Determination of Affecting Factor for Sustainable Agricultural Production: A Case Study in Tan Thanh District, Long An Province, Vietnam

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ABSTRACT

Background: This study aims to estimate the factors affecting the agricultural production process on the problem soil of Tan Thanh district as a case study to develop solutions for sustainable agriculture.

Methods: Through consultation with 150 households and 60 experts, Four primary and 18 secondary factors were identified that affect the agricultural land use of the community.

Result: The results show the factors of the consumption market, government organization, profit and soil quality that are the factors that receive much attention from experts by the "multi-criteria evaluation" method. On the contrary, the aspects of problem soil, irrigation capacity, flooding and drought time are of little interest to experts. The results have also proposed 12 groups of structural and non-structural solutions to improve the district's agricultural land use efficiency. Which focuses on the consumption market, cost, profit and government organization.

Key words: Impact factors, Land use, MCE, Tan Thanh district.

INTRODUCTION

Climate change sea-level rise has been having a significant influence on agricultural development of the Mekong delta in general and Long An province in particular by extreme weather conditions, erratic rain, prolonged heat, saltwater intrusion deep into the field (Le, 2019; Phan *et al.*, 2020; Pham *et al.*, 2020). Besides, the exploitation of hydroelectric resources of the upstream zone also contributes to increasing the impact of natural factors affecting farmers' agricultural production (Turner *et al.*, 2009; Tri *et al.*, 2013; Hong *et al.*, 2019; Tran, 2021).

Tan Thanh is located in a deeply flooded ecological zone and is contaminated with acid soils. As an area of acid sulfate soil accounting for 69.8% of the entire area of Dong Thap Muoi, Long An is considered a province with a vast area of acid soil, of which the most prominent district is Tan Thanh (People's Committee of Tan Thanh District, 2020). In recent years, agricultural production in the community has faced many problems because the farmer's spontaneous conversion of crops did not follow the general direction of the section. This impacted land use security because of saltwater transportation for brackish aquaculture due to the relatively high instantaneous profit (Pham *et al.*, 2019; Phan *et al.*, 2020). Then leads to the risk of farmers' production because the principle of the agricultural product market is always in the position of "good season, low price," affecting the life of producers (Phan *et al.*, 2020). Therefore, the study aims to identify the factors affecting the agricultural cultivation process of farmers.

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MATERIALS AND METHODS

Data collection

Secondary data collection

Collection of the reports of current situation land use 2020; economic and social development 2020; data of statistics, inventory of soil and map of existing land use 2020 and administrative Tan Thanh district map.

Primary data collection

The study interviewed 150 farmers and 11 commune administrative unit managers. Besides, the study consulted 60 experts to determine the affected factors.

Multi-criteria evaluation (MCE)

The study used the Analytical Hierarchy Process (AHP) tool to determine factors affecting agricultural land use (Fig 1).

RESULTS AND DISCUSSION

Current status of agricultural land-use in the study area

The results synthesized from land statistics and consulted agricultural managers of Tan Thanh district showed that the farmland area year 2020 has about 37,494.98 hectares (88.68%). The distribution area of mainly agricultural land use types is shown in Fig 2.

The main distribution areas are double and triple rice production land (Fig 2). For land-use type is fruits growing jackfruit and mixed fruits that combine other fruits were developing in recent years. The high price of jackfruit has changed farmers' psychology in farm production and affected the district's general development. The cash crop cultivation area is mainly the lotus, about 296.5 hectares. By 2020, aquaculture land area will still dominate (occupied about 4.48%) (Fig 2). The extent of forest cultivation in the district is mainly Melaleuca forest. Besides, farmers combine fish and honey bee farming to increase their income. Therefore, to develop sustainable agriculture, the community needs a more practical solution in changing the crop structure and concerns attention to critical products suitable for local conditions and meeting market demand.

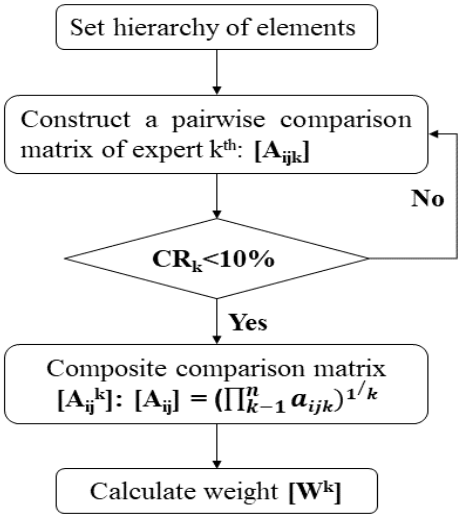


Fig 1: AHP in determining the weight of criteria (Source: Saaty, 1980).

Soils of the study area

Depending to the People's Committee of Tan Thanh district (2020), the total study area is 37,504.9 ha, including major soil groups: Alluvial soil (1,263.82 ha); Alluvial soil with Umbric horizon (6,602 ha) and Deep potential acid soil (15,506.1 ha). Triple rice crops are primarily grown on these soils. While double rice crops predominate on the shallow acid sulfate soils (9,854.77 ha). The Peatland covers an area of 1,797.95 ha and covers primary the Melaleuca forest.

Factors affecting agricultural production in the study area

Determining the factors that affect agricultural production in Tan Thanh district

According to Minh, *et al.* (2020), rice is cultivated under irrigation in the Vietnamese Mekong delta. As a result, it is usually rinsed with high productivity, leading to unsustainable water and soil exploitation, inefficient chemical inputs, the menace of disease and insect and pest problems. The results of consultation with experts and farmers directly engaged in agricultural production have identified primary factors affecting the farmer's output shown in Table 1.

Impact factors that affect agricultural production in the study area

The level 1 assessment, which includes physical, economic, social and environmental factors that affected the farmland use process, showed that economic factors influence (W=0.3263). While Fig 3 shows that social factors impact production in the district with an impact weight of W=0.2853.

Although it affects agricultural land use in the district, the level of impact is not much (Weight W=0.2059). Experts considered the environmental factor to have little effect on farmers' agricultural land use process in the Tan Thanh

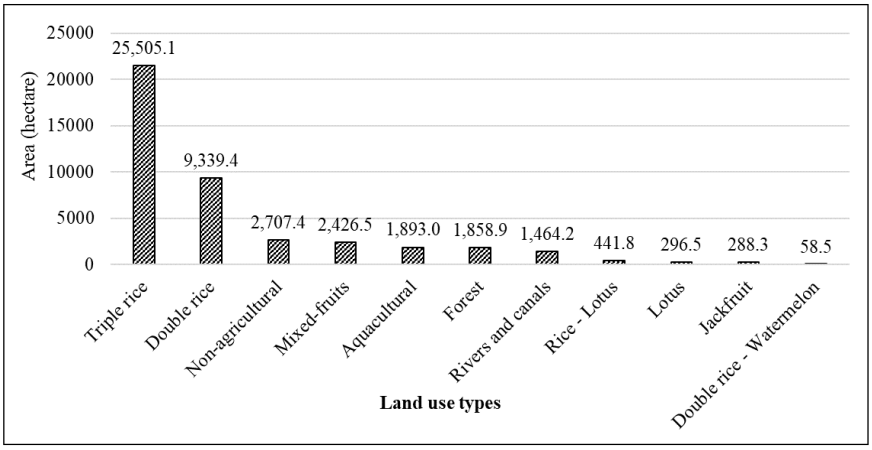


Fig 2: The area of land-use types in Tan Thanh district year 2020.

district (Fig 3). Experts believe the consumption market factor is the most influential in agricultural cultivation (Fig 4a). When there is a stable consumption market, farmers will feel secure in production and create motivation for farming development (Phan *et al.*, 2020). Profit is also a factor that receives much attention because farmers choose agricultural land use types, most of which only look at the initial profit, thereby leading to spontaneity in farming, breaking the general orientation planning of the district (Phan *et al.*, 2017; Rajendra *et al.*, 2019; Le *et al.*, 2019). Besides, the financial resource factor of the household also has a relatively high weight (W=0.2178) because farmers must have enough investment capital for the land use type when converting and replacing other land-use types. The agents of fertilizers and pesticides will charge an additional interest rate to increase the production cost of the farmers (Nguyen *et al.*, 2013; Nguyen, 2014).

Social factors

The results show that the government organization factor is believed to have the most impact on agricultural production (Fig 4b). Choosing the spontaneous land-use type is critical, especially when the planning is unsuitable or does not bring economic efficiency. It is difficult for the farmer to accept such planning (Pham *et al.*, 2013). In the current agricultural production, although it has been mechanized in agricultural output, the current agricultural labor source faces many difficulties. When farmers sow many seeds using fertilizers and pesticides according to their production habits, profits are reduced (Nguyen and Hoang, 2012).

Physical factors

The results show that the weather factor significantly influences the agricultural production process of the farmer (Fig 4c). Since this is a decisive factor in crop yield and quality. Rain causes the clay to swell, water in the soil does not drain quickly, it becomes soggy, roots work poorly, fungal diseases develop and seeds get sicker (Nguyen, 2019). Accordingly, rice yield will reach the highest value if water is provided appropriately and vice versa (Vo *et al.*, 2019). In addition, a lot of flooding will make the soil anaerobic, lack oxygen for root respiration and directly affect plants (Hoang *et al.*, 2006). However, according to Tran *et al.* (2017), the Tan Thanh district belongs to the potential acid sulfate soils area. Therefore, the impacts do not have much effect on the farming efficiency of the farmers.

Table 1: Factors affecting agricultural production in Tan Thanh district.

Factors level one	Factors level two	Other research
Economy	Farmers financial resources; Investment cost; Profit Consumption market	Khoza *et al.*, 2019; Schreinemachers and Berger, 2011; Ada *et al.*, 1998; Sajesh and Padaria, 2019; Nasim *et al.*, 2018; Ramasubramanian *et al.*, 2014; Das, H.P. 2005; Pham *et al.*, 2020; Phan *et al.*, 2017; Bowman and Zilberman, 2013; Rajendra *et al.*, 2019; Viaggi *et al.*, 2013
Socially	Labor source; Management organization; Farming habits of farmers; Agricultural materials	
Physically	Unusual weather; Flooding depth; Agricultural epidemics Alum influence; Dry time Rainy time; Irrigation ability	
Environmentally	Soil quality; Water pollution; Plant protection products	

(Source: Expert Consultation, 2020).

Table 2: The solutions improve agricultural production efficiency in the Tan Thanh district.

Impact factor	The solutions improve agricultural production efficiency.
Consumption market	To link product consumption with purchasing businesses, the government plays the role of a bridge.
Investment	To apply technical technology to products; Financial support.
Government organization	To regularly organize training courses and guide technical for farmers.
Labor demand; Farming habits	To approach the application of high technology in production; To access scientific and technical applications in agricultural production.
Agricultural materials	Strengthen inspection of agents of agricultural materials to avoid selling at incorrect prices or trading in poor quality materials.
Unusual weather	Regularly monitor and forecast the weather situation.
Agricultural disease; Irrigation ability	To clean the field, create a ventilated garden to prevent and cut off the source of pests and diseases that harm crops; It is necessary to complete the 3-phase power system to create conditions for building an electric pumping station.
Flood and Acid soil	To improve the system of dikes, it is necessary to properly scale up to develop fruits and build a soil drainage canal system; It should apply organic fertilizers.
Pollution	To replace chemical fertilizers that are harmful to the environment with biological drugs and organic fertilizers.

Environmental factors

Soil quality factors (nutrients, pollution) significantly affect agricultural production in the district (Fig 4d). In addition, intensive farming, increasing the crop has made the soil not have time to rest as well as the nutrients in the soil are increasingly depleted, especially not to release floods in the rainy season, which affects the nutrients in the soil increasingly consumed (Nguyen *et al.*, 2018). However, farming in the dike area for a long time has made the soil lose essential nutrients, leading to a decrease in crop yield and, at the same time, increasing production costs due to the continuous increase of fertilizer (Duong *et al.*, 2017). Furthermore, under rain and leaching, pesticides in the soil will accumulate and settle in the bottom mud layer in rivers, ponds and lakes, which have polluted water sources (VietNam environment administration, 2015). This accumulation can be so high that it is toxic to the soil, water, air and human health (Nguyen *et al.*, 2018).

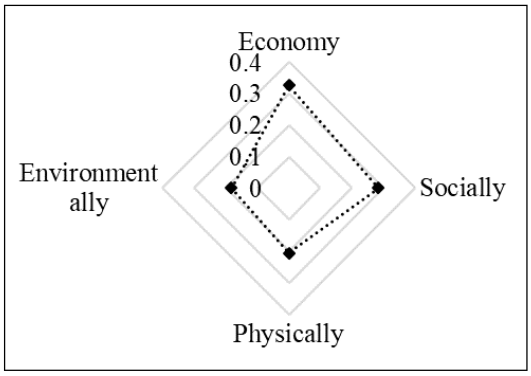


Fig 3: First impact level factor affecting agricultural production in Tan Thanh district.

In general, agricultural production in the study area is heavily influenced by the consumer market, the local government organizing agricultural production, profit of land use types and soil quality (Fig 5). The factors of flooding depth, acid soil, irrigation capacity, drought time and agricultural diseases have little impact. Therefore, farmers will have more capital to invest if the profit is higher and the land use type has good efficiency.

The recommendation for agricultural production

The study develops the strategies for sustainable agriculture, using land resources rationally, following natural conditions and helping people in Tan Thanh district adapt and respond to climate change conditions in the future. In addition to the agricultural recommendations in Table 2, acid sulfate soils are frequently deficient in phosphorus and hazardous for iron, aluminum, or manganese. The soil's physical characteristics are inferior. The depth range for jarosite mottles is 2 to 50 cm or more. Draining this soil is not advised. pH significantly drops after draining. For crop production, high liming rates (>10t/ha per 3-4 years) or long-term leaching would be necessary (Breeman and Pons, 1978). Shallow drainage is the most profitable method for raising medium-term rice crops (Xuan *et al.*, 1982).

The management needs should be based on field observations and numerous experiments on soil management, reclamation, fertility adaptation, rice varieties, *etc.*, conducted in the Mekong delta.

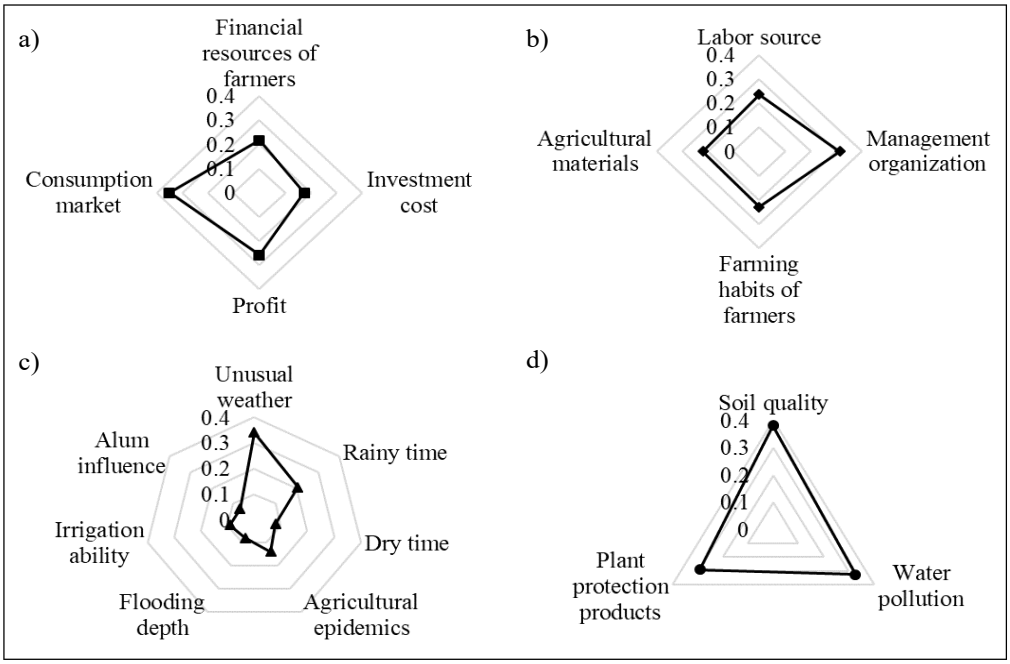


Fig 4: Level of impacts of economic (a), social (b), physical (c) and environmental (d) level 2 factors on agricultural land use in Tan Thanh district.

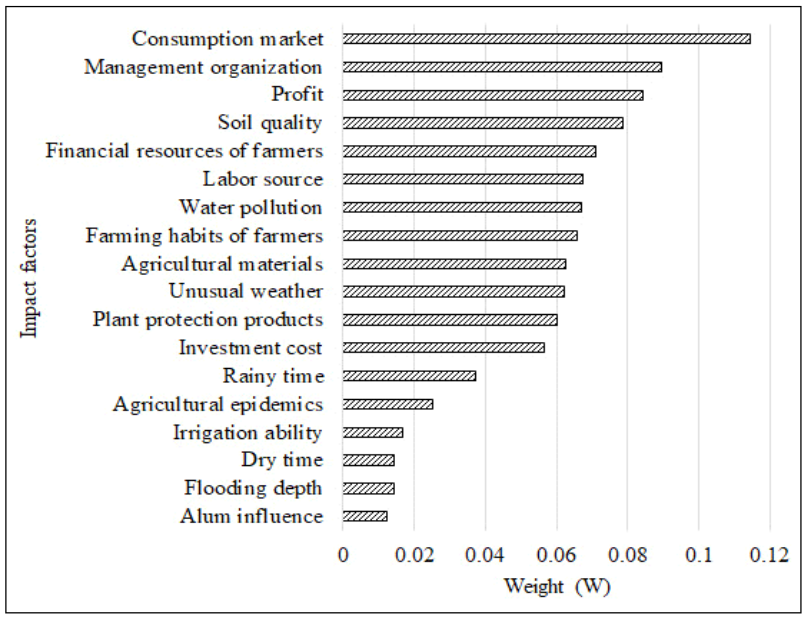


Fig 5: The impact of factors affecting agricultural production in Tan Thanh district.

CONCLUSION

The results have identified four level 1 in which the level of economic factors has the most influence and environmental factors that have little impact and eighteen level 2 aspects in which the aspects have a high impact as consumption market, government organization, profit and land quality. On the other hand, acid soil, irrigation capacity, flood depth and drought time are less influential factors. The results also suggest some structural and non-structural solutions in the agricultural process to adapt to the climate change conditions in the future.

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