American Journal of Agriculture and Forestry
2024, Vol. 12, No. 3, pp. 217-222
https://doi.org/10.11648/j.ajaf.20241203.18

Research Article

Empirical Analysis on Economic Sustainable of Rice Rain-Fed Area in Rural Cambodia

Darith Siek[1, 2, *], Sun Emmsethakar[4], Wen Yu[2], Shiwei Xu[2], Abdul-Gafar Ahmed[2], Sun Bunna[3], Siek Sourphimean[4], Siek Sourchhordaphear[4]

[1]Regional Polytechnic Institute Techno Sen Battambang, Ministry of Laboure and Vocational Training, Phnom Penh, Cambodia

[2]Agricultural Information Institute, Chinese Academy of Agricultural Sciences, Beijing, China

[3]Department of Curriculum Development, Ministry of Education Youth and Sports, Phnom Penh, Cambodia

[4]Siek Sour Company, Battambang, Cambodia

Abstract

This paper investigates the economic sustainability of Cambodian rural rice farmers. Rice in Cambodia is a stable crop just as in many other Southeast Asian countries. The rice plants not only provide food to people but also a source of feed for livestock. Based on survey about of 6 districts of the rural household in Battambang of Cambodia, a total 204 rice farmers were interviewed and multiple regression models was applied using the method of Ordinary Least Squares (OLS) to determine the factors affecting the Crop-livestock farmers' disposable income. The study aggregated the livestock of 3 species including cattle, pig and chicken in cattle unit standard known as Livestock Unit (LU). The result of the empirical analysis shows that many household demography factors as well as the socioeconomic factors influences the disposable income. The findings in the study provide an insight to the government and extension offices on effective development of economic sustainability of rice farming and livestock production system in the regions; investing more in public animal healthcare; ensure stable market prices for both rice and livestock, paying more attention on the factors limiting income in particular to poorer provinces and districts. Provide irrigation facilities accompanied with high technological varieties to encourage the double or even triple rice seasons. In addition, government (especially the ministry of agriculture) should embark on technological transfer among provinces and countries with successful agricultural system, orient farmers on the potential benefits of crop-livestock farming, provide training ground and scheme to local farmers.

Keywords

Sustainable Income, Rice Rain-Fed, Livestock, Battambang, Cambodia

1. Introduction

Sustainable farming is the simultaneous integration of environmental, economic and social factors into farm management taking into cognizance the nature base of the farm, covering the financial aspect (profitability) and the decision

*Corresponding author: darith9398@yahoo.com (Darith Siek)

Received: 30 May 2024; **Accepted:** 15 June 2024; **Published:** 27 June 2024

made by the farmer depending on their family demography. According to Richard [13], sustainable agriculture is the production processes of both crop and livestock which provides abundant output with little or no adverse effect on earth's resources or pollution of the environment. Today's agricultural practices pose serious challenges to the protection of natural, healthy and functioning ecosystem. Rice is produced in many ecosystems, each with specific variety of seed. Examples of this ecosystem include rain-fed lowland, rain-fed upland, deep-water, and irrigated ecosystem. Globally, rice grown under rain-fed ecosystem accounts for about 29% of the 140 million hectare and more than 90% of the rain-fed ecosystem are located in South and Southeast Asia [5, 9, 18].

Cambodia is an agrarian country spreading approximately 85.3% of the total 3.3 million hectares cultivation area under rain-fed conditions [1]. Rice production contributes immensely to Cambodian economy and it's critical to food security or the 18 million people in the country [17]. The annual paddy rice production is about 9.5 million MT (5.7 million MT, milled basis) with an increase of 200,000 MT from year 2015 [3], and expect in 2018 about 10.85 million MT [12]. According to FAOSTAT [4], rice yield in Cambodia (3.3 MT/ha) comparably to the neighboring countries is relatively low; Laos (4.2 MT/ha), Vietnam (5.8 MT/ha) and Thailand (3.1 MT/ha). In Cambodia, rice is grown on diverse landscape of the different ecosystem as mentioned above. Most of the rain-fed lowland areas in Cambodia are located around the Tonle Sap reservoirs, Tonle-Basaac River and Mekong River [6, 16]. Cambodian rice growing regions experiences distinct wet and dry season. Significant percentage (90%) of the total wet season rice area is rain-fed lowland. It was estimated that roughly 80% of the national rice production occurs in the wet season covering over 86% of the rice area and the dry season (irrigated) accounting for 20% of the rice production with 14% of the total rice area [14, 11]. This paper investigates the economic sustainability of Cambodian rural rice farmers using multiple regression models to estimate socio and economics factors affecting their disposable income. It also provides guidelines to farmers, extension officers and policy makers as to ways of improving rain-fed rice production.

2. The Conceptual Framework

The framework of farmers' behavior towards rain-fed rice area in rural Cambodia is conceptualized and presented in Figure 1. In rural Cambodia, rice production is one of the main sources of income for rural farmer by selling, source of food, source of feed for livestock, and seed for next season cultivation. Income from selling rice is mostly spend on fertilizer and other agrochemicals and in addition, some farmers purchase new breed for another season, rent machines for ploughing and harvesting and wages paid to laborers. In most cases, many famers work outside their farms as a form of earning extra income. Farmers also spend some portion of the income on their children's' education beside the social activities/ceremonies such as weddings and festivals. In other cases, some farmers choose to create their own small business.

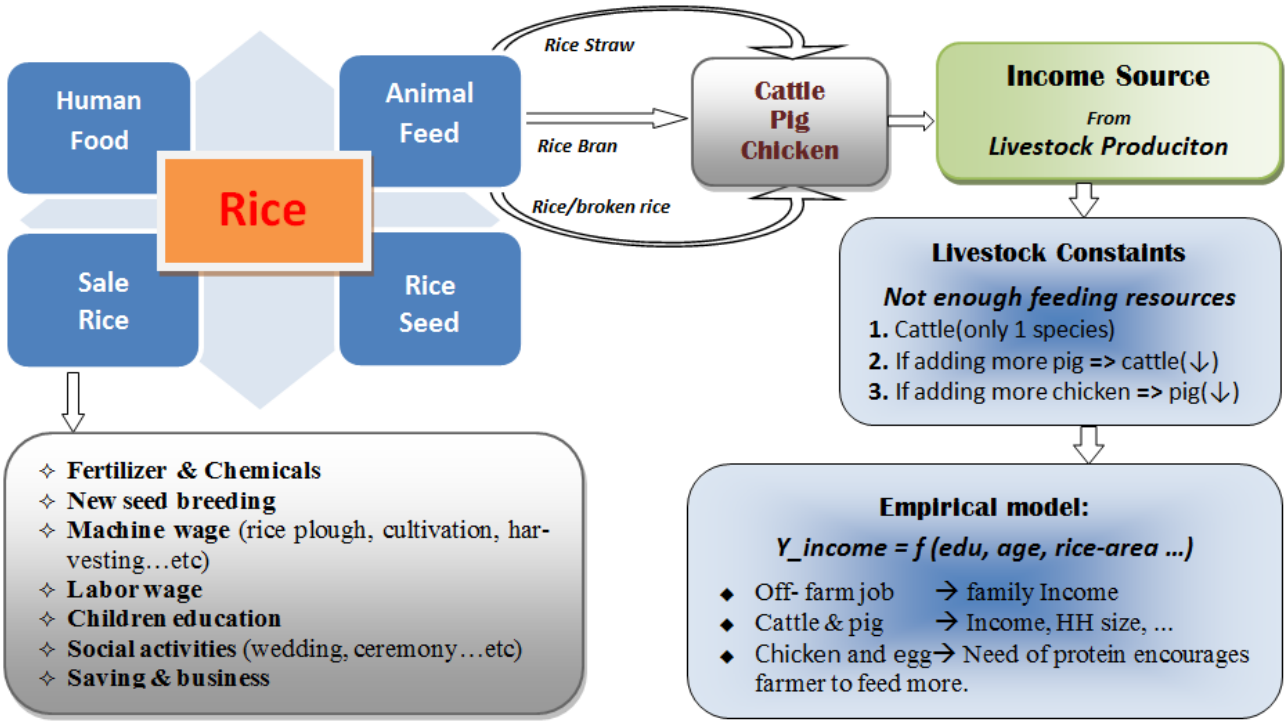

Figure 1. *The conceptual framework of farmer behaviors in rice rain-feed area in rural Cambodia.*

The local soil, whether conditions and availability of water has in the long history of rice production been favorable to the Cambodian farmers; rice has been an important source of food for human more so a huge potential source of livestock feed in the community. The annual rice harvest mostly includes the rice straw and paddy rice. Further supply chain widens the final stage of rice such as the rice bran and broken rice. In Cambodia, rice straws are predominantly used as feed composition for cattle and other ruminant animals especially in the rural regions, and rice bran as feed for pigs and paddy/broken rice as feed for chicken. Given the assumption of resource constraints, an additional livestock into the existing farm structure would require a reduction in the head count of the initial livestock raised.

For instance, if a farmer is faced with limited resources (income/feed) and the farmer wishes to bring additional livestock (pig and chicken), for the farmer to manage these livestock under his constraint, there is need to reduce the number of cattle. Another constraint to the size of livestock is the spread of diseases. Other factors such as household size, number of children (student) can easily influence the perception of farmers towards raising livestock to either increase or reduce or substitute a livestock to another still within the range of the farmer's economic constraint.

3. Materials and Methods

3.1. Data and Descriptive Statistics

The data used in this study were collected with structure survey in18 villages of 6 districts of the rural households in Cambodia. In total, 204 farmers were interviewed. Data collected were processed and analyzed in Agricultural Information Institute (AII) of Chinese Academy of Agricultural Sciences (CAAS) Beijing. The north-western of Cambodia is known for having long history of traditional rice farming and it is an important rice growing province. Battambang is one the province in the Tonle Sap reservoir, the rice area is about 307.575 ha achieving an estimated rice yield of 2.8 MT/ha in wet season and 3.8 MT/ha in dry season, totally producing an annual paddy rice of 795 611MT [10]. Besides rice farming that is during the off season, farmer search for part-time work/jobs in either public or private company providing them some stipend to support their family or next season farming (in this context we referred to this as off-farm jobs).

Table 1 shows the effectiveness household head with or without off-farm jobs. About 19% of the interviewed farmers had an off-farm job and the remaining 81% without off-farm job (focusing only on their farm). With inadequate rice technology and irrigation system, the farmers can only farm in a single or double season and during the off seasons, they tend to work outside to increase family income. In the table below, farmers without off-farm job have less land size compared with farmers with off-farm jobs (about 2.67 ha and 2.85 respectively). More so, because the farmers with off-farm job earn extra income, their disposable income is higher compared to farmers without off-farm jobs. Moreover, with much disposable income they can manage more livestock compared to their counterpart. According to author [2], the livestock unit coefficients are basically exchanging ratio among different livestock species in south Asia coefficients. In this study, we adapt this conversion ratio to cattle referred to as livestock standard in cattle unit coefficients "lu" where one head of cattle is about 0.4 pig and 0.02 chicken.

Table 1. *Descriptive statistics of the farmers with and without off-farm jobs.*

Variables	Data Description	Non-off-farm job		Off-farm job	
		Number	Mean	Number	Mean
area_rice	Rice area for farmer household working	166	2.67	38	2.85
age_hh	Age for household farmer	166	44.78	38	53.18
edu_hh	Education level for household head	166	5.42	38	4.11
size_labor	Labour size per household	166	2.75	38	4.26
size_family	Family size in household	166	4.31	38	5.61
n_offlabor	Number of labour for off-farm job	166	0	38	1.74
lu	livestock standard in cattle unit coefficients	166	7.83	38	8.33
di_income	Disposable income (*1000riel)	166	3192.95	38	8903.18

3.2. Modeling Households' Income Impacts

All data from the research were entered into EpiData software after which was transferred into STATA software for data generation and regression and analysis. Base on author [7, 8, 15] widely tool in econometrics, multiple regression models using Ordinary Least Squares (OLS) are considered relating individual performance on the family income as a dependent variable and a set of demographic variables including cultivation area for rice, household education, family size, farmer's age and size of labor. Other variables specific to income are off-farm job and livestock standard in cattle unit coefficients. The econometric analysis is shown in the constructed models below:

$$Y_{income} = \beta_0 + \beta_1.lnarea + \beta_2.lnedu + \beta_3.lnage + \beta_4.lnsizlabor + \beta_5.lnsizefami + \beta_6.nofflabor + \beta_7.lnlu + i.district + \varepsilon_i \quad (1)$$

The constants $\beta_0, \beta_1 \ldots. \beta_7$ are the coefficients of parameters of the econometric model that demonstrated the direction and strengths of the relationship between Y_{income} and the demographic and socioeconomic factors of the household farmers while the ε_i is explain the error term assumed to be distributed logistic. The *"ln"* after the coefficients is the logarithms of the variables.

4. Results and Discussions

The result from the multiple regression models demonstrates the relationship and significance of household income influenced by factors of the household demography among these factors include rice area, farmer's age, household labor size, family size, off-farm job and others mentioned in Table 2 below. The equation explains that all the variables in the model depict a 33.7% of variation in household income. The size of farmers' rice cultivated area (*area_rice*) is noticeably positive with 5% level of significant. If the rice cultivated area increases by1%, the family income would significant increase 37.8%. The proportion of the total land size brings high potential to crop and livestock management thus more investment and proper utilization of land is paramount to rice economic sustenance. The more the household labor the higher is expected for the household income to increase as the number not only provide labor but income from off-farm jobs as well. In the regression, with just 1% increase in household size, income is expected to increase by 40.3% likewise the household with off-farm jobs positively influencing income (1% level of significance) explaining that with a one percent increase in off-farm jobs, household income should increase by 58.3%. The off-farm job provides the highest form of increasing farmer's income in the model.

The empirical result estimation the household income among the districts (Banan, Moung Ruessei, Ratanak Mondul, Sangkae, Thma Koul) compared with the base district 1(Aek Phnum) illustrate that there is positive 5% significant difference in district 2 (Banan) and district 5 (Sangkae) expressing to about 70.1% and 66.5% respectively. This shows that there is an unbalance income among the districts of Battambang.

5. Conclusions and Recommendation

Rice production plays a crucial role to Cambodian economic development. Rice as a stable crop in Cambodia just as in many other South Asian countries is paramount to food security and thus its sustainability cannot be overemphasized. The rice plants not only provide food to people but also a source of feed for livestock which in turn provides addition source of income to the farmers. The rice production provides residues (rice straw, rice bran, broken rice) to support livestock management. However, with limited resources and other constraints such as diseases, farmers are faced with big decisions.

Table 2. *The regression results of household income.*

Variable	Definitions	Empirical models		
		Coef.	T-value	P>T
lnarea_rice	Logarithm of Rice area for farmer household	0.378 **	2.44	0.016
lnedu_hh	Logarithm of household's education	-0.007	-0.24	0.807
lnage_hh	Logarithm of household head's age	0.722 **	1.92	0.056
lnsize_labor	Logarithm of size labour	0.403***	3.26	0.001
lnsize_family	Logarithm of size family	0.557 *	1.54	0.126
n_offlabor	Number of labour for off-farm job	0.583 ***	4.3	0.000
lnlu	Logarithm livestock standard in cattle units coefficients	-0.092	-0.59	0.557
_Idistrict_2	Banan	0.701 **	1.97	0.050
_Idistrict_3	MoungRuessei	-0.271	-0.8	0.425

Variable	Definitions	Empirical models		
		Coef.	T-value	P>T
_Idistrict_4	RatanakMondol	0.556	1.35	0.179
_Idistrict_5	Sangkae	0.665 **	2.16	0.032
_Idistrict_6	ThmaKoul	0.425	1.21	0.229
_cons	_cons	2.657 **	1.98	0.049
No. of obs.	No. of obs.	202		
R-squared	R-squared	0.3367		
Adj R-squared	Adj R-squared	0.2946		

Note: *10% level significant; **5% level significant; ***1% level significant

According to the study, the size of household labor, off-farm jobs, size of rice area, age of the household head and family size have strong impact on the farmers' disposal income. Among these factors, the off-farm jobs and number of laborers in the family depict the highest significance level compared to other factors. This is possible because with large families comes less production cost and availability of labor more so the members of the family can easily support the family by having an off-farm job which in turn increases the disposable income of the household. The larger the farm lands the more benefit the famers get as this provides larger rice production increasing income, food and residue for the livestock.

On these points, government should invest more in public animal healthcare; ensure stable market prices for both rice and livestock, paying more attention on the factors limiting income in particular to poorer provinces and districts. Provide irrigation facilities accompanied with high technological varieties to encourage the double or even triple rice seasons. In addition, government (especially the ministry of agriculture) should embark on technological transfer among provinces and countries with successful agricultural system, orient farmers on the potential benefits of crop-livestock farming, provide training ground and scheme to local farmers.

Abbreviations

AII	Agricultural Information Institute
CAAS	Chinese Academy of Agricultural Sciences
UME	University Management and Economic
RUA	Royal University of Agriculture
STATA	Statistics and Data Science
OLS	Ordinary Least Squares
LU	Livestock Unit
MT	Metric Ton
Ha	Hectare

Acknowledgments

This paper was highly appreciate Pun Robarng, Chhoep Dany, Chay Samoeurn, Son Boren, Moun Sovannara, Doeurn Va, SuoSinoeun and Din Chamroeun, the graduate student of University Management and Economic (UME) and Royal University of Agriculture (RUA) for their contribution.

Conflicts of Interest

The authors declare no conflicts of interest.

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