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Drivers of agricultural transformation in the coastal areas of the Vietnamese Mekong delta

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ABSTRACT

Drivers of agricultural transformation vary from place to place. They need to be explored, especially under the new context of changing climate, environment and socio-economic development in coastal regions. This paper aims to discover the drivers of change through an analysis of the agricultural transformation process in the Vietnamese Mekong delta and then develop a framework for the next steps to meet sustainable development objectives. A mixed approach of qualitative and quantitative methods was applied to collect primary and secondary data. Major techniques used in data collection consist of Key Informant Interviews (KII), Focus Group Discussions (FGD) and household surveys with 203 farmers in three coastal provinces, including Ben Tre, Kien Giang and Soc Trang. The results showed that the agricultural sector has been transforming towards the diversification of crops and livelihoods. For example, there has been a shift from rice monoculture to integrated farming systems (i.e. rice-shrimp or grass-cattle) and a move from on-farm to more off-farm or non-farm incomes. This transformation was found to be driven by many factors that can be categorised into the '4Ps of change', consisting of the Price, the Producer, the Place and the Policy. The 4Ps of change are not isolated but interrelated. Then, considering the 4Ps of change, a holistic framework for sustainable agricultural transformation (SAT) has been developed. What distinguishes this SAT framework from others is a combination of value chain theory and agribusiness concepts. Hence, it would create resource use efficiency, add more value to products, deliver healthy food and contribute to successful transformation in the future. Successful implementation would need the government's readiness to provide a practical legal framework and efficient support to motivate all actors involved in the transformation process.

1. Introduction

Agricultural transformation is considered an essential process on the path to economic growth in most developed countries around the world (Timmer, 1998; World Bank, 2007; Boettiger et al., 2017a). It is an urgent need to address one of the greatest challenges to humanity, i.e. to feed the world's population in a sustainable, safe and nutritious, equitable and ethical way under pressure from climate change (Stringer et al., 2020). Successful transformation in agriculture can lead to income improvement, job creation, malnutrition decline, poverty reduction, and economic growth. Therefore, many studies have suggested that supporting agriculture in developing nations is the most effective way to help them move to higher income levels (World Bank, 2007; Ghosh, 2012; Boettiger et al., 2017b). Numerous studies have demonstrated that the nature, magnitude and pace of transformation vary among countries (World Bank, 2016; Boettiger et al., 2017b).

Many factors may act as drivers to influence the transformation at different levels. At the smallholder level, farmers' family dynamics, socio-cultural values, land tenure, succession, community factors and economic conditions play important roles (Inwood, 2013). Similarly, Pinnawala and Herath (2014) emphasised the importance of social factors affecting agricultural productivity, such as relationships, behaviours, attitudes and beliefs, along with natural conditions, such as weather, climate, soil, etc. Bowman and Zilberman (2013) reviewed

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different variables that may influence farmers in decision-making, such as the farmers' attitudes, resource availability, education and knowledge, as well as biological and geophysical factors of the farm and the conditions of input and output markets.

At the agricultural system level, drivers may include internal social factors, external social factors and political factors (Archer et al., 2008), or national-level policies related to irrigation and extension investment or market forces (Renaud et al., 2015). Gandhi (2014) identified seven major drivers, including scarcity of land, urbanisation and increasing commercialisation of agriculture, need for change in scale and reorganisation of production and marketing, economic liberalisation, changing food consumption patterns, the rural economy and infrastructure development, and the information technology revolution. The World Bank (2016) also stated that agricultural and rural transformation is strongly influenced by demographics, agro-ecological resources, infrastructure development, and changes in consumer demand and international markets. In an analysis of the transformation in 30 countries, Boettiger et al. (2017b) demonstrated that drivers could be grouped into three categories: transformation readiness from the government, quality of the national agricultural plan or strategy, and mechanisms to translate plans into on-the-ground impacts. As such, the drivers influencing the agricultural transformation are multidimensional, interconnected, dynamic and temporal.

The World Bank (2016) defined a pathway of transformation, starting from an Agriculture-based phase, then successively going through a Pre-transition phase, a Transition phase, and an Urbanised phase, before reaching the Developed phase. Based on the declining shares of agriculture in the country's GDP (Gross Domestic Product) and employment, Vietnam is currently at the Transition phase in the pathway. The share of the labour force employed in agriculture fell from 73 % in 1990 to 49 % in 2017, and the contribution of the agricultural sector to total GDP decreased from 38 % to 15 % over the same period (GSO, 2002, 2018a). However, figures for the contribution to GDP vary between agro-ecological regions. In the provinces of the Vietnamese Mekong delta, the most productive agricultural region of the country, the share of agriculture in the total economy is still higher than that of the whole country. For example, it was 36 % in Ben Tre and Kien Giang, and 40 % in Soc Trang province, compared to 15 % in Vietnam, in 2017 (BTSO, 2018; KGSO, 2018; STSO, 2018; GSO, 2018a).

As mentioned, many drivers, which vary among countries or even regions within a country, affect the agricultural transformation. However, previous studies on Vietnam's agricultural transformation and development have mainly focused on the country level (Cuc, 1995, 2003; De, 2006; Son, 2008; World Bank, 2016). There is a lack of such analysis for the Vietnamese Mekong Delta (VMD) and its coastal areas in particular. These areas are highly vulnerable to socio-economic and environmental changes, consisting of climate change, sea-level rise, and various other changes as consequences of the significant development in the whole Mekong river basin (Binh, 2015; IMHEN and UNDP, 2015; Smajgl et al., 2015; Evers and Pathirana, 2018; Smajgl, 2018; Nguyen et al., 2021). An analysis of the agricultural transformation and its drivers in these coastal areas, where agriculture is still the dominant livelihood of the majority of the population, is thus needed and will contribute to adaptive and sustainable development in the region.

This paper will address this gap with three objectives. The first objective is to investigate the agricultural transformation in the coastal areas of the VMD from 1975 to the present, and the second objective is to analyse its influencing drivers. These two objectives aim at understanding the culture and context of changes. Then, drawing on the understanding gained, the third objective of the paper is to propose an agro-ecological farming framework, called the Sustainable Agriculture Transformation (SAT) framework, to develop safe and sustainable pathways for adaptation in the coastal region.

2. Methodology

This study applied various social research methods described by Newman (2014) and the approach of using stories for evaluation described by Krueger (2015). The study is participatory action research, where both primary and secondary data were collected and analysed to achieve the study objectives (FAO, 2006, 2011). Following the above approaches, we designed an integrated method consisting of the following components.

2.1. Review of literature and selection of study sites

Literature related to the research topic was reviewed intensively. The keywords for the review included 'agricultural transformation', 'drivers of change', 'coastal area', and 'Mekong delta'. This step helped the research team get a broad understanding of the topic, as presented in the Introduction. The reviewed documents were then extended to the national and local literature relevant to the topic, including all types of statistics and project reports, policies and implementation reports, etc., from various levels of government (FAO, 2011). This also provided guidance for study site selection and development of checklists and questionnaires for the data collection steps. Based on the literature review and the study objectives, we selected three coastal provinces in the VMD for the study, including Ben Tre, Soc Trang and Kien Giang provinces (Fig. 1). From further consultations with local staff during the data collection, three representative districts, i.e. Ba Tri district in Ben Tre, Tran De district in Soc Trang, and An Bien district in Kien Giang, were chosen as the study areas. These districts represent different biophysical and social-economic conditions of the coastal region and have shown some remarkable agricultural transformations in recent decades.

2.2. Data collection

This study collected both primary and secondary data through a multi-step engagement and survey process at three administrative levels: province, district, and commune (FAO, 2011). The duration of the data collection was six months, from August 2018 to February 2019. The process is summarised in the following:

- At the provincial level, we used the Key Informant Interview (KII) technique (FAO, 2011) to collect primary data by interviewing staff and experts from the Department of Agriculture and Rural Development (DARD), the Department of Natural Resources and Environment (DONRE), and the Statistical Offices of the three provinces. The purposes were to elicit their opinions and understanding of the agricultural transformation and the drivers of various changes, and in particular how they have occurred in relation to policies from the central government and provincial governments, as well as in relation to the whole country's development. Secondary data were also collected from these agencies in terms of official reports and policy documents.
- At the district level, we collected primary and secondary data with the same approaches from the Sub-DONRE and Sub-DARD (i.e. DONRE and DARD at district level). The purposes were similar to those for the provincial level but focused more on policy implementation and practical outcomes. During the KIIs, the research team identified three communes for more detailed investigation, including Bao Thuan commune in Ba Tri district, Vien Binh commune in Tran De district and Tay Yen A commune in An Bien district.
- At the commune level, one Focus Group Discussion (FGD) per commune was carried out using the following participatory tools: timeline analysis, mapping exercise, seasonal calendar, transect walk and observations (FAO, 2006, 2011). In the end, a household survey was conducted using a structured questionnaire. There were 203 households involved in the survey, including 76 households in Bao Thuan commune, 66 households in Vien Binh commune, and 61

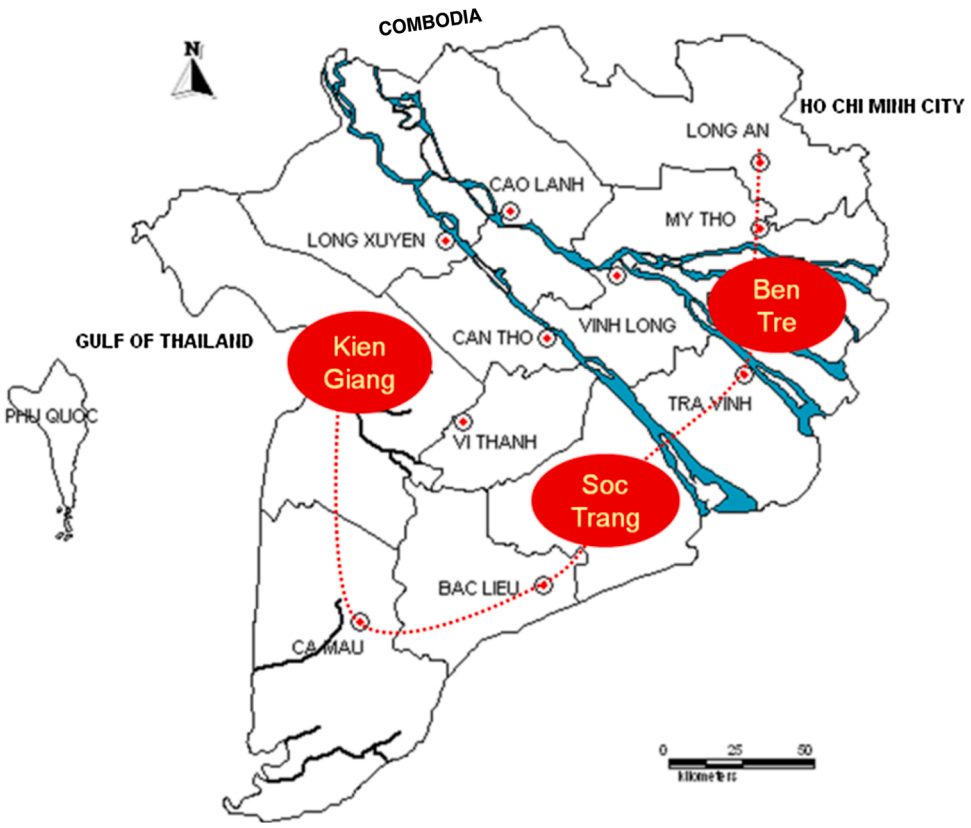

Fig. 1. Map showing the study provinces.

households in Tay Yen A commune. The questionnaire focused on the farmers' decision-making in changing production models and the associated hindering or enabling drivers related to biophysical, socio-economic and policy conditions.

2.3. Data analysis and interpretation

The qualitative information and data from the KIIs and FGDs were analysed using an inductive approach, as described by Thomas (2003). Firstly, the raw data were condensed and classified into different categories. Secondly, they were selected corresponding to the study's objectives. Finally, the findings were documented and discussed in a logical and locally suitable way, which employed the approach of using stories for evaluation, as described by Krueger (2015), to interpret the results. After the above steps for the three study objectives, the following analyses were conducted.

For the transformation, we used the Timeline Analysis method (FAO, 2011) to:

- Create a timeline from 1975 to 2020, and then identify relevant events and impacts based on the literature review and data from the KIIs and FGDs.
- Map the events into phases in the transformation pathway (World Bank, 2016), including the Agriculture-based (or Stagnancy) phase, the Pre-transition phase, and the Transition phase, i.e. the three phases that are applicable for Vietnam.
- Identified the changing phases with breakthrough events, e.g. the Doi Moi policy in 1986 and Joining WTO in 2007.

For the analysis of the drivers of change, we found that drivers that were either enabling or hindering agricultural transformation, as recognised by the respondents, could be categorised into four groups: the Price, the Producer, the Place and the Policy, which are called the '4Ps of change'. We also used quantitative data from statistical yearbooks and household surveys to show agricultural production development and calculate the indicators necessary for interpretation.

Based on the learning from the 4Ps and using the concepts of the value chain and agribusiness, we developed an agro-ecological farming framework called the Sustainable Agricultural Transformation (SAT) framework. It provides a crucial link between the production and consumption sides and facilitates a good combination of top-down governance and bottom-up practices for successful transformations, as recommended by Stringer et al. (2020).

3. Results and discussions

3.1. Study sites and description

Table 1 shows that the three selected districts each cover roughly the same area (370–400 km^2 per district). However, they have different population densities. This difference may lead to different livelihood activities, as districts with higher population density tend to raise more livestock. According to the official statistical data (STSO, 2018) Tran De district grows only two rice crops per year, whereas the two other districts cultivate three crops per year. However, we found from the FGDs that many places in Tran De also grow three crops per year, in practice. That is why the total rice planted areas and production figures for Tran De are higher than those of the other districts. In aquaculture, An Bien has the largest area of 26,042 ha, compared to Ba Tri 6292 ha and Tran De 6826 ha. However, most aquaculture in An Bien is extensive or improved extensive levels (i.e. integrated rice-shrimp farming systems). At the same time, Ba Tri and Tran De pay more attention to intensive cultivation, resulting in big differences in productivity among the districts. The above findings are useful for identifying different drivers and comparing various livelihood strategies in the dynamic environment of the VMD.

Table 1
Information of three districts at the research sites.

Items	Ba Tri (Ben Tre)	Tran De (Soc Trang)	An Bien (Kien Giang)
Population (1000 people)	189.8	134.6	126.8
Total land area (km^2)	367.3	378.0	400.3
Population density (people/km^2)	517	356	317
Average farm size* (ha)	0.7	3.0	3.0
Rice planted area (ha)	37,284	45,284	32,340
✓Winter-spring (ha)	*11,967*	*22,750*	*14,427*
✓Summer-autumn (ha)	*12,108*	*22,534*	9597
✓Autumn-winter, traditional crop (ha)	*13,209*	—	8312
Rice production (tons)	171,833	274,690	137,621
✓Winter-spring (tons)	*62,312*	*144,804*	*62,832*
✓Summer-autumn (tons)	*51,701*	*129,886*	*52,303*
✓Autumn-winter, traditional crop (tons)	*57,820*	—	*22,486*
Buffalo (heads)	351	188	87
Cattle (heads)	97,042	10,222	120
Pig (heads)	17,434	25,368	19,889
Poultry (heads)	648,700	476,520	256,362
Aquaculture area (ha)	6292	6826	26,042
✓Intensive and semi-intensive (ha)	3189	4291	*30*
✓Extensive and improved extensive (ha)	3103	2535	*26,012*
Production of fishery (tons)	109,812	79,734	37,032
✓Catch (tons)	*93,250*	*52,472*	*11,609*
✓Aquaculture (tons)	*16,562*	*27,262*	*25,423*

Sources: BTSO, 2018; KGSO, 2018; STSO, 2018; and the Household Survey in this study.

3.2. Agricultural transformation

An overview of major events of the agricultural transformation in the coastal areas of the VMD is summarised in Fig. 2, obtained with the timeline analysis. After the country's reunification in 1975, Vietnam followed a central planning approach that showed many difficulties for economic growth, causing *stagnancy* in development. Agriculture was collectivised and centralised with less consideration of local conditions. Farmers had no rights to make any decisions on their farms. Additionally, rice crops in the region were heavily destroyed by brown planthopper outbreaks in 1977–1980, with the most severe damage happening in 1978. Some investments were made for irrigation with hand-made canals, but rice yields and production were low. For example, the average rice yield in Kien Giang was 2.0 tons/ha/crop in 1976, which dropped to 1.7 tons/ha/crop in 1978, then grew slowly to 2.7 tons/ha/crop in 1985. The growth of agriculture did not keep up with the population explosion, resulting in food shortages and extreme poverty. In fact, the shares of agriculture in the country's labour force and GDP were as high as 75 % and 42 % respectively in 1980 (GSO, 1991). Vietnam had to import 7.0 million tons of food in the period 1975–1985. The highest level of imports occurred in 1979, after the severe brown planthopper infection, with a total loss of 1.6 million tons of rice (Dung, 2012).

To cope with the situation, in 1986, the sixth Communist Party Congress announced its reform (Doi Moi) guidelines, shifting from central planning to market orientation, led by the central government. After this breakthrough event, the economy was untied by a proper legal framework, moving the country to a *pre-transition phase*. In agriculture, the reform policy became effective in 1988 with Resolution No. 10 (Politburo of Communist Party of Vietnam, 1988) and a series of related policies. These policies gave smallholders land-use rights and the freedom to purchase inputs and sell outputs. Later, the first Land Law was enacted in 1993, and a formal agricultural extension system was also established from national to grassroots levels (Government of Vietnam, 1993).

In relation to the studied provinces, many big irrigation projects were conducted to prevent saltwater intrusion into rice development. Additionally, many other policies were enacted to promote growth. The most important were the Birth Control policy by the Prime Minister, Decision No. 270 in 1993 (Prime Minister of Vietnam, 1993) and the Poverty Reduction policy by the Prime Minister, Decision 135, well-known as Programme 135, in 1998 (Prime Minister of Vietnam, 1998). As a result, rice planted areas expanded, rice yields increased, the number of people per household declined, and the poverty rate reduced (Fig. 2). Thanks to rice development, Vietnam shifted from being a food importer to producing enough food for domestic consumption. Eventually, it had a surplus available for export, from 1989 (Dung, 2012).

However, rice intensification caused many environmental problems such as pollution and loss of natural habitat for wildlife (Francisco and Glover, 1999; Be et al., 2007). Recognising such negative impacts, on

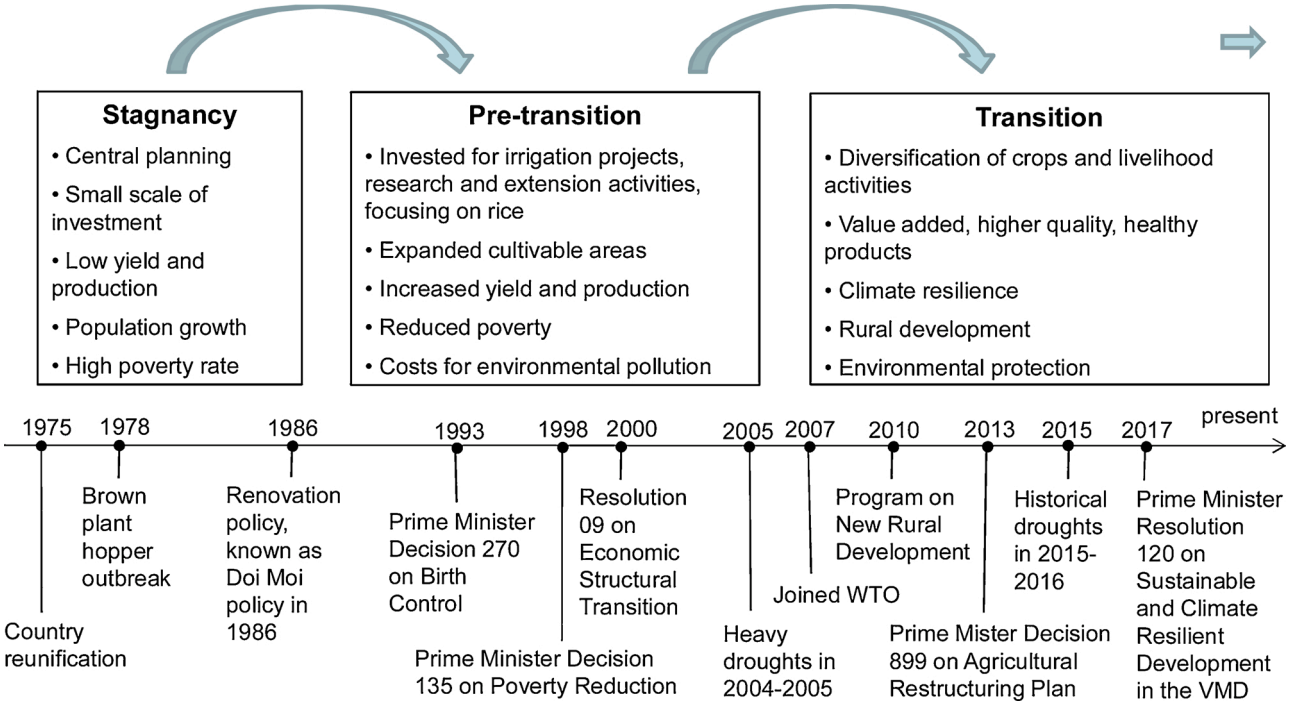

Fig. 2. Timeline of the agricultural transformation with major events in the coastal areas of the VMD based on the KIIs and FGDs.

15th June 2000, the government promulgated Resolution No. 09/2000/NQ-CP (Government of Vietnam, 2000) regarding several undertakings and policies on economic reform and agricultural product consumption. Thanks to this Resolution, there was a change in land use towards diversification of agricultural products, such as cash crops, shrimp, livestock, etc., instead of rice monoculture.

Furthermore, the extreme drought in 2004–2005, causing salinity intrusion, heavily damaged rice production. This event pushed farmers to shift to brackish aquaculture. The data collected from the three provinces showed a trend of converting rice areas to aquaculture. A big jump in aquaculture areas was observed from 1996 to 2006, compared to the other 10-year intervals over the past three decades (Fig. 3).

Later, the transformation moved to a *transition phase* marked by many events. In 2007, Vietnam officially joined the World Trade Organization (WTO), which brought pros and cons for economic growth in general and the agricultural sector in particular, depending how well the country reacted to the high level of competition under the WTO regulations. Many scholars identified urgent solutions for agricultural products if Vietnam wanted to take advantage of its WTO membership. The solutions included applying good agricultural practice (GAP), producing large and stable yields, assuring high quality and nutrition, and keeping production costs low (Hoang, 2007; Trang, 2007). After one year, on 5th August 2008, the seventh Conference of the Central Committee of the Communist Party made an important Resolution, No. 26/NQ-TW regarding agriculture, farmers and rural areas. This Resolution focused on the necessity to improve knowledge and skills to use land, labour and other resources efficiently to increase yields, quality and competition levels of agricultural products. The implementation of the Resolution was concretised by many policies. The most significant ones were the Prime Minister Decision No. 800/QD-TTg in 2010 to approve the 'National target programme on new rural development for the period of 2010–2020' (Prime Minister of Vietnam, 2010), and the Prime Minister Decision No. 899/QD-TTg in 2013 to approve the project 'Agricultural restructuring towards raising added values and sustainable development' (Prime Minister of Vietnam, 2013).

The VMD is recognised as one of the deltas most vulnerable to climate change in the world, of which the coastal provinces are affected at the highest level (IPCC, 2007; MONRE, 2011). The extreme drought in 2015–2016 was a significant event affecting the agricultural sector, creating a strong push toward transformation in coastal areas (Nguyen et al., 2021). Consequently, on 17th November 2017, the Prime Minister signed the specific Resolution No. 120/NQ-CP on Sustainable and Climate-Resilient Development of the VMD (Government of Vietnam, 2017). Such major events have shaped the current agricultural sector and rural areas in the delta. Many programmes and projects have been developed towards diversification of crops and livelihood activities; value-added, high-quality and healthier agricultural products; environmental protection and adaptation to climate change.

In summary, many significant events have occurred in the agricultural sector and rural areas over the past couple of decades in the coastal areas of the VMD. The share of agriculture in total GDP has been declining. There was also a shift within agricultural sectors towards higher-value production systems. Data clearly showed a reduction in crop cultivation, as the percentage of cultivation in total agricultural output value went down from 65 % to 44 %, while aquaculture grew from 24 % to 45 % between 1996 and 2016 for the three surveyed provinces combined. However, the change varied from province to province (Fig. 4), affected by many drivers, as discussed in the following section.

3.3. Drivers of change

Agricultural transformation is defined as a process through which a single farm shifts from its traditional production system to a highly specialised production system towards market orientation (Ghosh, 2012). Therefore, asking farmers why they shifted from their previous farming system to the current one is important in analysing the drivers of change. According to the household survey analysis, there are many drivers influencing the change, which can be grouped into four categories: Price, Producer, Place, and Policy, named the '4Ps of change', as depicted in Fig. 5.

The *Price* category includes economic drivers such as input and output market conditions. These drivers accounted for 37 % of the total survey responses. Farm profits depend so much on the prices of inputs and outputs that farmers have to consider them in deciding whether to grow a certain crop. Prices of inputs influence farmers' decision-making in many ways. For example, rice farming is labour intensive. Still, in recent years, the price of labour was increasing, especially at peak times, because of the migration of young people to cities. This was one reason that made farmers shift to other farming systems that use less labour, such as cattle or shrimp. Farmers also mentioned that the market prices of seeds, fertilisers, pesticides, gasoline and other inputs were increasing over time. They also faced problems of fake fertilisers, fake pesticides, and low-quality seeds. All contributed to increased production costs.

Similarly, output market conditions, including fluctuating prices of agricultural products and changing conditions of export markets, were mentioned as important drivers. Shifting to shrimp cultivation was driven mainly by export markets. The total export value of fishery products increased from USD 0.67 billion in 1996 to USD 7.04 billion in 2016, of which the share of shrimp was about 40–50 % (GSO, 2018). Various studies identified that the price of agricultural products was also affected by changes in food consumption patterns and demand for higher quality and convenience. Consumer attitudes and willingness to pay for differentiated crops or particular attributes, such as organic, or local production, or pesticide-free, or sustainable, were important factors (Archer et al., 2008; Bowman and Zilberman, 2013; Gandhi, 2014; World Bank, 2016). Our household survey found that some local products may have added value. For example, Ba Tri cattle in Ben Tre has a

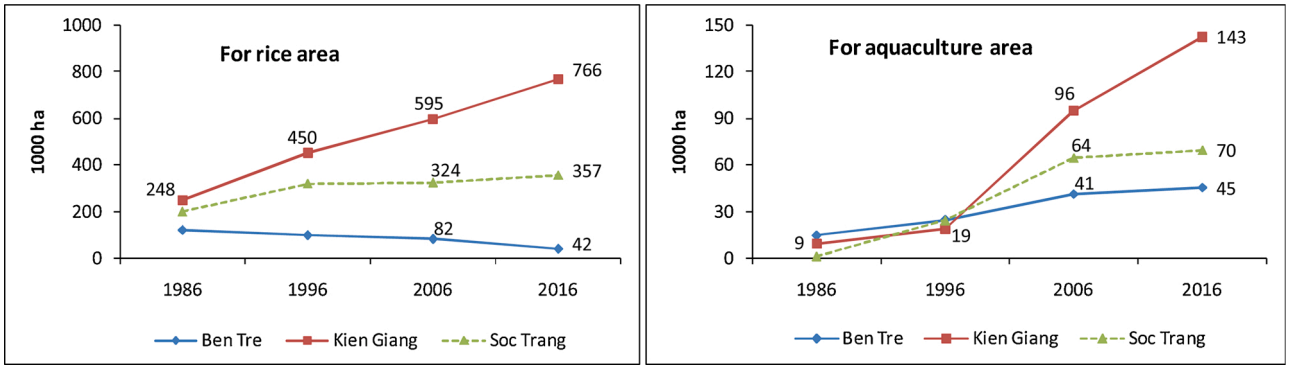

Fig. 3. Development of rice area and aquaculture in Ben Tre, Kien Giang and Soc Trang provinces between 1986 and 2016 (Data collected from Provincial Statistics Offices).

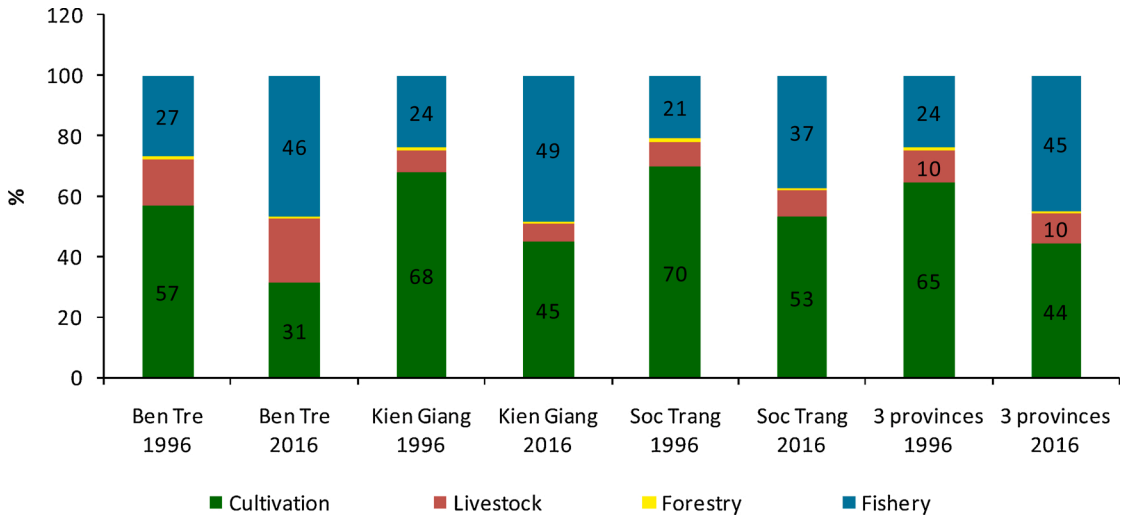

Fig. 4. Changes in agricultural production at the three surveyed provinces between 1996 and 2016 (Calculations from gross output value at the current price, data collected from Provincial Statistics Offices).

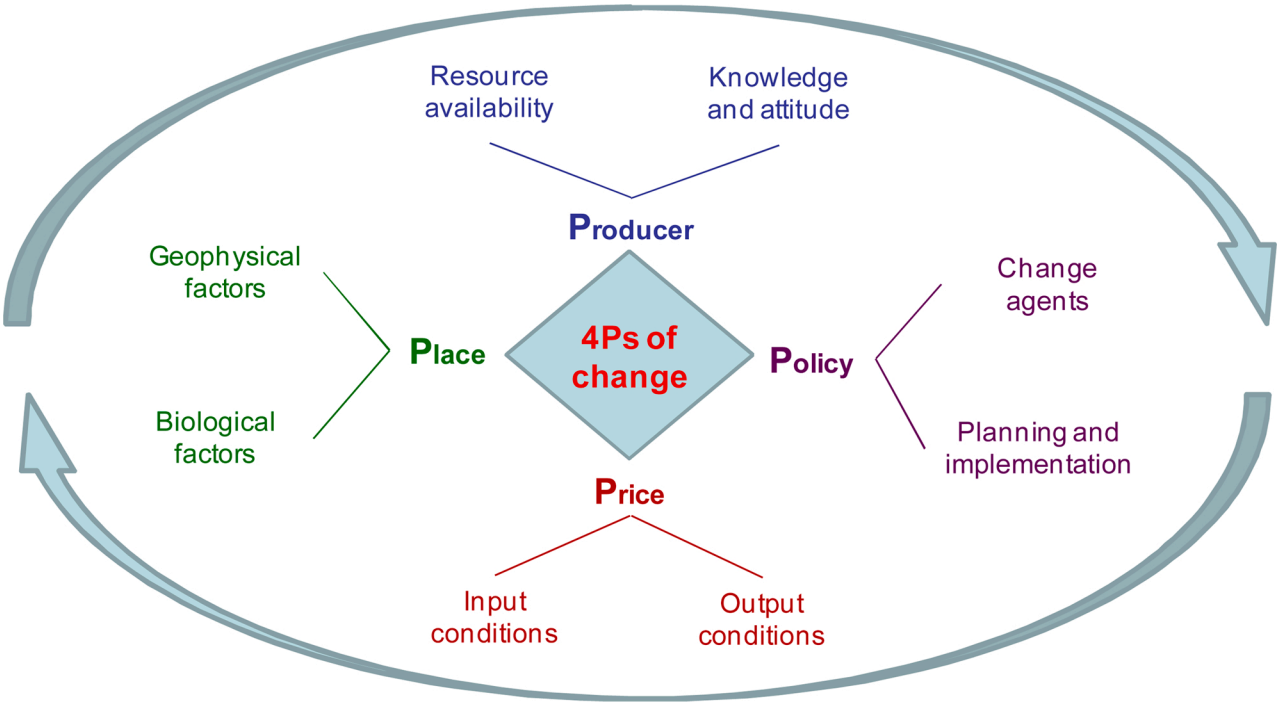

Fig. 5. Drivers of change in agriculture in the coastal areas of the Vietnamese Mekong delta.

specific trademark, while rice and shrimp in integrated rice-shrimp farming systems in Kien Giang are known as 'clean' or 'pesticide-free' thanks to good quality control and low levels of chemical application. However, these products have still been sold at similar prices to conventional ones that did not have any quality control or trademark. Therefore, there is a need for proper marketing strategies and actions to promote these advantages to improve economic efficiency.

Drivers that belong to the *Producer* category shared 23 % of the total responses. They include resource availability, knowledge and attitudes of farmers. The survey showed that farmers' decisions on whether to shift from one production system to another depended mainly on land, labour, and financial capital. Often, rice farming is suitable for any area of land. However, if farmers wanted to shift to a rice-shrimp system, a small plot (i.e. below 0.5 ha) would not be appropriate due to its low economy of scale. According to a survey on An Bien district's rural areas, 71.2 % of agricultural households had less than 2.0 ha (ABSO, 2018). Our household survey of the district, however, revealed that the farmers who ran rice-shrimp farming systems had an average area of 2.4 ha per farm. This means that land consolidation has occurred, i.e. farmers who owned a small piece of land have lent their land to others. Labour availability at household and community levels also influences the transformation. Farmers become older and their children move out of the agricultural sector. The average age of household heads who are farm decision-makers is already 53 years old. Therefore, farmers tend to select farming systems that are labour extensive, such as livestock or aquaculture, instead of rice intensification. However, these changes require a large amount of initial investment. Many farmers could not afford such investment costs, and they had to borrow from the bank or their relatives.

Besides, farmers' knowledge and attitudes play an important role in

such decision-making. Most farmers in the VMD have good experience with rice farming. To gain new knowledge and skills, farmers learn mainly from their neighbours, mass media, extension workers and input agents in an informal manner. Therefore, they still face problems with a lack of proper technologies at the beginning of new practices, particularly for shrimp and cattle production. Farmers' attitudes and behaviour also influence their readiness to transform to a new production model. Better technology can improve productivity only if farmers decide to use it (Pinnawala and Herath, 2014). High economic returns and low risk are essential determinants affecting willingness to apply technology. Diversified farming systems like rice-shrimp integration, grass-cattle, rice-vegetable, or two rice crops per year (instead of three rice crops) were recognised as proper strategies according to farmers' perception and practice in the region. However, the application of such farming systems is strongly affected by the Place, as discussed in the following.

The *Place,* which includes geophysical and biological drivers, accounted for 20 % of total survey responses. Many of these drivers influenced the transformation, such as land and soil conditions, freshwater shortages, salinity intrusion and abnormal weather. First, land scarcity is an important driver. Table 1 showed that the total land area is more or less the same in the three surveyed districts. Still, there are significant differences in the total population, resulting in different population density. For example, the population density in Ba Tri is 517 people per km^2, higher than 317 people per km^2 in An Bien and 356 people per km^2 in Tran De. Likewise, according to our survey, farm sizes are also significantly different among the three districts. The average land area per household in Ba Tri is 0.7 ha, while this figure in An Bien and Tran De is 3.0 ha. With such a small piece of land, farmers in Ba Tri could not earn enough income with rice production, and thus many of them shifted to grow grass for cattle. Typically, land with bad soil conditions, e.g. affected by salinity, low pH, high elevation, sandy, or far away from canals, forms priority cases for the shift. Tran De has a higher population density than An Bien, but its cattle herd is much larger than that of An Bien, respectively 10,222 and 120 heads. This is because there are many sand ridges that are not very suitable for rice cultivation in Tran De.

Second, rice intensification requires a significant amount of fresh water. However, flow fluctuation from the Mekong river and higher frequency of droughts have recently put rice production at increasing risk due to freshwater shortages (Government of Vietnam, 2017). Third, sea-level rise in the coastal areas has caused further saltwater intrusion and higher salinity levels in canal and river networks. These problems become serious where irrigation systems are insufficient. Fourth, abnormal weather such as high temperatures or rainfall variability was also recognised by the local people. There is a strong linkage between freshwater shortage, salinity intrusion and abnormal weather. The combination of these drivers has caused heavy damage to crops and deteriorated local people's livelihoods, as evidenced in the results of the KIIs, FGDs, and household survey about damages due to the recent extreme drought in 2015–2016 (Box 1).

To adapt to such challenges, the farmers in each location have had different options for changing their production systems. In Ba Tri, there was a shift from rice production to grass cultivation for cattle. Statistical data shows that land for grass in Ba Tri increased from 104 ha in 2012 to 1227 ha in 2017. Over the same period, rice land fell from 14,425 ha to 13,132 ha (BTSO, 2018). Meanwhile, the main strategy in Tran De was to stop growing the third rice crop, and in An Bien it was to diversify the production system by applying rice-shrimp rotation crops. Fig. 6 shows the growth in the shrimp area and the decrease in the rice planted area in An Bien district, notably after the extreme drought in 2015–2016.

The fluctuation of weather-related drivers challenged decision-making about transformation actions significantly. For example, when farmers shift to shrimp farming, which is brackish water-based production, they need high salinity concentration levels in canal or river water. But normally, after a few dry years with high salinity levels, the salinity level goes down. These low-salinity years occurred in 2006 and 2017, as shown in Fig. 6, seriously affecting shrimp production due to the lack of brackish water. For example, the shrimp yield in An Bien's extensive farming systems decreased from 440 kg/ha in 2015 to 400 kg/ha in 2017 (KGSO, 2018). On the other hand, thinking that there would not be another dry year after the extreme drought in 2015–2016, some farmers in An Bien accepted the risk and cultivated a third rice crop in the dry season of 2016–2017. These farmers were lucky and gained a good yield while other farmers regretted making different decisions. This paradox brings about many difficulties for the government in helping farmers deal with these challenges.

In addition, biological drivers such as pest or disease infestations also influence agricultural systems. The rotation of crops, such as rice and vegetables in Tran De, or rice and shrimp in An Bien, is a good strategy to reduce pest and disease outbreaks in monoculture. Another example was from our FGD in Tran De. The local farmers have increasingly raised loach fish, not only because of its high market price, but also to avoid infestation with shrimp diseases. In short, these drivers differ so much from place to place. They should be considered in the future development of transformation options for adaptation.

Drivers related to the *Policy* category shared 20 % of the total responses in the household survey. They include two types: change agents, and planning and implementation of policies. Change agents are defined as people whom farmers trust and interact with regularly to help them modify their practices and thus contribute to transformation (Boettiger et al., 2017b). It was found that change agents in the study areas are the people providing technical knowledge, offering finance, selling inputs, and buying outputs. Farmers recognised that scientists and extension officers from the local government strongly influenced agricultural transformation by providing technical support. Indeed, much scientific knowledge and advanced technology has been transferred to farmers through extension officers of the public agricultural extension system. The survey results indicated that 49 % of respondents had participated

Box 1
Damages due to the extreme drought and saline intrusion 2015-–2016 in the three surveyed districts.

Ba Tri district: the damages due to the drought and salinity intrusion in 2015–2016 were as follows: 19,404 affected households; 12,079 ha of affected crop areas; 15,000 households that lacked fresh water for domestic use; and total losses estimated at VND 370 billion.

An Bien district: in the 2015 summer-autumn and autumn-winter crops, the total rice planted area of An Bien district was only 5.6 %, but the damaged area was 19.2 % of Kien Giang province. The damaged area's ratio to the planted area was 33.5 % (5691 over 16,987 ha) compared to 9.7 % in Kien Giang province. This means that An Bien district had a higher level of damage than other districts. The damage was even more severe in the 2016 winter-spring crop, with 22,516 ha, approximately 54.4 % of the total rice planted area.

Tran De district: according to the Soc Trang People Committee Decision 1383/QD-UBND, dated 6th June 2016, the total area of damaged crops by drought and salinity intrusion in the winter-spring crop of 2015–2016 in Tran De district was 3664 ha; of which rice comprised 98.6 % and other crops 1.4 %. The total aid compensating for the losses to farmers in the district was VND 5.2 billion.

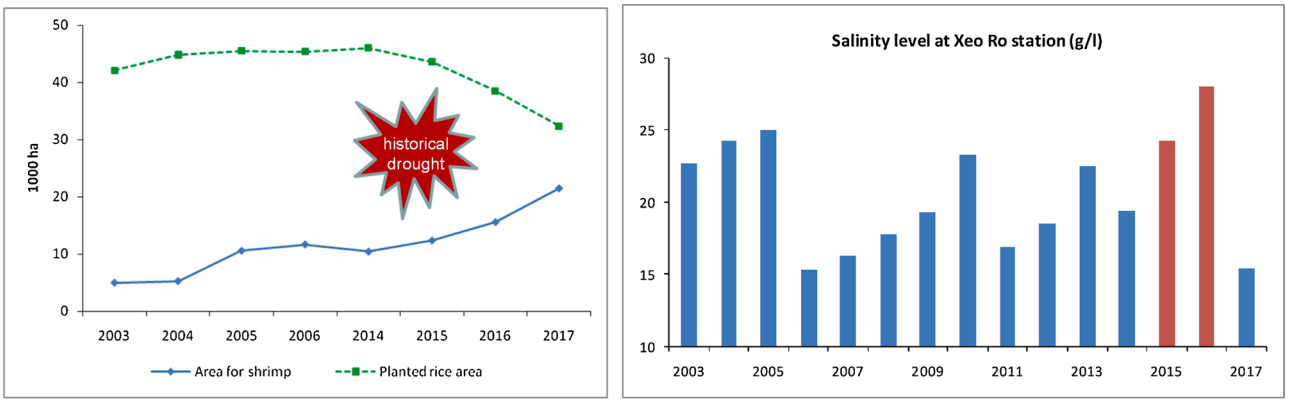

Fig. 6. Change in rice and shrimp areas and salinity levels in An Bien district (Source: Data collected from Sub-DARD in An Bien district).

in at least one training class from the governmental extension centre in the past five years. 84 % of them reported that the techniques were relevant to their needs. Training topics cover most aspects of farming technology regarding rice, vegetable, shrimp, fish, pig, cattle, goat, and poultry production. Farmers may also receive technical knowledge from input agents, such as pesticide, fertiliser, seed companies or shops, which are available everywhere in rural areas. However, these companies or shops normally try to make farmers buy their products (i.e. seeds, fertilisers, pesticides) rather than giving technical advice.

The development of the official banking system was another factor contributing to successful transformation. According to the household survey, 44 % of farmers borrowed funds from official bank systems with affordable interest rates. Selling and buying traders also influence farmers' decisions, which are often made based on market prices. Most agricultural products are sold as raw materials to local traders at the farm gate. In principle, farmers can bargain with the traders, but it is often the traders who eventually decide the price. If a farmer does not want to sell products to a certain trader due to the low price offered, they can find another trader. However, it is often the case that the later trader may know about the previous offer, and offer an even lower price. There is a farming contract policy to encourage fair contractual sales of farming products (Prime Minister of Vietnam, 2002), but it does not work well in practice. Therefore, farmers rely primarily on traders. Farmers also reported that when they chose a trader, and both sides trusted each other, the trading would be easier and the relationship would last for a long time. On the other hand, traders may also provide valuable information about national or global markets, which would help farmers select suitable crops or varieties for the next season.

Proper planning and effective implementation of policies are other crucial drivers for agricultural transformation and rural development. As understood from the FGDs and KIIs, many relevant policies have been planned and implemented. For example, investment in irrigation to control salinity intrusion was a key driver of increased rice production in coastal areas. Recently, local governments have produced new policies to guide farmers, because rice farming has become riskier due to more frequent droughts and uncertain salinity intrusion. There was a good example from An Bien district after the extreme drought in 2015–2016. The local government enacted Decision 1418/QD-UBND of An Bien People Committee about 'Guiding on rice land planning management and implementation process for converting rice land with low productivity to rice-shrimp model in An Bien district', dated 17th February 2017 (ABPC, 2017). Based on this legal framework, large areas of the traditional production model of two rice crops per year have been allowed to convert to integrated rice-shrimp farming, a more sustainable and locally suitable production model. As a result, there have been faster changes in rice and shrimp areas since the 2015–2016 droughts, as depicted in Fig. 6.

Meanwhile, the Ba Tri district government applied new guidance about 'Guiding, supporting for two rice crop production towards sustainability and stability' from Ben Tre Provincial People Committee (Document No. 4030/UBND-KT, dated 9th June 2017). In principle, the policy indicated that two rice crops per year should be cultivated for more sustainable production, i.e., better soil improvement and pest control. Therefore, farmers could grow two rice crops and one additional cash crop in freshwater areas. In salinity affected areas, which are suitable for only one rice crop, an integrated rice-shrimp farming system should be cultivated. Nevertheless, depending on their willingness and readiness, farmers are still allowed to decide to cultivate three rice crops per year, on the condition that they must be wholly responsible for the risk to their production in case of disasters. Based on this policy, some farmers in Ba Tri reported in the FGDs that they have been growing three rice crops per year since late 2017. They accepted the risk of losing the third crop in case of severe drought or salinity intrusion because they needed the rice straw to feed cattle.

Besides, there were also other national programmes and international projects, such as the National New Rural Development programme (Prime Minister of Vietnam, 2010), the National 135 Poverty Reduction Program (Prime Minister of Vietnam, 1998), and various programmes or projects from development partners such as the World Bank, CIDA, GIZ, ADB, and IFAD. These programmes and projects enhanced the transformation by making various types of investments in rural areas for developing infrastructure, providing new farming techniques, offering small amounts of credit, providing sustainable livelihood options, finding new markets, and building capacity.

As such, the 4Ps of change have been analysed and illustrated with practical examples. The FGDs and the survey indicated that the Price, the Producer, the Place, and the Policy categories accounted for 37 %, 23 %, 20 %, and 20 % of total responses, respectively. It could therefore be concluded that the most significant drivers relate to economic factors, followed by farmers' characters and resources, then geophysical and biological factors, and the planning and implementation of policies. But it is necessary to understand that all of them are interconnected. The lack of any mentioned conditions would be a barrier to successful transformation.

3.4. A proposed agro-ecological farming framework for sustainable agricultural transformation

While the agricultural transformation has achieved remarkable results over the past couple of decades, the coastal areas still face many problems under the current fast-changing socio-economic and environmental conditions. The above studies of the agricultural transformation and related 4Ps of change have provided an insight into the culture and context of changes. A way forward to facilitate planning for a more appropriate and timely transformation could then be established.

Developing a systematic framework that addresses the complexity,

dynamics, and interconnection of the 4Ps is essential to improving the pace of transformation. Fig. 7 presents a proposed agro-ecological farming framework, namely the Sustainable Agricultural Transformation (SAT) framework, based on the learning from the 4Ps and using value chain and agribusiness concepts. In this way, the framework could efficiently link the production and consumption sides and support practical integrated top-down and bottom-up practices for the development of safe, equitable and sustainable transformation pathways (Stringer et al., 2020).

A value chain is a set of activities that a firm operating in a specific industry performs to deliver a product or service to the market (Porter, 1985). In the SAT framework for the agricultural sector (Fig. 7), the value chain comprises two stages: (1) what farmers produce, and (2) what markets or consumers need, to form the agribusiness process (Gandhi, 2014). In recent years, due to focusing more on the production side than the consumption side, the incident called 'high yield leading to low price' kept happening to many agricultural products (rice, fruits, vegetables, pigs, cattle, poultry, shrimp, catfish, etc.) in the VMD. Therefore, a systematic view should be considered for the whole value chain, from inputs to products and then to markets, as depicted in Fig. 7.

The first stage is from 'Inputs' to 'Safe Farming Products'. The key actor here is farmers, i.e. the 'Producer'. Various 'Farming Change Agents' need to be involved at this stage to help farmers transform to agro-ecological farming to produce safe farming products. For example, scientists could provide safe farming practices and suitable techniques that may use fewer inputs but produce higher quality outputs, taking into account local natural and social conditions. The local government's extension officers then have proper approaches to transfer such techniques to the farmers to produce safe and sustainable products. Other change agents, such as input traders and banking brokers, need to support farmers appropriately, such as offering inputs with good quality and affordable prices, providing financial capital at low interest rates, etc. As most of the current farmers in the region are Market-Oriented Conventional Smallholders, the proposed framework would provide them with better supply chain security, increased access to credit, and appropriate technology and training, as defined and suggested by Stringer et al. (2020).

The next critical stage is to bring these products to market. There are some advanced farming techniques for safe farming (e.g. GAP production, organic farming, ecological products, etc.) that have been applied to yield high-quality products. However, these products' benefits, i.e. for a healthy society, have not yet been adequately appreciated. Their market prices are still comparable to those from conventional farming. Business people and related Market Change Agents, including output buyers, logistic agents, distributors, exporters, etc., are important actors. They provide a good understanding of consumers' needs, find markets for products, raise awareness in consumers, increase value through post-harvest processing, and give feedback to producers for proper production planning. These issues are all critical and thus need to be addressed for a sustainable agribusiness system.

Along the value chain, the government must play an essential role as a provider of Policy drivers. The proposed SAT framework is based on relevant central government policies or programmes, including the Prime Minister's Decision 80 'Four-Actor linkage between farmers, scientists, businessmen, and government' (Prime Minister of Vietnam, 2002), and the national programme 'Agricultural restructuring towards raising added values and sustainable development' (Prime Minister of Vietnam, 2013). Therefore, the government's role is critical to motivate all actors and facilitate collaborative and innovative approaches for sustainable agro-ecological farming and agribusiness systems through effective implementation of practical legal frameworks, policies and efficient support provisions.

4. Conclusions

This paper found that agricultural transformation has been occurring in the VMD through changes in production systems from rice monoculture towards more diversified and sustainable production, leading to production growth, income improvement, poverty reduction and rural development. Such achievements have contributed to changes in the country's economic structure. Many events have marked the process and various drivers have enabled and hindered the transformation. They were found to fit into four categories: the Price, the Producer, the Place, and the Policy, which are called the 4Ps of change. The most significant drivers relate to economic factors (the Price), followed by the farmers' characters and resources (the Producer), then geophysical and biological factors (the Place), and the planning and implementation of Policies. Drawing from the analysis, the authors have developed a framework that considers the 4Ps of change in combination with value chain theory and agribusiness concepts for governmental planning. The framework addresses the need for a more systematic approach with better linkages between the consumption and production sides. It also helps harmonise top-down planning and bottom-up practices for good governance, a critical condition for successful transformation. A good transformation pathway for the coastal Mekong Delta's farmers thus could be supported through increasing their access to markets, resulting in better supply chain security, and building their capacity for increased access to credit and appropriate technology and training, which are supported by other key actors, i.e. scientists, government and private businesses. This is in line with the Vietnamese government's Innovation and Industry 4.0

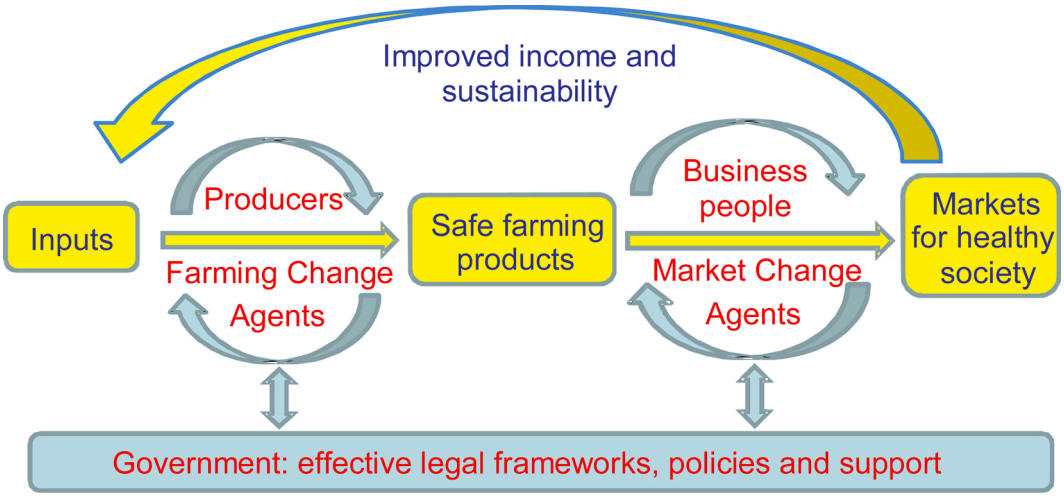

Fig. 7. The agro-ecological farming framework for sustainable agricultural transformation (SAT framework).

initiatives for sustainable development of the VMD. Therefore, the proposed SAT framework could be used to accelerate the transformation process to meet the government's objectives and the local communities' need to adapt to the fast-changing environment and socio-economic development in the coastal VMD. It could also be applied to the whole VMD and other regions with a similar context, e.g. at the transition phase of development, but with a very dynamic, productive and market-oriented agriculture sector.

CRediT authorship contribution statement

Binh Nguyen Thanh: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing - original draft, Writing - review & editing, Visualization, Project administration. **Tien Le Van Thuy:** Validation, Investigation, Resources, Data curation, Writing - original draft, Writing - review & editing, Visualization, Project administration. **Minh Nguyen Anh:** Investigation, Resources, Writing - original draft, Writing - review & editing. **Minh Nguyen Nguyen:** Conceptualization, Methodology, Writing - review & editing, Supervision, Funding acquisition. **Trung Nguyen Hieu:** Conceptualization, Methodology, Writing - review & editing, Supervision, Funding acquisition.

Declaration of Competing Interest

The authors report no declarations of interest.

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