average annual income and expenditure

The average annual income and expenditure on rice farming are presented in the foregoing Table 1 having all the values in USD. The expenditures include seeds, 83.60; water, 51.09; agro-chemicals such as fertilizers, 230.37, herbicides, 55.73, and pesticides, 58.06; operational costs that include landhold rental, 292.61, land tillage, 139.34, transplanting, 53.41, harvesting 418.01, and other associated cost, 95.10. The total expenditure is approximately lumped to 1, 475.12. On the other hand, the gross income is approximately 2090.06. The net income is 614.94.

The cattle farming average annual income and expenditure as depicted in Table 2. The expenditure includes the cost of purchased of the two cattles, 278.67; cattle housing, 23.22; feeding cost, 71.99; medicines, 9.29; medicines, 9.29; breeding, 18.58; operational cost, 41.80 and 1.49 for the land use compensation and other cost respectively. The total expenditure is 445.04. All values are in USD. The gross income consists of the values of matured cattle and calves, that is, 325.12 and 743.13 respectively. The total income is approximately 1,068.25. Finally, the net income is 623.21.

Table 1: Average Annual Income and Expenditure on Rice Farming

Item	Particulars	Cost Details In USD	Amount In USD
Expenditure	Seeds	83.60	1,475.12
	Water	51.09	
	Agro-Chemicals		
	Fertilizers	230.37	
	Herbicides	55.73	
	Pesticides	58.06	
	Operational Cost		
	Landhold Rental	292.61	
	Land Tillage	139.34	
	Transplanting	53.41	
	Harvesting	418.01	
	Other Cost	95.10	
Gross Income	Palay	2,090.06	2,090.06
Net Income			614.94

Table 2: Average Annual Income and Expenditure on Cattle Farming

	Particulars	Cost Details In USD	Amount In USD
Expenditure		278.67	445.04
	Cattle Cost	23.22	
	Housing	71.99	
	Feeding Cost		
	Green/Dry Fodder		
	Rice Bran		
	Molasses	9.29	
	Medicines	18.58	
	Breeding		
	Natural		
	Artificial Insemination		
	Operational Cost		
	Land Use Compensation		
	Other Cost	41.80	
		1.49	
Gross Income	Value of Matured Cows	325.12	1,068.25
	Value of Calves	743.13	
Net Income			623.21

3.2. Rice-Cattle integrated farming system average annual income and expenditure

Table 3 provides the combined average annual income and expenditure on rice-cattle integrated farming system. The amount of expenditure, gross income and net income is 1 920.16 USD, 3 158.31 USD, and 1 23r8.15 USD respectively.

Table 3: Average Annual Income and Expenditure on Rice-Cattle Integrated Farming System

Particulars	Rice Farming In USD	Cattle Farming In USD	Amount In USD
Expenditure	1,475.12	445.04	1,920.16
Gross Income	2,090.06	1,068.25	3,158.31
Net Income	614.94	623.21	1,238.15

Among the expenditures enlisted in Fig. 4, the operational cost provide greater share to cash outflow of 998.47. The amount of agrochemicals used is 344.16. The costs of seeds and water are 83.60 and 51.09 respectively. The expenditures in Fig. 5 depicted the distribution of inputs in decreasing manner which started from the cost of two cattles, feeding cost, operational cost, housing, breeding and medicines. The expenditure for rice farming is approximately thrice that of cattle farming. Likewise, the gross income for rice farming is about twice that of cattle farming. The observed individual net income was found to be almost the same. Moreover, the combined net income doubles the return to the farmer.

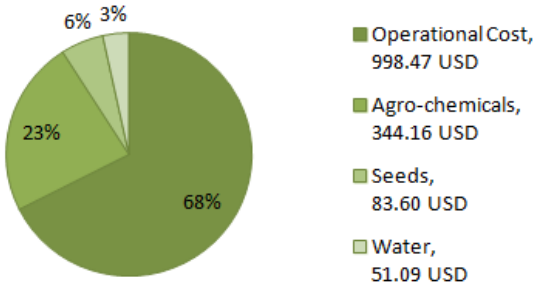

Fig. 4: Annual Average Expenditure of Rice Farming

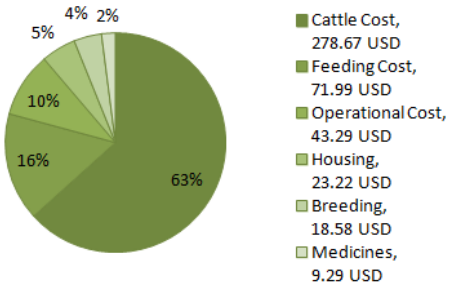

Fig. 5: Annual Average Expenditure of Cattle Farming

4. Conclusions and Future Directives

4.1. Conclusions

The rice-cattle integrated farming system or RCaIFS is a resurgence of past practices together with the new technologies that supports sustainable agriculture in terms of social, economic and environmental

dimensions. The RCaIFS concept provides alternative approach to alleviate the economic conditions of subsistence farmers. It also integrates natural processes of nutrient recycling that took place between rice plants and cattles. The intellectual merit of this study includes the use of new and past knowledge as well as the innate skills of framers for greatly improving their self-reliance while substituting human capital for costly inputs.

The empirical study shows the doubling effect of net income of the farmer. It also provides an idea of decreasing synthetic fertilizers as soil amendments using organic manures to further increase the yield. Moreover, the integrated farming system serves as food security measure acting as an alternative source of income against the disastrous effect of bad weather conditions during rainy seasons.

4.2. Future directives

The future directions of this work enfold development of agricultural machinery to support the integrated farming system, further improvement on socio-economic aspects of the farmers, environmental aspects such as significant sequestration of carbon as one of the agricultural by-products, and integrated pest management systems. Moreover, the concept of agricultural system being viewed as system of systems towards a framework of agricultural sustainability will be initiated for small landholders in the Philippines.

5. References

[1] R. Bosma, U. Kaymak, J. van den Berg and H.M. J. Udo, "Fuzzy Modelling of Farmers Motivations for Integrated Farming in Mekong Delta," *IEEE Int. C Fuzzy Systems*, 2005.

[2] K. P. Lai, "Situation and measure of eco-environmental protection in the rural," Technol. Life, vol. 10, 2010.

[3] L. N. Sun, "Discuss on protection of ecological environment in the rural," Technol. Life, vol. 11, 2010.

[4] L. A. Marks, E. G. Dunn, J. M. Keller and L. D. Godsey, "Multiple Criteria Decision Making (MCDM) Using Fuzzy Logic: An Innovative Approach to Sustainable Agriculture," *IEEE P ISUMA-NAFIPS*, 1995.

[5] E. G. Dunn, J. M. Keller, L. A. Marks, J. E. Ikerd, P. D. Gader and L. D. Godsey, "Extending the Application of Fuzzy Sets to the Problem of Agricultural Sustainability," *IEEE P ISUMA-NAFIPS*, 1995.

[6] Y. Xiao and S. Weizheng, "Optimization System Research on Productive Project of Large Scale Farms based on Genetic Algorithm," *Int. C Computer Application and System Modelling*, 2010.

[7] S. Wen and S. Wen-jun, "Decision of Production Planning in Agricultural Management Using Genetic Algorithm," *IEEE*.

[8] Jeppiaar, "Scope and Consequence of Fertilizer on Global Emissions and its Effect on Climate Change," *IEEE*, 2010.

[9] Z. Li, J. Li and Y. Li, "Problems and countermeasures existing in the rural ecological environments in Hunan province, China," *IEEE*, 2011.

[10] W. Berry, *The Unsettling of America: Culture and Agriculture.* New York: Avon, 1996.

[11] Q. Ahmad and I. Sarwar, "An Intelligent Agri-Information Dissemination Framework: An e-Government," *IEEE*, 2008.

[12] A. K. Singh, "Precision Farming," *Water Technology Center*, 2007.

[13] J. Zhang and W. Su, "CH_4 Emissions from Rice Fields and Reduction Countermeasures in the Three Gorges Reservoir Area," *IEEE*, 2011.

[14] A. Q. Sun and K. N. Wu, "Optimization of Land use Structure Applying Grey Linear Programming and Analytic Hierarchy Process," *IEEE*, 2011.

[15] G. Yao, "Urban Agrarianism in America," *IEEE*, 2011.

[16] K. K. Smith, *Wendell Berry and the Agrarian Tradition: A Common Grace.* Lawrence: University Press of Kansas, 2003.

[17] K. P. Singh, "Integrated Farming Systems for Smallholders in India – Models and Issues for Semi-arid Tropical Conditions," *IFSA 17th Int. S International Farming Systems Association*, 2002.