

RICE PRODUCTIVITY IN SOUTH CENTRAL COASTAL VIETNAM: DETERMINANTS AND ROLE OF FARMER PARTICIPATION

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Abstract

Rice plays a crucial role in Viet Nam's food security and overall political, economic, and social stability as rice accounts for more than 90% of total cereal production. Despite rapid progress in rice productivity and rice exports, main concerns remain in the country such as persisting poverty, climatic changes, land use conversion and rice yield stability. This study uses econometric models to estimate the factors affecting rice productivity in the Central Vietnam. Findings indicated farmland quality, farmers' participation in the rice production, the application of new "3 Decrease- 3 Increase" approach, pest conditions and production costs are major factors to rice yield while agricultural extension services were not effectively accessed. Striking insights from the results emphasized the significance of farm size, land consolidation and farmers' participation in the large paddy field. Policy implications that contribute to increase in rice productivity, agricultural development and new rural development were also highlighted.

Key words: rice yield, farmer participation, farm size, new rural development, Viet Nam

1. INTRODUCTION

Growth in agribusiness productivity is considered essential in achieving sustainable economic growth and significant level of food security in a developing country like Viet Nam. The sources of productivity differences over time among regions in Vietnam has emerged as a central theme of rural development. Research on agricultural productivity is not a new topic that mainly focuses on economic and technical factors while research on rice yields which take into account environmental factors has not fully explored. The South central coast region is seen not only as a small paddy production one, its rice farms are typically not large in size but also a densely populated area with frequent natural disasters and relatively low economic benefits from rice cultivation. Since then, perfunctory attitudes and the intention of giving up farming/ rice production to engage in off-farm activities is emerging seriously. Therefore, it is necessary to have policies of relevance to promote the development sustainability of this region and increase rice productivity as well as maintain the farming values and efficiency of rice production to ensure national and regional food self-sufficiency and security.

This study focused on the factors that influence the rice yield in the South central coast Viet Nam from two economic and environmental perspectives, thereby the social issues involved are addressed. The striking discussion of this research showed that the quality of agricultural extension services and staff should be improved, dealing with how effectively to reduce the risk of outbreaks of pest and diseases, the merits of adopting improved rice seed varieties, application of farm models friendly to environment and gaining farmer community's trust to maintain/strengthen agricultural development in this region. New rural policies and its implications to increase the productivity of rice crops towards green agriculture are thus contributing to the development of regional rural areas.

2. MATERIALS AND METHODS

2.1. Rice productivity

There is no universal definition of the term, productivity. Productivity is one important component of the monitoring, analysis and supervision of company performance. The term productivity was probably first mentioned by the French mathematician Quesnay in an article in 1766 (Kendrick, John W; 1985).

Changes in productivity are of great importance at all levels national, industrial, company and personal (Sumanth, D. J; 1998)

It has commonly been defined and used by Economists as the ratio of output to the volume of inputs in a given period of time (Antle, M. J. & Capalbo, S.M., 1988). In particular, it is the amount of output produced by each unit of input and it measures how efficiently production inputs, such as labour and capital, energy and information change are being used in an economy to produce a given level of output (Anyanwu S. O; 2013). This understanding/definition of productivity is the least controversial and the most commonly used/accepted because of two related aspects: (01): this definition suggests what productivity is thought of to be in the context of an enterprise, an industry or an economy as a whole; (02); Regardless of types of production, economic or political systems, this definition of productivity remains the basic concept which is the relationship between the quantity and quality of goods and services produced and the quantity of resources used to produce them (Prokopenko, J.; 1987). It is evident that in the literature on productivity that almost all the definitions of productivity center on “outputs” and “inputs”.

The way in which inputs and outputs are defined is the reason for the differences in productivity definition and its measurements. There are different measures of productivity and the choice between them depends either on the purpose of the productivity measurement and/or data availability. The concept of agricultural productivity has been extensively used to explain the spatial organization and patterns of agriculture by scholars with reference to their own views and disciplines. For example, Agricultural productivity may be defined as the “ratio of index of local agricultural output to the index of total input used in farm production” (Shafi, M; 1984). Agricultural productivity refers to the output produced by a given land of input(s) in the agricultural sector of a given economy (Fulginiti, L. E; et al, 2004). Formally, it can be defined as the ratio of the value of total outputs to the value of total inputs used in farm production (Oluwatayo, I. B; 2008). In other words, agricultural productivity is interpreted in agricultural geography as well as in economics as “output per unit of input” or “output per unit of land area”, and the improvement in agricultural productivity is generally considered to be the results of a more efficient use of the factors of production, viz. physical, socioeconomic, institutional and technological.

Olaoye, A. O (1985) observed that productivity as a concept can assume two dimensions: namely Total Factor Productivity (TFP) and Partial Factor Productivity (PFP). Similarly, Chambers, R. G (1988) argued that productivity measurement is an approach to measure the production rate of technical change and can be conceptualized as comprising two main components. The first component is partial factor productivity (PFP) and expressed as the ratio of total output Y and any x_i input used to produce that output. The second component is the total output Y ratio with summation of all input X_i . In particular, the first relates to productivity that is defined as the relationship between output produced and an index of composite inputs; meaning the sum of all the inputs of basic resources notably labour, capital goods and natural resources.

Total factor productivity indexes: $A = Y/(aL + bK)$ where Y , L and K are the aggregate level of output, labor and capital Inputs, and a and b are appropriate weighting terms.

It was argued that agricultural productivity should be calculated in terms of labour productivity because this is an important factor affecting the agricultural sector income. In addition, labor productivity is a measure of the amount of goods and services that the average worker produces in an hour of work. The level of productivity is the single most important determinant of a country's standard of living, with faster productivity growth leading to an increasingly better standard of living; thus; and this view makes sense in policy implications (Lal, 2011). In rice cultivation, soil also plays a very important role as it provides structural stability for plants and retains and relinquishes water and the nutrients necessary for plant growth. In addition, if land use is an input factor in the PFP calculation formula, it not only reflects the quality of the land but also reflects the farming techniques, farming experiences and fertilizer use. For these reasons this study used land productivity to calculate the rice yield.

2.2. Factors affecting the productivity of rice production

2.2.1. Rice variety

The application of new rice seed/ rice varieties promises higher yields than traditional varieties. Mbam & Edeh (2011) also pointed out that the use of new, improved rice varieties will have a strong and positive impact on rice yields in Anambra, Nigeria as they will enable growing of the crop with less pesticides, less fertilizers, less water, good resistance to pests.

Obasi & Associates (2013) have shown that the increase in the number of laborers in agricultural production will increase the productivity of rice in Imo, Nigeria. The study by Olujenyo, F. O. (2008) demonstrated that labor is calculated by the day number of farming and has a positive effect on agricultural productivity.

2.2.2. Propaganda activities & agricultural extension services

Knowledge acquisition, processing and transmission are of vital importance in today's knowledge-based economy. The provision of agricultural extension is made to enhance farmers' knowledge and skills toward improved yield (M. A. Baloch; G.B. Thapa; 2016). El-Juhany (2011) argued that due to pest, diseases and indeed the ineffective extension services provided to farmers the productivity of date palm trees has declined in Baluchistan, Pakistan by 37% and 30% within a decade in Arab countries. Similarly, research conducted from a questionnaire survey covering 200 date palm farm households, group discussions, and surveys of key informants in the Panjgur District of Balochistan showed that the small-scale farmers who used the extension services produced a better yield compared to that of the medium- and large-scale farmers. The extension package's appropriateness/relevance is conceptualized as the extent to which the objectives and real practice of the program are consistent with the local requirements and priorities. Packages provided for farmers are need based, agro-ecology based, market based, affordable inputs, availability and quality of inputs and consider indigenous knowledge of farmers. Communication is a major component of agricultural extension and extension agents utilize various methods to deliver messages to their clientele. Extension educators should choose different methods of information delivery to maximize program efficiency, effectiveness (Jones et al., 2007). Frequency of extension contact on a regular bases help farmers to learn and discuss in detail about agricultural extension knowledge and innovations which influence, enhance and develop farmers' farming practice and rice yield.

Vietnam is a country in Southeast Asia well known for its ability to grow rice for food consumption and also for export. Agricultural extension policy plays a very important role in transferring and guiding farmers to apply science and technology, production process to bring high efficiency. Exposure of extension workers to farmers through training; demonstration; consulting, providing agricultural services and on farm visits. A recent research by Sattaka, P., et al (2017) on production sustainability for food and cultural security of glutinous rice farmers in Vietnam concluded that extension services were found to be very active and comprehensive, playing a key role in fostering the sustainable production of glutinous rice and helping to ensure local food and cultural security in Vietnam. If the extension policy is appropriate and effectively implemented, farmers will be able to access and acquire sufficient knowledge and information to increase their productivity. Therefore, extension policies can be a factor influencing rice yields.

2.2.3. Labor input

Obasi & Associates (2013) have shown that the increase in the number of laborers in agricultural production will increase the productivity of rice in Imo, Nigeria. The study by Fazoranti (2005) demonstrated that labor is calculated by the day number of farming and has a positive effect on agricultural productivity.

2.2.4. Production cost

Tracking production costs helps not only to reveal overall farm profit or loss, but it can also signal which particular enterprise or products are financially viable (Newton, 2004; Wiswall, 2009). In Anyanwu's

(2013) study of factors affecting the agricultural productivity of high-tech farm households, it has been shown that as agricultural investment increases, farm productivity increases.

2.2.5. Mechanical devices application in farming

Mechanical devices application has mainly been done on soil tillage (plows, harrows) and on harvesting (reapers, shakers, combine harvesters). Agricultural mechanization implies the use of various sources and improved farm tools and equipment, with a view to reduce the drudgery of the human beings and draught animals, enhance the cropping intensity, precision and timelines of efficiency of utilisation of various crop inputs and reduce the losses at different stages of crop production. A study by the World Bank & FAO (2009) noted that the lack of machinery used in agriculture is one of the major causes of the depletion. Outdated machines/equipment used in harvest system could cause post-harvest grain loss (for example, during the processes of harvesting, transportation, drying,). Low level of mechanical input, underutilization of available mechanical power and reliability on human power in most of these areas contributed to low production efficiency in agricultural production in Umuahia North LGA of Abia state, Nigeria. The contribution of agricultural mechanization has been well recognized in enhancing the production and productivity of different crops due to timeliness of operations, better quality of operations and precision in the application of the inputs (S. R. Verma, 2006)

2.2.6. Irrigation system

Munir et al. (2002) collected data in Pakistan to examine the effects of irrigation on agricultural productivity, in which variable irrigation was the dummy variable (water taken from canals, wells, water taken from the canal and well). Research results indicated that water from one of the three options yields much higher yields than does not use the three services, and water from wells and channels.

Similarly, Aridah, A et al (2015) investigated effects of irrigation systems on productivity of date palm in Sebha Region, Libya. In particular, effects of different types of irrigation systems on fruit quality of common cultivar date were investigated. The analysis showed that the type of irrigation system has a significant effect on productivity, with the sprinkler irrigation system having a higher effect on palm production compared to surface irrigation; however; surface irrigation system has a higher effect on the palm production compared to drip irrigation.

2.2.7. Apply 2 new agricultural production approach/programs

"Programs as 3-reduction 3-increase" focuses on the reduction of seed sowing, reduction of nitrogen fertilizer and reduction of pesticides use while there is the increase in rice yield, increase in the grain quality and increase in economic efficiency. Another approach/ program called "1-need 5-reduction" "is to use the right seed variety for crops, to use the certified and registered seed; to reduce amount of irrigation water, to reduced harvest losses (harvested by combined harvesters and drying methods) and to include program as "3 decrease, 3 increase".

In addition to the two programs mentioned above for green agriculture, the Vietnam Ministry of Agriculture and Rural Development (MARD) has also implemented the development of rice fields for enhance productivity and efficiency. However, due to some limitations in the south central coast such as the agricultural land is limited, small-grain size which could not meet requirements to keep land in good agricultural and environmental conditions

2.2.8. The fertilizer usage

Fertilizer replenishes nutrients for plants, helps plants grow well, increases the resistance to pests and diseases, thus, the amount of fertilizer contributes to increase the rice productivity. Mbam & Edeh (2011)'s study on factors affecting rice yields made similar findings that the higher the fertilizer used, the higher the rice yield was.

2.2.9. Soil quality fertility

Land sustainability is a global issue. The study by Fritee (2008) identified the relationship between soil quality and agricultural productivity. Results indicated the significant impact of soil quality, its positive effect on rice yield. This implied that good soil quality provides good conditions for crops under hot

weather conditions. Also, soil quality and irrigation systems are two factors that played key roles in increasing agricultural productivity in India.

2.2.10. Pest insects

Insect pests are a factor affecting rice yields because when the amount of pests increases, the rice will be prevented from growing, resulting in reduced rice yields, thereby reducing yield. According to Aggarwal et al. (2006), pests caused the reduction of agricultural output, which is an important issue in tropical countries.

2.2.11. Demographic characteristics of farm households

Anyanwu et al. (2013) have shown that education is significant at 5% and has a positive effect on Nigeria's agricultural productivity. Well-qualified and educated labor seemed to get better capability of acquire/catch better knowledge in science and technology that leads to better productivity. Obasi, P. C., et al (2013) have identified the relationship between farming experience and productivity in farm households in Nigeria. The results show that as the well-experienced the farmers were, the better in rice yield the farmers gained. This could be explained from the fact that the long-term cultivation will help farmers have more helpful experience in farming practices.

To ensure national coverage and representativeness, the study embraced 5 communes in two major provinces of the Central South Vietnam: Hoa Tri 1 and Hoa Tri 2 in Phu Yen Province; Dai Cuong, Dai Minh and Dien Phuoc communes in Quang Nam province.

Based on the above analysis framework, findings from focus groups and agricultural characteristics of this region, the research model is proposed to study the factors affecting rice yields in the central south Vietnam as follows:

$$Y = b_0 + b_1Ed + b_2Ex + b_3La + b_4Sv + b_5Pc + b_6Md + b_7Is + b_8Sq + b_9Pa + b_{10} "3D3I" + b_{11}Fu + b_{12} 3Lm + b_{13}Pi + e$$

The contents and how to measure variables are described in detail in Table 1

Table 1. Data description and model's variables

STT	Variables	Items
	Dependent	
1	Rice yield (Ry)	Rice yield in 2014 (quintal / 500 m ²) / per crop year)
2	Rice-cultivated area (Ra)	rice-cultivated area in 2014 (500 m ²)
	Independent	
3	Education (Ed)	Total years of farmer householder's study
4	Experience in farming (Ex)	Total years of householder's farming
5	Labour (La)	Number of laborers in doing farming, including the numbers of the outsourced
6	Seed varieties provided farm cooperatives (Sv)	Do farmers use the Seed varieties provided farm cooperatives? 0: No, 1: Yes
7	Production cost (Pc)	Production cost for farming (million VN Dong)
8	Mechanical devices (Md)	Do farmers apply Mechanical devices in farming? 0: No, 1: Yes
9	Irrigation system (Is)	Assessment of farmers about irrigation system in enhancing efficiency in farming activities (Likert scale from 0-5; Not really good – Very good)
10	Soil quality/ fertility (Sq)	Assessment of farmers about Soil fertilizer in rice cultivation? Likert scale from 0-5: Not really good- Very good
11	Propaganda activities & Access to Extension services (Pa)	Likert scale ranging from 0: absolutely not, to 5: very often

	Pa1: Farm visit of agricultural extension agents	Frequency levels of visit, Likert scale ranging from 0: absolutely not, to 5: very often
	Pa2: Organization of rehearsal model	Frequency levels of organizing rehearsal model application of new technology in rice cultivation. Likert scale ranging from 0: absolutely not, to 5: very often
	Pa3: Training in using inorganic chemicals	Frequency levels of organizing the training in using inorganic chemicals. Likert scale ranging from 0: absolutely not, to 5: very often
	Pa4: Training on pest prevention	Frequency levels of organizing the training on pest prevention. Likert scale ranging from 0: absolutely not, to 5: very often
	Pa5: Seed varieties guide	Frequency levels of organizing classes on advising new seed varieties for increasing rice yields. Likert scale ranging from 0: absolutely not, to 5: very often
12	“3D3I approach”	Do farmers apply “3D3I approach”? 0: No, 1: Yes
13	Fertilizer usage (Fu)	Amount of fertilizer use on every 500 m ² /per year (kg/ per year)
14	Large-scale farm model (Lm)	Do farmers participate in Large-scale farm model? 0: No 1: Yes
15	Pest insects (Pi)	Overall assessment of farmers about level of Pest insects during a year. Likert scale ranging from 0: very much to 5: very little

Sampling includes various rules-of-thumb which have been advanced, including (a) a minimum sample size of 100 or 200 (Boomsma, 1982, 1985), (b) 5 or 10 observations per estimated parameter (Bentler & Chou, 1987; see also Bollen, 1989), and (c) 10 cases per variable (Nunnally, J. C., 1967). This research is consistent with Bollen (1989) and this study included 16 observational variables, with a sample size of at least $16 \times 5 = 80$, so the sample size (195 households) in this study was proper enough.

Descriptive statistics showed that the average yield in the two provinces of Quang Nam and Phu Yen was higher than that of in the south central coastal region (7.04 quintals / 500 m² / per year) compared to 5.96 quintals / 500 m² / year), from processed data of Statistics Department. The average agricultural extension was rated at 3.43. Meanwhile, irrigation system and soil quality were rated at 3.99 and 3.9. The above results showed that the farmers considered that the irrigation system and soil quality are good, while the extension policy was assessed at average level.

Table 2. Variable description

No	Variables	Minimum	Max	Mean	Std. deviation
1	Education	0	15	8,26	2,83
2	Experience	4	64	32,35	11,25
3	Labour	1	32	2,73	2,69
4	Seed varieties	0	1	0,82	0,39
5	Production cost	0,62	9	2,31	1,05
6	Mechanical devices	0	1	0,98	0,12
7	Irrigation system	1	5	3,99	1,14
8	Soil quality/fertility	2	5	3,90	0,72
9	Propaganda	1	5	3,43	0,81
10	3D3I program	0	1	0,75	0,43
11	Fertilizer use	10	272	55,28	30,87
12	Large-scale farm model	0	1	0,43	0,496
13	Pest insects	1	5	3,51	1,04
14	Rice yield	1,9	12	7,04	1,35

3. DATA ANALYSIS

Table 3. Model Summary

Model	R	R square	Adjusted R square	Std. error of the Estimate
1	.668	.446	.431	1,01721320

Variance inflation factors (VIF) tests were done to test the multi-collinearity of variables in the model. The results of VIF test of all 5 independent variables are less than 10, so there is no multi-collinearity. Estimated results using the OLS method are presented in Table 4 below.

Table 4. Regression statistics

Model	Unstandardized coefficients		Standardized coefficients	t. value	P-value/ Sig	VIF
	B	Std. error	Beta			
Constant	3.260	.441		7.394	.000	
Pcost	.239	.074	.188	3.249	.001	1.130
3D3I	.553	.198	.177	2.794	.006	1.368
S fertility	.371	.117	.197	3.176	.002	1.305
P/insects	.302	.083	.233	3.658	.000	1.374
F.model	.720	.162	.265	4.442	.000	1.206

From the above results, the multivariate regression model of factors affecting rice yield in in the south central coastal provinces (model I) is as followed: $Y = 3.26 + 0.265 \text{ farm model} + 0.233 \text{ pest insects} + 0.197 \text{ soil fertility} + 0.188 \text{ CHIPHI} + 0.177 \text{ 3G3T}$

The regression model had a coefficient of $R^2 = 0.446$ and a corrected R^2 of 0.431, indicating that the five dependent variables the pest insects, soil quality/fertility, production cost and 3D3I approach explained 43.1% of the variation in rice yield in two in the south central coastal provinces: Quang Nam and Phu Yen. Regression results showed that the farmers' participation in the large-scale farm models had a significant effect on the rice productivity. The regression coefficient of this variable indicated that, when other factors remain unchanged, farmers' participation in large-scale farm model would increase the rice yield to 0.265 quintals /500 m²/ crop year. Farmers' participation in farm models seemed to reduce the number of plots and nearby farmers merged their lands into large-scale farms, such as getting rid of paddy-field ridges and farming together in bigger rice plots, which made it convenient for cultivation, reducing labor costs and machinery rent. In addition, when participating in the large-scale farm models, the farmers sowed the same seed varieties, bred at the same time and performed other farming stages that were almost homogeneous, thus, this reduced prevented the spread of pests and diseases on the farms.

The pest status had a significant impacted on rice productivity in in the south central coastal region. The regression coefficient of this variable was 0.233 which implied that, when other factors remain unchanged, the decrease in number of insect pests would increase the rice productivity by 0.233 kg / 500 m² / year. Similarly, soil quality had a positive effect on rice productivity in in in the south central coastal region with a regression coefficient of 0.197. This indicated that, when other factors remain unchanged, the increase in soil quality by 1 point from the farmers' assessment, the productivity of rice increased to 0.197 quintals / 500 m² per year. This result was similar to the conclusion of Fritee (2008)'s study on the meaningful role of soil quality in increasing rice yield. It is clear that soil quality plays an important role in improving the rice productivity as soil is a source of nutrients for plant growth. On the other hand, soil quality not only reflects the nature of the soil, but also reflects the use of fertilizers as

well as the practices of farmers to improve soil quality. Therefore, it can be said that the use of fertilizers and soil improvement techniques can affect the rice yield.

Production cost was an important factor in the productivity of in in the south central coastal region. The results showed that production costs had a positive effect on rice yield with a correlation coefficient of 0.188. This also means that when production costs increased to 1 million VND per 500 m² per year, the rice yield would increase to 0.188 quintals / 500 m² / per year provided that other factors did not change. This correlation was positive as expected, because the high production costs means the the large investment in production, which would make rice plants grow better, produce more, reduce grain losses at harvest time and resulting in higher yields.

Farmers' participation in the "3 Decrease- 3 Increase" program is a significant factor in rice productivity. The estimation coefficient of this variable indicates that, when other factors did not change, participation in the 3 Decrease 3 Increase approach/program increased productivity by 0.177 tons per 500 m² per year compared to non-participation. However, the efficiency of participating in "3 Decrease 3 Increase" approach/program was three-fold lower than participation large-scale farm model. The reason was that the launch of the 3 Decrease 3 Increase model has been done relatively long time ago. According to the sharing of local extension staff that the local people/farmers were very enthusiastic in applying this model but since the date the management and monitoring of extension officers were no longer regularly done, farmers didn't follow the standard process strictly as guided. Therefore, some stages have not been implemented in accordance with regulations, resulting in reducing efficiency of the model.

Finally, the level of access to extension information and extension policies implemented in in the south central coastal region was limited and had very little or even no impact on rice yields. This was explained that the farmers have access to many sources of information, but the information is likely not really effective for rice cultivation. Specifically, during the interview, many farmers responded that the extension department at the district level conducted demonstrations and offered training sessions on pesticide use to farmers but the reality was that farmers applied lessons/instructions from the training sessions, farmers realized that that certain plant protection products were not really effective. Gradually, they seemed to lose belief in extension information and they used only the products/items they had previously used and found it effectively from the recommendations of pesticide dealers/stores. The problem was that the extension program was implemented, but only if its emphasis on widespread dissemination was not effective enough, then, considering its usefulness as well as feedback/opinions/reflections from farmers could be a successful point.

Table 5. Summary of regression for each province

Model	Province	Model	Adjusted R ²
II	Phú Yên	Rice yield = 1,989 + 0,33 « 3D3I program» + 0,187 Production cost + 0,432 Soil fertility + 0,56 Fertilizer use	0,509
III	Quảng Nam	Rice yield = 3,002 + 0,257 « 3D3I program» + 0,265 Soil fertility + 0,206 farm model + 0,259 Production cost	0,436

Regression results showed that model II (in Phu Yen province) had a correlation coefficient of 0.509, which was 50.9%. The variation in rice yield was explained by four factors: participation in "3D3I approach", production cost, evaluation of soil quality and amount of fertilizer used. They were significant at 5% and positive impact on rice productivity in Phu Yen province. Insect pests and participation in farm model had a very little or no impact on rice yields; and a new positive factor for rice yield was the amount of fertilizer used. When other factors were constant, increase in average yearly fertilizer use (1kg / 500m² / year), the rice yield would increase by 0.56 quintal / 500m² / per year.

In model III (in Quang Nam province), the adjusted R² was 0.436, which means that 43.6% of the variation in paddy productivity in Quang Nam was explained by four factors: farmer households, participation in "3D3I approach", production cost, evaluation of soil quality and participation in farm

model. Insect pests had no or very low impact on rice productivity in Quang Nam, while the four factors were significant at 5% and positive.

4. CONCLUSIONS AND IMPLICATIONS

This study used a multivariate regression model to determine the factors affecting rice yield in the south central coastal Vietnam that provided information useful to industry educators and farmers. Based on these findings, growers seek information on the best approach to implementing sustainable practices. Research results showed that there were five main factors affecting rice yield, namely, pest status and disease, farmers' participation in Large-scale farm model, applying "3D3I approach"/model, soil fertility/nutrient level and the average cost of production. Showing these factors is essential for improving rice productivity, for developing a green agriculture and building new rural areas in the south central coastal region that are generally recommended and highlighted below:

Firstly, the role of proper propaganda to help farmers do farming effectively and meet the farmers' expectations should be reconsidered and enhanced. The results indicated that the Propaganda activities & Access to Extension services seemed not the influential factor the rice yield, thus, the issues may be raised whether these activities are effective enough. Pingali ; P (2007) took a similar approach, showing that there was no correlation with extension officers and the adoption of green revolution modern varieties and this suggests that the causes of failure and success in extension need to be examined critically and systematically. Extension workers need to develop proper demonstration models for the use of new organic fertilizers on the certain region's characteristics that provide high economic returns, to advise how to control and guide farmers to use fertilizer efficiently to increase productivity without harming the environment (H.D Bui, T.T Trinh, 2017). Additionally, for farmers who didn't participate in the "3D3I model/program/approach, the extension staff should regularly exchange information to persuade/encourage and mobilize farmers to participate. Giving training sessions on the benefits of the program as well as how to implement the program should be held regularly. At the same time, extension officers need to provide good and timely support to farmers when they encounter difficulties during their first participation in the program. Another major challenge in developing an effective extension system is the lack of continuity due to frequent changes in administrative establishment or other top-level officials managing the state-level extension system, thus, there is limited space for following and understanding the views of feedbacks of farmers. Extension staff really play an important role as a bridge to bring advanced science and technology into reality and gain the trust from farmers in applying positive approaches highly recommended in the agriculture. Therefore, they need to be trained and retrained regularly to improve their professional skills as well as promote their flexibility and creativity in their work. Further research should specifically investigate the continuity and efficiency of propaganda activities & Access to Extension services in rice farming (Trinh, T. T., & Bui, H. D. (2017).

Secondly, farmers' participation in the Large-scale farm model was an important factor affecting rice productivity. Actually, in order to develop the model of rice production in the direction of a green agriculture, contribute to building new-type rural areas, promoting productivity, quality, safety and stabilize farm income for farmers, it is a necessity to have big efforts from both farmers and state/authorities. In particular, the state appropriately encourages and mobilizes the farmers into the agriculture cooperatives and apply the farm model and Large-scale farm model via promulgating financial mechanisms and policies to support farmers the finance to increase rice yield. Local authorities need to integrate the implementation of agricultural development programs, new rural development, prioritize funds for implementation of land consolidation for large sample fields. Mobilizing and persuading people to agree on land consolidation should be emphasized. As such, there is an active approach of linking four main farm stakeholders: the state, farmers, scientists and entrepreneurs which would be worthwhile and advantageous from the input of production organization focused to the management and consumption of output.

Thirdly, Vietnam's agricultural development strategy and green agriculture has to look at the pesticides production and use. The production of pesticides in the country is only mainly at the level of import, to

extract, bottled and labeled raw materials depend on the foreign suppliers. Nearly 100% of active ingredients, 90% of additives and 50% of products are imported from abroad. An issue is that the control of smugglers, traders selling/distributing chemicals which are not registered for use in crop protection while farmers/Users of agricultural chemicals are also not likely to understand/be trained/guided about pest biology to recognize when control measures are required and when they are best. Facing this situation, the State should promulgate mechanisms and policies to promote the broad application of science and technology, especially biotechnology and information technology to agricultural production and management. To prioritize investment in scientific and technological programs on the production of pesticides widely used in agricultural production to prevent or control pests, diseases, weeds, and other plant pathogens in an effort to reduce the pesticide's impact on human health and the environment without affecting crop productivity that is appropriate to the conditions of production and business in region. One factor stakeholders could consider is the introduction of measures to prevent pests and diseases that are environmentally friendly such as using natural enemies. Natural-use approach models, or measures to limit the use of chemicals in pest and disease prevention should be replicated to protect crops without harming the environment.

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