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ECOLOGICAL ECONOMIC ASSESSMENT OF THE PRODUCTION MODELS IN DIFFERENT FORMS OF DIKES IN PLAIN OF REEDS OF DONG THAP MUOI AREA, VIETNAM

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Abstract

Currently, many studies have carried out related to the Ecological economic models. The study focused on Modeling, ecological footprint, landscape assessment, partition and evaluating the ecosystem serviceThis study focuses on building the evaluation process in ecological economic for production models in terms of flood in different forms of dikes in plain of reeds that proposesthe Evaluation on integrated element groups: i) Degree of adaptation to soil, ii) classification of environmental quality, iii) classification of economic efficiency. the evaluation result of 112 selected models in the northern region of Tien River, there has been 25 models produced in high level - ecological economic, mostly the two seasons production model: rice - rice in the both of semi-dike and full-dike, 2 rice - 1 crop in in the semi-dke.

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Key words: Ecological economic, Semi-dike/August-dike, full-dike.

1. Introduction

Dong Thap Muoi is a deeply submerged area of Mekong Delta, Vietnam. This area has a very complex flood successionin the last few years. Floods enter on two ways: Through the border (7000-9000 m3/s) andTien river (200 - 500m3/s). Floods drain on two ways: Vam Co river and follow the drain beneathNational Highway 30 and 1A. Floods usually last 5-6 months (from July to November, December) [1], [2], [3].

In Vietnam, the studies of ecological economic have had some initial results and solved the livelihood basically towards the special economic zones which aredependedexcessively on natural resources and natural conditions. [4], [5], [6]

Globally, approaching to research and apply ecological attitude in solving the issues of security, society, resources and environment has been concerned recently and through some studies, some places has proven the correctness of this approach [7], [8], [9], [10], [11].

The problems are, (1). The flood succession inrecent years has been quite complex; (2). Natural disasters and climate change are unpredictable and hard to control; (3). The networks of dikes and embankments aredense and operate inconsistency, spontaneous and (4). The models of farming within dikes are unstable, spontaneous ... so its impacts to the economic efficiency of production models insidedikes, ecology and environment become more and more profound with the increase of scale and intensity. Therefore, it is needed to study for solving the problems of livelihood and sustainable development of floodplains in general and the areaswithin dikesin particular,which stem from the qualification and quantitication of the impacts ofdikes to the aspects ofeconomy, environment, ecology;then seek the harmonious solutions ensuring the ability ofboth exploitation (economy) and protection (ecology).

2. Materials and study methods

2.1. Tragets and study area

- Spatial range is the districts which located to the north of Tien river (Dong Thap Muoi) in Dong Thap province: Thanh Binh, Hong Ngu, Tam Nong and Tan Hong.
- Study targets:

+ Environment (focus on soil and water) within the forms of dikes.

+ The forms of dikes in the northern part of Tien river, including the semi-dikes and full-dikes.

+ The forms of farming, landuse within the forms of dikes and the economic efficiency of models.

+ Assess the level of economy - ecology of production models.

2.2. The main research contents of subject

- Investigate and assess the status of production models within the forms of dikes.
- Assess the level of groundadaptation of production models.
- Investigate and assess the operational situation of dikes.
- Analyze the economic and environmental efficiencies (soil and water).
- Assess the economic - ecological level of production models within the forms of dikes.

2.3. Study methods

2.3.1. Investigation, collecting information methods

- Collecting primary and secondary data in the study area:

- Preliminary investigation by lines, points, specifically identified the study area on the map scale of 1/100.000.

2.3.2. Soil and water sampling methods

- Soil samples were collected in the agricultural production models and just sampled at cultivated soil horizon.The criteria for analysis include: pH, $Al3^{+}$.

- Water samples were collected and fixed in the survey plots then samples were analyzed at a laboratory. The criteria for analysis are: pH, BOD, COD.

- The sampling process was executed via 04 times: 04/2008 (assess the status preliminarily); 12/2008 (assess the flood season); 06/2009 (assess before a flood) and 01/2010 (assess after a flood).

2.3.3. Data treatment methods

- Statistical analysis to compare the environmental situation and the economic efficiency between the forms of dikes, between the production models and between farming seasons according to flood succession, to have the view of status and evaluate the impacts.

- Therefore, classifying the environmental quality and economical efficiency according to the different levels of models.

2.3.4. Investigation using survey form

Monitor,investigate and interview with a total survey forms of 400. The interviewees arelocal managers and farmers.

Monitor the farming models: build Notebooks - Diaries, with the critiria: farming calendar; cultivation techniques; use of fertilizers, pesticides; cost of labor, irrigation; income, profits; the operation of dikes...

2.3.5. The assessment of soil adaptation of farming models

The evaluation of adaptability of soil is based on 04 factors: crop calendar, characteristics of each type of soil, forms of dikes and farming models.

There are 11 soil types and 03 crop calendars (before a flood, duringa flood and after a flood) in the study area. Adaptability is divided into 04 groups (N: non-adaptability; S3: less adaptability; S2: mediumadaptability; S1: high adaptability)

2.3.6. Calculation of economic efficiency and productive efficiency methods

To assess the economic efficiency of production models, through survey forms, notebooks of tracking models, this subject selected and calculated the following parameters:

(1). *Gross output GO, (2). Basical investigation, (3). Intermediary cost IC, (4). Value Added VA, (5). Mixed income MI, (6). Profit (Pr).*

From these parameters, this subject calculated the efficiencies for each group as follows:

Efficiency per cost of materials:
+ Gross output per cost of materials: $H_{GO}^{C} = GO/DC$.
+ Profit per cost of materials: $H_{Pr}^{C} = Pr/DC$.

Efficiency per unit of labor:
+ Gross output per labor: $H_{GO}^{L} = GO/LD$.
+ Profit per labor: $H_{Pr}^{L} = Pr/LD$.

2.3.7. Classifucation method

The problem of classification had used was the geometric mean, then the distance of points (saltus) for each classification can be calculated according to Aivasian formula (1983), which has the form:

$$S = \frac{S_{max} - S_{min}}{1 + lgH}$$

Where S is the distance of points in each classification, S_{max} is the bigest geometric mean point, S_{min} is the smallest geometric mean point, H is the total number of cells (survey plots) that were assessed.

The final calculation results were arranged into 4 classifications: 1- non-adaptability, 2- less adaptability, 3- medium adaptability, 4- high adaptability.

This problem of classification was used similarly to classify the following factors: *soil adaptation; environment; economic efficiency.* The synthesis of classification results of 03 former factors was the basis to evaluate and arrange the economic - ecological efficiencies for each cell.

2.3.8. Mapping, GIS methods

Edit database. The data of base maps were collected from study area, data of field investigation, data of environmental analysis via the sampling points, the results of synthesizing and analyzing data, documents such as soil adaptation, environmental quality.

Use specialized software (MapInfo) to digitize basemap, convert data, overlap maps, perform and display maps.

3. Discussion of results

3.1. The status of distributing production models

The study area was the northern region of Tien river which located in Dong Thap Muoi, this is a deep floodplains with a dense network of canals and dikes. The forms of dikes often run along the channels, depending on the extent of submersion and the requirement of crop protection then either semi-dikes (prevent floods in August) orfull-dikes (prevent floods all year) are laid. In the areas with semi-dikes, locals often cultivate two crops per year till August and then discharge excessively over the field.

The distribution of production modelshas been unstable, many models appeared spontaneously without planning and followed the trend of market, thus the efficiencies of economy and ecology had to be concerned and evaluated.

The production models insidefull-dikesoccupied 22.33% (an area of 322.559 km2) andthe production models inside semi-dikes occupied 77.67% (an area of 1,166.985 km2) in whole study area. The most common model in study area was the Rice - Rice model (occupied 55.46% by area and 65.60% within semi-dikes).

3.2. Evaluating the soil adaptation of production models

3.2.1. Evaluating the status of soil adaptation of production models

Within semi-dikes There were 06 models to assess inside semi-dikes: rice-rice, rice-produce, rice-rice-produce, rice-shrimp, catfish, only produce.

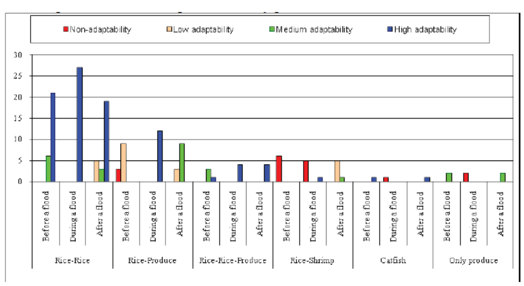


Fig 1: The adaptative succession of models inside semi-dikes.

In 52 plots of study area, with an area of 256.415 km2, in 3 seasons, the season during a flood had the highest percentage of plots of High adaptability(84.62%) and the lowest was the season before a flood, with a percentage of plots of High adaptability reached 44.23%.

Within full-dikes

There were 07 models to assess inside full-dikes:rice-rice, rice-rice-rice, rice-produce, rice-rice-produce, rice-shrimp, only produce, produce-produce-rice.

The full-dikes had a total of 50 plots with an approximatearea of 376.777 km2, the season during a flood had the high percentage of plots of High adaptability (70%), was higher than the season before a flood (36%) and after a flood (28%).

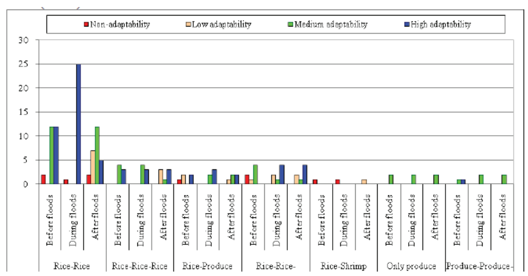


Fig.2.The adaptative succession of models inside full-dikes.

The rice-rice model had the highest adaptability, the rice-shrimp model mainly was at a level of non-adaptability, theproduce model had a stable adaptability ranged from medium to high, rice model hadall 4 levels of adaptability but most of themwere ranged from medium to high. The areas within semi-dikes had a better adaptability than the areas within full-dikes, because floods have been discharged frequently in order to receive sediments to field within semi-dikes, thus these areas have been improved in fertility and the content of necessary nutrients.

3.2.2. Evaluating the classification of soil adaptation of models

The evaluation results showed that the farming models with high adaptability were: rice - rice (WS-SA), rice - rice - produce (semi-dikes); Medium adaptability: only produce, produce - produce - rice, rice - produce (semi-dikes) and low adaptability: rice - shrimp, catfish.

3.3 Economic efficiency of production models inside the forms of dikes

3.3.1. Within semi-dikes

3.3.1.1. Rice - rice model (WS-SA)

The results of survey and analysis showed thatthe criteria of income such as GO, GO/DC, GO/LD after a flood (winter-spring season) were usually higher than before a flood (summer-autumn season), while the criteria of profit (Pr, Pr/DC, Pr/LD) were relatively stable over the survey's time.

Among the total cost of rice season, the cost of fertilizers and labors at harvest was highest. The labor value calculated on materials and labors in the season after a flood (winter-spring) was tended to be higher than before a flood.

3.3.1.2. Rice - produce model

Before a flood,the criteria such as income (GO), cost of investment (DC), profit (Pr); gross output per unit of material (GO/DC) and profit per unit of material (Pr/DC) had reached the highest values. This movement showed that the process of rice - produce cultivation within semi-dikes was tended to reduce economic efficiency between beforea flood to aftera flood, which was clearly showed via the indices of income and profit.

About the total cost of investment on the crops of rice - produce, the results recorded that the cost of investment on fertilizers, pesticides and promoting growth products was highest.

3.3.1.3. 2 rice- produce model

Productivity, income (GO), profit (Pr) before a flood were the highest, and the cost of investment (DC) for this season was also the most. In the remaining time of observation, except the productivity obtained during a flood was higher than after a flood; the indices of income (GO), cost of investment (DC) and profit (Pr) during a flood had the lowest values.

The targets of economic efficiency changed similarly. Except the index of GO/DC, the remaining indicators such as Pr/DC, GO/LD, Pr/LD of this farming model within semi-dikes at the time before a flood were higher compared with these at the time after a flood.

3.3.1.4. Specialized Produce farming model

The evaluation results shows that the criteria of profit (Pr, Pr/DC and Pr/LD)of this model during a flood were highest, and different from former models, while the criteria of income (GO, GO/DC and GO/LD) were lowest.

About a total cost of investment of specialized produce farming model, this results showed that each produce crop required the cost of investment for 12 items such as costs of seeds, fertilizers, pesticides and invest for labor's activities including the cultivation, fertilizing, soil preparation, watering, spraying and caring for plants. Like other models, costs of fertilizer and pesticides were highest, with the investment rate of 26% and 13%, respectively. While the cost of investment for labors were very low, many households have cultivated according to the attitude of earning profit from labor.

3.3.1.5. Rice - shrimp model

The survey results showed that almost the criteria of income or profits earned from this farming model were very low during a flood and different from these criteria after a flood. Especially, the criteria of income (GO) and profit (Pr) were very high after a flood. The change of criteria of GO/DC and GO/LD; Pr/DC and Pr/LD and profit per labor were higher than the values of income and profit per unit of materials, i.e., with this model, the economic efficiency receiving from a unit of labor was high when a unit of capital was invested. Thus, under the view of economic aspect, this is one of the modelsthat have had high efficiency. A large amount of cost of investment with many stages required labors such as fertilizing, weeding, spraying, tilling must be invested in order to produce a rice crop; the cost of investment of fertilizer and pesticides was also occupied high proportion including NPK (12%), DAP (9%), urea (7%), fungicides (8%) ...

3.3.1.6. Catfish model

The results showed the criteria of GO (income) and GO/LD (revenue per labor) after a flood of models were very high and different clearlyfrom the time before and during a flood. While the remaining criteria hadsimilar values between the time of survey.

Profit was stable relatively over the time of survey, demonstrated the very high effectiveness given by labor via the criterion of Pr/LD, which was much higher than the criterion of Pr/DC, the cost of investmentof raw materials such as fish seeds and foods for fish was very high, so the income or profit per labor had higher value than the income and profit per unit of material.

The survey of seasonal cost of catfish showed thatthe cost of fish seeds was highest (60% of total cost), followed by the cost of foods for fish (27%).

3.3.2. Within full-dikes

3.3.2.1. Rice - rice model

The evaluation results showed that the criteria of financial efficiency and economic efficiency after a flood were higher than before and during a flood. The investment cost (DC) and profit (Pr) in all three survey time were not realized a difference, except the output after a flood was still dominant.

Gross output per unit of material (GO/DC) and per labor (GO/LD) after a floodwere still higher than other times of survey, while the value of profit per a unit of material (pr/DC) and profit per labor (pr/LD) were relatively stable over the time of survey.

Regarding the proportion of production costs of rice - rice model within full-dikes, cost of fertilizers and pesticides occupiedthe highest proportion of total production cost with a ratio of 27 % and 17%, respectively.

3.3.2.2. Rice - produce model

The evaluation results showed, towardsthe rice - produce model insidefull-dikes, the economic indices varied according to the trend of reducing efficiency at the time before and aftera flood. Before a flood, the financial criteria such as GO (income), DC (fee), Pr (profit) and the efficient criteriasuch as GO/DC; Pr/DC; GO/LD and Pr/LD had higher values compared with these criteria after a flood.

In the proportion of investment cost of rice - pruduce model, the survey on 2 forms of dikes showed: thecost of produce season occupiedthe highest proportion was fertilizer (44% in full-dikes, 61% in semi-dikes), the ratio of investment for pesticidesin full-dikes and semi-dikes were 14% and 6%, respectively.

3.3.2.3. 2 rice - produce model

The results showed that the investment cost (DC) of the season after a flood was lower than the season before a flood due to the decrease of initial cost such as land preparation, fertilizer ... In addition, because of the characteristics of production seasons (rice, produce), there was a difference in the value of income (GO) between the time before a flood to after a flood, this criterion was depended abundantly ona factor of market, changes in prices and an object of cultivation. Before a flood, locals have produced rice so the local income have been higher than the income of produce season (after a flood), profit has decreased after a flood due to the dependence on 2 factors of income and capital expenditure.

3.3.2.4. Specialized Produce farming model

The survey results indicated that the harvest yield and the criteria of income were high before a flood, while the criteria of profitwere similar in all three times of investigation. It is suggested that, although income was unstable at the time ofsurvey, but due to the dependence on other impact's factors like investment cost (including the cost of materials and labors), the profit of this farming model after each seasonwas still stable. The cost of labors occupied a low proportion inside full-dikes, while the capital expenditure of fertilizer had the highest proportion of 56% of total investment cost. It is suggested that labor efficiency brought higher value of profit than material.

3.3.2.5. Rice - rice - rice model

The survey results showed that the volatility of economic criteria before, during and aftera floodhad the difference between the criteria of income to the criteria of profit. The criteria of income such as GO, GO/L?, GO/DC virtually had alow volatility and reached the highest values during a flood. Whereas, the criteria of profit (Pr, Pr/DC, Pr/L?) were differrent significantly between before a flood to aftera flood. Thus, towards the volatility of economic criteria, it can be seen that rice - rice - rice model has also provided a relatively stable profit for households. Regarding the total investment cost for each crop in this model,it can be seen that, rice is one of the objects of cultivation needed a lot of costs and labors. Among them, the highest cost are still focused on fertilizers and pesticides including insecticides, fungicides, herbicides ..

3.3.2.6. 2 produce - rice model

The survey results show that before a flood, almostcriteria of income including GO, GO/DC or GO/L?reached the highest values, while the criteria of profit were reaching the highest value duringa flood. Thus, with 2 produce - rice model, the 2 produce seasons have had more income and profit than rice season. However, thismodel is still considered to be one of the models having the stable profitability in both value per labor and value per material. It is necessary to get more studiesthat assess deeply the economic and environmental factors in order to get more general evaluation on production efficiency.

3.3.3. Classifying the economic efficiency of production models

The economic efficiencies of production models before, during and after a flood were classified according to the following order: 1- low efficiency; 2- medium efficiency; 3- high efficiency.

In the surveys before, during and aftera flood, the economic efficiencies of models have been relatively low. Almost survey's plots were rated at a level of 1 (low economic efficiency)

After the general classification, only 3/7 plots of rice - shrimp model reached a level of high economic efficiency (an classification of 3); 3/53 plots of rice - rice model (within semi-dikes); 4/7 plots of rice-shrimp model and 1 plot of catfish models were rated at a level of medium efficiency. All remaining plots were rated at a level of low efficiency.

Environmental succession inside the forms of dikes

3.4.1. Surface water quality

In the crop within semi-dikes before a flood, the environmental quality of rice-shrimp and specialized Produce farming models has been relatively better than other models. In the crop after a flood, besides rice-shrimp model, the rice-rice, rice - rice - produce and rice - produce models have improved in surface water quality. The crop before a flood within full-dikes, the produce - produce - rice and rice - produce models have had a better surface water quality than other models.

In the crop after a flood, the rice - rice was the best because the criterion of BOD5 reached a standard of 100%, observations also showed that the values of BOD5 was lower than the area within semi-dikes and the criterion of COD has also decreased abundantly, among them, the 2 rice - produce and rice - produce models inside full-dikes had the lower criterion of COD than the models inside semi-dikes; in contrast with the rice - rice and rice - shrimp models, the criteria of COD within semi-dikes has been better than this criteria within full-dikes. The remaining models have not been evident.

3.4.2.Soil environment

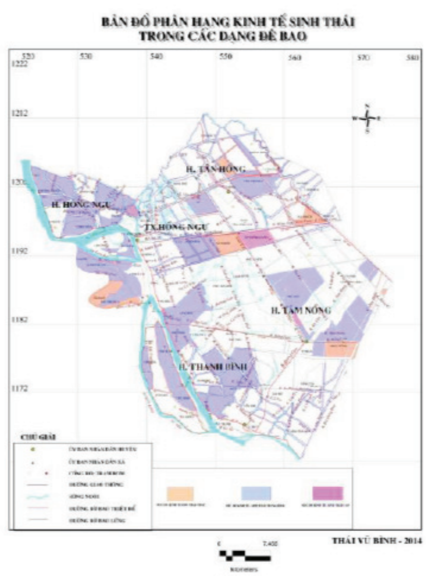
In the crop before a flood within semi-dikes, the specialized produce farming and produce - rice models have had a better quality of soil environment than other models. In the crop after a flood, rice - produce model have had the best soil quality among the remaining models. pH inside full-dikes has had better trend than pH inside semi-dikes but the content of exchangeable aluminum has been higher. Similarly, the soil quality of rice - produce model inside full-dikes was better than other models.

It is initially noticed that the criterion of $Al3^{+}$ in farming models within semi-dikes has been better than this criterion within full-dikes, with 5/8 farming models inside semi-dikes (rice - rice, rice - produce, produce, 3 rice, 2 produce - rice) had this result. Whereas, the trend of soil pH in the area within semi-dikes as well as full-dikes has been superior after a flood. Thus the quality of tillage has been impacted slenderly. This result also showed the effectiveness of using flood water in order to improve farmer's tillage in study area.

3.4.3. Evaluating the general classification of environmental quality in study area

After intergrating the general classification of environmental components in study area, the results showed that most of the environments in farming models have reached as a level of medium (grade 2). 11/32 survey plots showed the good condition of environment (grade 3), including 9 farming plots within semi-dikes, with rice - rice, rice - produce, 2 rice - produce, rice - shrimp, specialized produce farming models and 2 points within full -dikes with rice - rice model. The condition of environment at 6/32 survey plots was not good (Grade 1) among 2 plots inside semi-dikes and 4 plots inside full-dikes.

Thus Rice - Rice model had many cells which were categorized in high level of environment; followed by Rice - Rice - producemodel and those models have been mostly located inside semi-dikes.



3.5 Economic- ecological efficiency of production models within the forms of dikes

The results of classification let the economic - ecological efficiency of farming models within dikes was arranged in accordance with the levels: low economic-ecological efficiency, medium economic-ecological and high economic-ecological efficiency.

Among 7 cells (cell) which hadthe low economic-ecological efficiency, 6 cells was located inside full-dikes (occupied 85.7%) and 1 cell was located inside semi-dikes, in 7 models whose economic-ecological efficiency was low, 6 models were cultivated 3 crops peryear (occupied 85.7%).

There are 90 cells (cell) which had the medium economic-ecological efficiency, including 57 cells within semi-dikes (occupied 63%) and 33 plots within full-dikes.

The highest proportion was belonged torice - rice model with 47 cells, followed by rice - produce with 15 cells. Among the medium economic-ecological models, the ratio of 3 crops cultivation was 23% (21 models).

Conclusion

The processes and methods to assess the economic - ecological extent of production models were built on the basis of integrated adaptive factors of soil, environmental efficiency, economic efficiency. These processes and methods are feasible and conduce many intuitive results, which can be used for the purposes of laying the production in space and time in order to ensure not only the economic development but also the maintenance and protection of environment and ecology.

The farming models within the forms of dikes in Dong Thap Muoi have not been generally reasonable, farming techniques and operating solutions of dikes in some models have not conduced a good economic - ecological efficiency.

The 2 crops cultivation inside semi-dikes has reached the levels of economic - ecological efficiency between medium extent and high extent. Inside full-dikes, the farming models have reached the levels of economic - ecological from low extent to medium extent.

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