Identifying Opportunities and Challenges for Creating a Climate-Smart Food System in Vietnam

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Abstract

This study examines various elements of food production, consumption, processing and distribution of food products in Vietnam to identify the challenges and opportunities for developing a sustainable and climate-smart food system. Both primary and secondary data are collected to analyze changing consumption pattern due to income growth and urbanization and identify constraints and opportunities of the current system. The results suggest that rice is already an inferior good for middle class and rich urban populations. These households are consuming more high value food products such as meat, dairy products, fruits, and vegetables. The positive and declining expenditure elasticities of rural population suggest that as income grows rural households will eventually start consuming less rice and more other food products. Since Vietnam's economy continues to grow with doubling of GDP in the next decade, per capita rice consumption both in urban and rural and across different income will continue to decline.

Rising consumption of high value products like meat, fish, fruits and vegetables and dairy products in the future will require significant transformation of the current food system which is faced with several constraints due to high rate of intensification, low diversification at the farm level and poor awareness of farmers of climate smart agriculture practices. One of the interesting findings of this study is that vertical integration has led farmers to specialize in one crop that fetches better price because of market access. This system restricts farmers to introduce a non-rice crop in between two rice crops. In many instances, farmers move away from rice and specialize in another crop if there is strong buy back program. This system also does not allow farmers to switch variety as it might jeopardize their buy back contract with the company. However, several measures can be adopted to transform the food system to be sustainable, climate resilient and meet the changing consumption patterns. First of all, the existing information nodes need to be strengthened by supplying regular updated and reliable information and training. Secondly, farm level crop diversification should be promoted as a strategy to improve sustainability and climate resilience. Crop diversification refers to the addition of new crops or cropping systems to agricultural production on a farm. Finally, in the vertically integrated contract system where companies sign a contract with the farmers should be encouraged to prescribe sustainable crop management practices and avoid overuse of fertilizers pesticide and weedicides.

Keywords

Food Systems, Climate Smart Agriculture, Vietnam

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Acronyms

SDG	Sustainable Development Goals
GDP	Gross Domestic Product
MMR	Mixed Method Research
FGD	Focus Group Discussions
KII	Key Informant Interviews
VHLSS	Vietnam Household Living Standard Survey
GSO	General Statistics Office
VND	Vietnamese Dong
Kg	Kilogram
AIDS	Almost Ideal Demand System
IV	Instrumental Variable
OLS	Ordinary Least Squares
SUR	Seemingly Unrelated Regression
CSA	Climate smart Agriculture
HLPE	High Level Panel of Experts
GDP	Gross Domestic Product
RRD	Red River Delta
MRD	Mekong River Delta
CGIAR	Consortium of International Agriculture Research

Introduction

1.1. Background

To achieve the Sustainable Development Goals (SDGs) related to poverty, climate change and food and nutrition security by the year 2030, we need to change the way food is produced, processed and consumed. This is a very ambitious goal and will have to be met in the context of climate change impacts in all aspects of food and nutrition security: increasing resource constraints and trade-offs, massive urbanization, an ageing farming population, a need to rapidly reduce emissions from food systems, and dietary shifts (Dinesh, et al., 2018). Perhaps it is in food systems, more than anywhere else, that we have the perfect illustrations of the noticeable certainties of climate change. If evidence were needed that the challenges of a changing climate are not just those of the future, but of today, recent food price shocks, crop failures, disease and damage caused by natural disasters should suffice. These events are not, of course, determined by weather alone, but are the manifestation of complex and cross-scale social, political, economic, and ecological processes, and should serve as a warning against simple interpretations of contemporary food systems. Dealing with these complex issues is essential, if we are to understand how climate change contributes toward risks to the food system, thereby enabling targeted coordination of policies within and across governments. The impacts of global climate change on food systems are expected to be widespread, complex, geographically and temporally variable, and profoundly influenced by socioeconomic conditions. Historical statistical studies provide evidence that climate change will affect agricultural yields and earnings, food prices, reliability of delivery, food quality, and, notably, food safety.

If we study the global food system for past few years, we will find that the global agricultural productivity has increased, as has the requirement for labor-intensive production, but chemical inputs have created water pollution problems; topsoil depletion has reduced soil fertility; and biodiversity has been challenged through dependence on a lesser number of seed varieties. Industrial food processing has provided the high consumption classes of the world with ready-made foods of a reliable standard, but the waste produced from food packaging have created major problems. Moreover, the energy required to process and transport food has also risen steeply (Pirog et al., 2001).

Vietnam is considered as one of the countries to be severely affected by climate change, particularly in the coastal areas. Rises in average temperatures have been observed over the

last decades, as well as substantial changes to precipitation patters. The average temperatures have been rising and the total precipitation has increased, especially during the rainy seasons, which is important for flood water management. In northern Vietnam, the precipitation during the dry seasons has decreased, which poses important challenges to water management.

Agriculture is a key economic pillar in Vietnam, contributing to approximately 15 % of the country's gross domestic product (GDP) (Word Bank, 2017). Population has also been rapidly growing reaching approximately 100 million people by the year 2017. More than half of the population live in rural areas and are highly dependent on agriculture and agriculture-related industries (World Bank, 2017). Along with the growing population, dietary preferences are also changing. Cereals represent the largest share of food consumed with 80% per capita annual calorie intake (Hoang, 2017). Land for food production in Vietnam is limited, while demand is growing due to the combined effects of population growth and dietary change. Therefore, the solution seems to be directed towards intensification of agriculture. However, the continued intensification of agriculture production with unregulated chemical inputs, may eventually increase the toxic and hazardous chemicals in the soil, air, and ground water. Also, many farmers lack access to quality technical information regarding production options, weather patterns and risks.

As countries pass through agrarian transitions that reshape the livelihoods and landscapes of the countryside, they tend to experience a parallel transition in diet and nutrition. Vietnam is undergoing such transformation in recent years because of strong economic and rapid growth in urbanization. It used to be one of the poorest country in the world three decades ago, but is now considered as one of the most dynamic emerging economy in the world (Davis 2016; Vanham 2018). The main contributors of this economic development have been international integration through trade liberalization, domestic reforms through deregulation, and enormous investment in human and physical capital though public investment (McCaig and Pavcnik 2013). According to Hoang (2018), newly-growing rich and high-income households in Vietnam are putting also huge pressure on the country's food supply chain due to changing consumption patterns away from rice to high-protein foods (e.g., meat, seafood, and eggs).

Therefore, substantial attention needs to be shifted towards understanding:

- What will it take to increase the agricultural productivity, enhance food and nutritional security and raise farmer incomes to get rural communities out of poverty in a world where climate is changing?
- How could we build resilience to climate change and climate change related stresses affecting agriculture?

Thus, in the above context, this study examines various elements of food production, consumption, processing and distribution in addition to infrastructure, institutions and markets in Vietnam to identify the challenges and opportunities for propagating a sustainable and climate-smart food system. This includes how the products are grown, how it is managed and harvested, how value is added, how it is transported, and how the food is purchased and other relevant consumer behaviors. Thus, through this study we try to understand the following key issues for Vietnam:

i. What are the changes in the consumption patterns that will drive the food system transformation?
ii. What are the producer/farmer practices, which enables leapfrogging of traditional learning curves through application of technology and adoption of best practices?

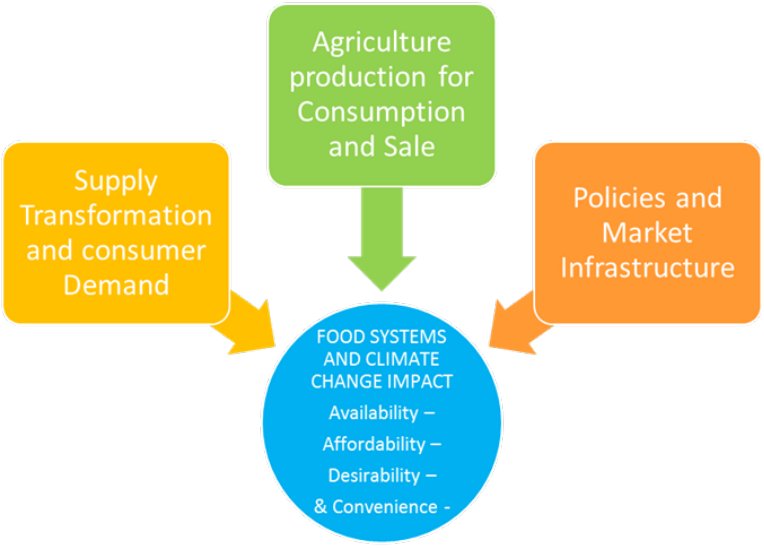


Figure 1: Conceptual Framework Linking Food Systems to Climate Change

(Adapted from Frameworks for Food Systems Analysis Promoted by the Global Panel on Agriculture and Food Systems for Nutrition)

1.2. Objectives

In view of the above context, the objective of this study is to explore what are the constraints and opportunities for creating climate-smart food systems along the value chains for (1) cereals, (2) roots and tubers (3), and livestock in Vietnam. Thus, the study aims:

- To understand how the urban and rural diets have changed in climate change/variability affected areas;
- To assess the current production systems and its contribution (positive/negative) to environmental effects; and
- To explore the channels, processes and supporting institutions where CSA related changes needs to be introduced.

1.3. Methodology and Approach

This is a mixed methods research (MMR) which include both qualitative and quantitative data collection methods. Under mixed method approach, both inductive and deductive perspectives are assessed since the mixed method approach involves back and forth movement in order to combine the knowledge from both methods (Newman & Benz 1998).

The study adopts a convergent parallel design of MMR. A convergent parallel design entails that the researcher concurrently conducts the quantitative and qualitative elements in the same phase of the research process, weighs the methods equally, analyzes the two components independently, and interprets the results together (Creswell & Pablo-Clark, 2011).

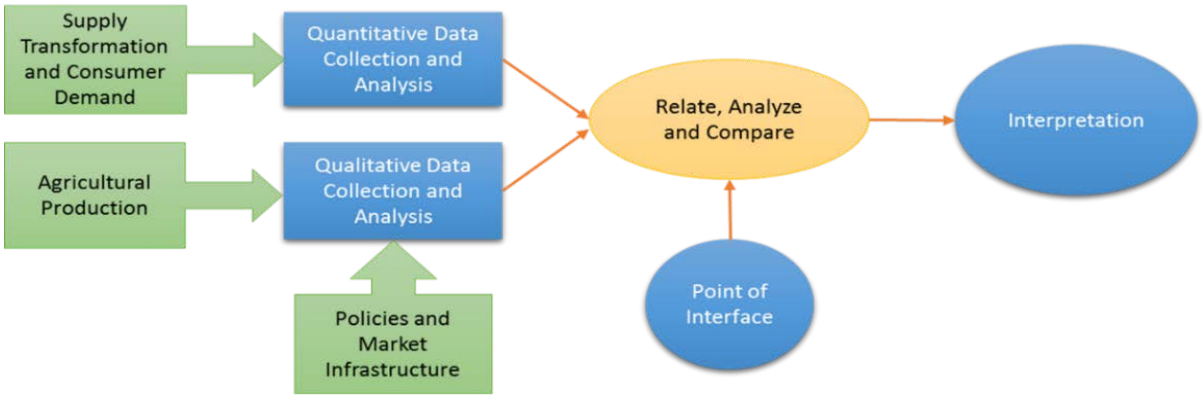


Figure 1: Convergent Parallel MMR Design for this Study

With its quantitative strand of data collection and analysis, the study tries to understand the supply transformations and consumer demands – or in other words - why the producers or the farmers grow, what they grow. And with its qualitative strand of data collection and analysis, the study tries to explore and understand how food is grown, managed, harvested, how value was added, and how it was transported – in other words - how people grow what they choose to grow.

1.3.1. Primary data gathering

Sea level rise presents a major threat to Vietnamese agriculture by increasing the risk of salinity of limited arable land. Agricultural lands are concentrated along the coast in the two major deltas in Vietnam viz. Mekong River Delta and the Red River Delta. These two regions are also the major food producing pockets of the country. Mekong River Delta region can be called the rice granary of the country. Hence, for this study we chose both these river delta regions of Vietnam to gather our primary data. The selected provinces in the Red River Delta region were Thai Binh and Bac Ninh. The selected provinces in Mekong River Delta region were Tra vinh and Bac Lieu.

Figure 3: Map of Vietnam with Research Sites Marked

The survey districts in Thai Binh were: Vu Thu, Kien Xuong and Dong Hung.

The survey districts in Bac Ninh were: Que Vo, Gia Binh and Luong Tai.

The survey districts in Tra Vinh were: Cau Ke, Tieu Can and Cang Long.

The survey districts in Bac Lieu were: Hong Van, Hoa Binh and Bac Lieu City.

Primary data gathering was done using Focus Groups (FGDs) and Key Informant Interview (KIIs), techniques. These techniques were chosen to gather contextual details of various food production process and to add the perspective of local food growers and suppliers. Both the techniques used purposive sampling strategy, as the study participants were recruited according to pre-selected criterion relevant to the study, such as specific study locations and practicing specific chosen crops like rice, maize, potato and shrimps. A total of 14 FGDs (7 FGD in Red River Delta region and 7 FGD in Mekong River Delta region) were conducted with farmers. Each FGD comprised of 8 to 12, mixed male and female participants. The KIIs were planed across the supply chain actors for each crop selected in the study. We conducted a total of 76 KIIs (40 KIIs in Red River Delta region and 36 KIIs in the Mekong River Delta region) across the four selected provinces and for three different crops in each region.

1.3.2. Secondary data and documents

1.3.2.1. Data

Multiple years of (2012, 2014, and 2016) Vietnam Household Living Standard Survey (VHLSS) data were used for estimating the demand system. The General Statistics Office (GSO) of Vietnam conducts these Surveys.[1] Each of these surveys contains information on more than 9,000 households. These households were appropriately sampled, selected from more than 60 provinces, 680 districts, and 3,000 communes. Two-thirds of the total samples were from rural areas, which is proportional to the rural-urban population in Vietnam. The collected information covers a wide range of areas, including education, health, employment, income and expenditures, and sociodemographic profiles. The main variables of interests for this study are food consumption and expenditures, and demographic variables.

The VHLSS contains information on food consumption and expenditures for 54 different food and drink items. Since not all the households consume these entire food items, for simplicity of demand estimation, we categorized these items into eight broad groups: rice, other cereals (e.g., maize, wheat and cereals products), fish and aquatic products, meat and eggs, fruits and vegetables, edible oil, beverages (alcoholic and non-alcoholic), and miscellaneous food items (details sub-commodity groups are in Table 3).[2] In the survey, the sampled respondent was asked "how much was your household consumed a food item over the past 30 days and how much was the cost"? So, we derived unit price of a food item

[1] Detailed data collection protocols and methods can be found at: http://www.gso.gov.vn.
[2] Household consumed food away from home was excluded because of absence of consumption data.

dividing the expenditure by the respective physical quantity consumed by a sampled household. Consumption of food items were measured in kilogram (kg), and drinks were in liter, whereas food expenditures were measured in thousand dong (VND). Therefore, prices are in thousand VND/kg.

Since, in many cases, physical quantity of consumption of the specific food item was missing, but expenditure data were available, we extracted those values using mean district level consumption. However, if expenditure data were missing, we excluded those samples from the analysis, assuming households do not consume that specific commodities. Moreover, observations featured outliers (extreme values) were excluded from the demand analysis. Therefore, our demand analysis includes over 22,000 observations, covering three periods, 2012, 2014, and 2016, which is the largest dataset ever used for food demand analysis in Vietnam.

1.3.2.2. Almost-Ideal Demand Systems (AIDS)

1.3.2.2.1. Model background

Early work on modeling consumer demand was grounded on the following system of demand relationships:

$$q = D(\boldsymbol{p}, \boldsymbol{z}, \boldsymbol{\varepsilon}) \qquad (1)$$

where $\boldsymbol{p}$ and $\boldsymbol{q}$ denote a price and a quantity vector, $\boldsymbol{z}$ is a vector of exogenous variables, and ε is a vector of random shocks. The Linear Expenditure model (Stone 1954), the Rotterdam model (Theil 1965; Barten 1964), the Translog model (Christensen, Jorgenson, and Lau 1975), and the Almost Ideal Demand System (AIDS) (Deaton and Muellbauer 1980) are examples of this demand system. The main concern of equation (1), however, was to specify $D(.)$ such that it is both flexible and consistent with economic theory. Otherwise, various estimation problems might arise, including the important one, dimensionality problem due to large number of parameters to be estimated (Nevo 2010). This problem can be tackled imposing aggregation (Gorman 1959) and symmetry (Spence 1976; Dixit and Stiglitz 1977) restrictions. Additionally, the utility function is required to be separable and additive to guarantee consistent estimates.

Because of tremendous development of programming software and gradual improvement of computing capacity during last decades, a complete demand system with imposing these restrictions can easily be estimated now. For example, quadratic extension of AIDS

(QUAIDS) introduced by (Banks, Blundell, and Lewbel 1997) can be estimated using "quaids" STATA command developed by (Poi 2012). The application of this model in food demand analysis becomes increasingly popular recently, such as food demand analysis by (Mottaleb et al., 2018) for Bangladesh and for Vietnam by (Hoang 2018). Importantly, there is a more recent development in modeling complete demand system with endogenous regressors, using "aidsills" STATA command by (Lecocq 2015), which is much more faster and efficient than "quaids". Moreover, demographic as well as instrumental variables can be included in the model to control endogeneity problem. The present study utilized this model to estimate a complete demand system for food items for rural and urban households in Vietnam.

1.3.2.2.2. The Main Model

Suppose, budget (expenditure) share equation for good $i\ (= 1, \dots\dots, N)$ for household $h\ (= 1, \dots\dots, H)$, w_i^h, can be expressed, following QUAIDS form by Banks, Blundell, and Lewbel (1997), as:

$$w_i^h = \alpha_i + \gamma_i' \boldsymbol{p}^h + \beta_i \{x^h - a(\boldsymbol{p}^h, \theta)\} + \lambda_i \frac{\{x^h - a(\boldsymbol{p}^h, \theta)\}^2}{b(\boldsymbol{p}^h, \theta)} + u_i^h \qquad (2)$$

with the price (non-linear) aggregators

$$a(\boldsymbol{p}^h, \theta) = \alpha_0 + \alpha' \boldsymbol{p}^h + \frac{1}{2} \boldsymbol{p}^{h\prime} \Gamma \boldsymbol{p}^h$$

$$b(\boldsymbol{p}^h, \theta) = \exp(\beta' \boldsymbol{p}^h)$$

where x^h is the log total-expenditure; $\boldsymbol{p}^h$ is the vector of prices of N goods; $\alpha = (\alpha_1, \dots\dots, \alpha_N)'$, $\beta = (\beta_1, \dots\dots, \beta_N)'$, $\Gamma = (\gamma_1, \dots\dots, \gamma_N)'$, and θ are the set of all parameters to be estimated; u_i^h is an error term.

These parameters must satisfy the following three sets of theoretical restrictions: (i) additivity: all must sum to zero over all equations except the constant term, (b) homogeneity: log price-parameters must sum to zero within each equation, and (c) symmetry: the effect of log price i on budget share j must equal the effect of log price j on budget share i.

Differentiating equation (2) with respect to x and p_j, omitting h superscripts, we get the following equations:

$$u_i = \beta_i + 2\lambda_i \frac{\{x - a(\boldsymbol{p}, \theta)\}}{b(\boldsymbol{p}, \theta)} \qquad (3)$$

$$u_{ij} = \lambda_{ij} + u_i(\alpha_j + \gamma_j \boldsymbol{p}) - \lambda_i \beta_j \frac{\{x - a(\boldsymbol{p}, \theta)\}^2}{b(\boldsymbol{p}, \theta)} \quad (4)$$

From these above equations, three sects of elasticities can be computed: (i) Expenditure elasticities: $e_i = \frac{u_i}{w_i} + 1$; (ii) Uncompensated price elasticities: $e_{ij}^u = \frac{u_{ij}}{w_i} - \delta_{ij}$, where δ_{ij} is the Kronecker delta, and (iii) Compensated price elasticities: $e_{ij}^c = e_{ij}^u + e_i w_j$.

1.3.2.2.3. Extension of the Model

Demographic variables in the demand system

Since demographic profiles of households are heterogeneous, it is important to include in the demand system. Household heterogeneity can be included in the system through the constant term as:

$$\alpha^h = As^h \qquad (5)$$

where $A = \alpha_i'$, a linear combination of a set of demographic variables s^h. This approach is called translating approach and introduced by (Pollak and Wales 1981), which allows the level of demand to depend upon demographic variables.[3]

Instrumental-variable (IV) techniques to control endogeneity

Prices and total expenditure variables in equation (2) are likely to be endogenous, therefore, ordinary least squares (OLS) or seemingly unrelated regressions (SUR) (linear or nonlinear) do not provide consistent estimators. This implies that the error term, u_i^h, may be correlated with the total expenditure, x^h. It may also be correlated with prices, $\boldsymbol{p}^h$. This is because unit prices of goods, in most of the cases, are computed as the ratio of expenditures and quantifies. The rationale is since a given good may differ in quality by household, its computed unit values may reflect these quality differences, and therefore, may depend on tastes and preferences (Deaton 1988). However, potential biases can arise because of these correlations, which can be accounted with IV and augmented regression techniques (Hausman 1978).

Suppose that a set of IVs are available, such as for budget alone or for prices alone or for both. Then equation (1) can be augmented with the error vector $\hat{\boldsymbol{v}}^{\boldsymbol{h}}$ predicted from estimating

[3] This approach is more restrictive than the scaling approach introduced by Ray (1983) and used in Poi's (2012) STATA command.

reduced forms of x^h and$\boldsymbol{p}^h$**.** The error term can be written via the orthogonal decomposition, $u_i^h = \boldsymbol{\rho_i}\hat{\boldsymbol{v}}^{\boldsymbol{h}} + \varepsilon_i^h$, along with assuming $E\left(\varepsilon_i^h \middle| x^h, \boldsymbol{p}^h\right) = 0$ for all i and h.

The present study used STATA 15 to estimate QUAIDS with income as an instrument for expenditure, setting$\alpha_0 = 5$, which is little less than the mean log of expenditure.

1.4. Report organization and Scope

The report is organized as follows. The first chapter focuses on objectives of the study and describes methodology and approaches including data requirements. Next, the macro picture on understanding the drivers and the trends of food system in the Vietnam is described. In this chapter, supply chain of different crops is explained. Next, changing consumer patterns are analyzed to get insight on the need of the future food system. In the next chapter, constraints and opportunities of the current food systems are identified. It includes discussion on key entry points for initiating or improving climate smart agriculture (CSA) practices in Vietnam. Finally, concluding remarks and policy implications are discussed

Components and Trends of the Vietnamese Food System

2.1. Food Systems

A food system is a complex system consisting of several elements (environment, people, inputs, processes, infrastructures, institutions, etc.) or sub systems that relate to the production, processing, distribution, preparation and consumption of food, and the outcomes of the activities performed within these subsystems. As presented in the High Level Panel of Experts on Food Security and Nutrition (HLPE), report 12 (2017), the food systems framework (Figure 4) identifies three core constituent elements and five main categories of drivers. The three core constituent elements are: food supply chains, food environments and consumer behavior. And the five drivers are: biophysical and environmental; innovation, technology and infrastructure; political and economic; socio-cultural; and demographic drivers (Ingram, 2011). Biophysical and environmental drivers include natural resource and ecosystem services, and climate change. Political and economic drivers include leadership, globalization, foreign investment and trade, food policies, land tenure, food prices and volatility, conflicts and humanitarian crises. Socio-cultural drivers include culture, religion, rituals, social traditions and women's empowerment. Finally, demographic drivers include population growth, changing age distribution, urbanization, migration and forced displacement. The relative impact of each driver will depend on the type of food system in question, the type of actors involved, and the type of actions and policies that are decided upon (Nesheim et al., 2015).

This study dwells into the three core constituent elements of food system in Vietnam (food supply chains, food environments, and consumer behavior), in context of a specific biophysical and environmental driver which includes climate change and its impacts.

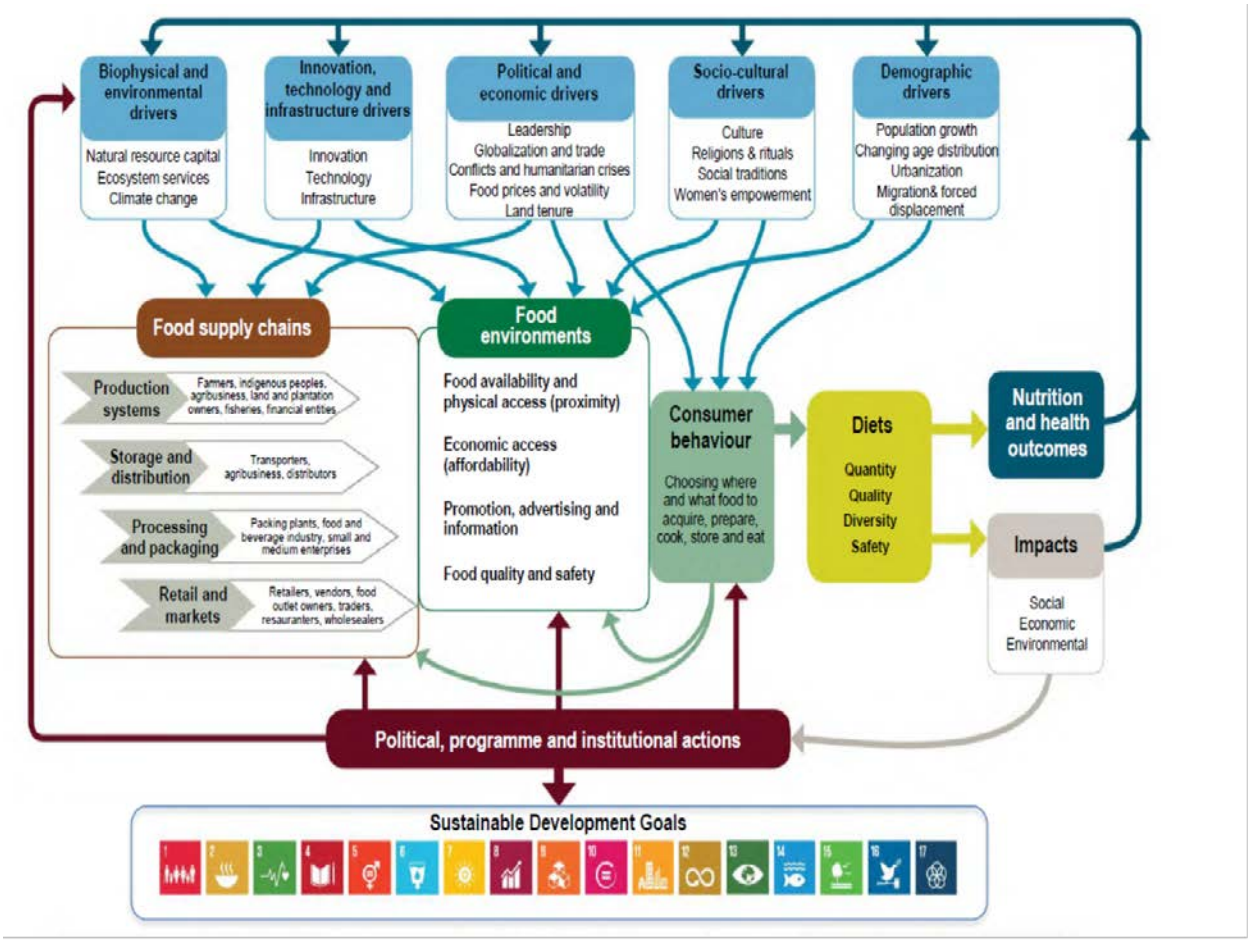


Figure 4: Food Systems Framework, From HLPE Report 12, 2017

2.2. Food Environment

Since the introduction of economic reforms under "*Doi Moi*" in 1986, Vietnam's agriculture has made striking progress. However, concerns related to quality and food safety remain--resulting in low export prices and doubts among domestic consumers. While the Government of Vietnam has traditionally played a major role in supporting smallholder agriculture, smallholders no longer rely only on public infrastructure and public services to remain competitive. Partnering with private companies have become crucial to help them meet new and emerging market requirement. And thus the private sector or the private companies have become an important stakeholder impacting the course of Vietnamese agriculture.

2.2.1. Evolution of rice-based food system in Vietnam

Speaking of local food systems in Vietnam unavoidably means speaking about rice. Rice has long been a main food staple in Vietnam and is deeply ingrained in the country's culture, traditions, and economy (Dao et al., 2013). The combined impact of war-time disturbances and incentive problems associated with "collective" agriculture resulted in stagnant rice production during the 1960s and 1970s. To address a growing food shortage, Vietnam, both before and after the 1975 unification, needed to import rice, totaling more than one million tons per year (Bui Ba Bong and all, 2010). To address the severe disincentives from the "collective agricultural system", farmers were permitted, after 1981, to sell their surplus production once they fulfilled their supply quota. Modest gains were made, although per capita production still did not recover to the level of 1960. More radical reforms were brought in with the launch of the Doi Moi policy in 1986, recognizing agricultural households as the basic unit of production and introducing a freer market for agricultural inputs and products. These reforms, together with subsequent advances in the development and spread of improved rice varieties, and investments in irrigation and water resources management, helped incur a dramatic growth of rice productivity and commercialization (Dao et al., 2013). The growth rate of rice production between 1990 and 1999 was an average of 5.6% per year, driven by increases in yield (2.8% per year) and planted area (2.7% per year). The total harvested area of paddy in Viet Nam is almost 7.5 million ha, with the largest proportions of paddy harvested area being in the Mekong River Delta (50.5%) and Red River Delta regions (16.1%) (ADB, 2013). Despite areas outside the Mekong and Red River deltas experiencing rice deficit, Viet Nam produces a surplus of rice and has been a significant net exporter of rice since 1993. In 2012, the Vietnamese government enacted Decree No. 42/2012/ND-CP[4],

[4] http://ap.fftc.agnet.org/ap_db.php?id=406

which was replaced by Decree No. 35/2015/ND-CP[5] in 2015. The decree provides 500,000 Vietnamese Dong (VND) per hectare per year to farmers directly producing rice, approximately $22.00 (USD). The policy aims to improve farmer incomes, maintain total area of land devoted to rice production, and increase rice exports. Implementation of the policy in 2012 had a positive effect on total production area, which increased from 7.76 million hectares in 2010 to 7.9 million hectares in 2013(Gro Intelligence, 2018)

2.2.2. Agricultural Diversification

Crop diversification was seen as a difficult proposition due to high humidity in Vietnam. Only "Chinese furrows" or the elevated nursery bed technique, widely developed in the Mekong delta, made it possible to set up other crops (market gardens or orchards) (Devienne, 2006). At present, Vietnam is trying to find means to promote other crops, other than rice exports. Converting rice fields into fruit or vegetable orchards has been a challenge as the small farmers prefer to maintain their food security by producing rice for their own consumption. The diversification of production and activities is easier in the communes (villages) located near urban areas or well serviced by roads. Remote communities find it difficult and challenging to diversify to fruits, vegetables and aquaculture due to difficulty in transferring farm products to market while they are still fresh.

The study results show that the diversification in the Red River Delta region results in finding other crops in that region like maize, potato, and vegetables. Diversification in the Mekong River Delta region has resulted in promotion of shrimp aquaculture or fruit tree production.

Vietnam enjoys numerous favorable conditions for vegetable and fruit production in which climate and ground are suitable with tropic, subtropical vegetables and fruits and some temperate vegetables and fruits. Vietnamese vegetable and fruit sector have gained satisfactory achievements in domestic consumption and export.

Vietnam also has a coastline of 3,260 kilometers, and hence, aquaculture is now a strength that facilitates the expansion and promotion of economic development. Shrimp farming is most advantageous in the Mekong Delta Region, because this area has an aquaculture area of about one million hectares (including 700,000 hectares for shrimp farming) (Van and Bao,

[5] https://luatminhkhue.vn/en/decree-no-35-2015-nd-cp-dated-april-13--2015-of-the-government-on-management-and-use-of-paddy-land.aspx

2017). As per the reporting of Vietstocks, Vietnam's shrimp exports in recent years have generated higher turnovers than rice exports (US$2.2 billion in 2016), making shrimp the second most valuable agricultural commodity after coffee (US$3.36 billion in 2016) In 2016, the value of shrimp exports reached USD 3.15 billion, accounting for 45% of total seafood export turnover.

However, government restrictions on land use prevent smallholder farmers from profiting by using the land for other agricultural uses. According to Decree 69, Articles 6.1 and 10.1, rice farmers must acquire permission from local authorities before diversifying the crops they grow. Decrees 69 contradicts crop diversification goals. Keeping farmland in rice production will not necessarily improve farmer incomes, instead, farmers should have the flexibility to choose the most appropriate crops for their parcels of land.

2.3. Food Supply Chain

The food supply chain comprises of the actors and activities that takes food from production to consumption and to the disposal of its waste (Hawkes and Ruel, 2012). The steps of the food supply chain include production; storage and distribution; processing and packaging; retail and markets.

Vietnam has organized, effectively working and vertically integrated food supply chains for most of its food items but not without challenges. The challenges remain in ensuring supply chain resilience which can cope with the event of disruptions brought on by the changing agriculture landscape, increasing population, volatile markets and weather variability.

The supply chains that we investigated in this study are :

1. Rice
2. Potato
3. Shrimps
4. Mango
5. Vegetables

We conducted KIIs for each supply chain actor operating in the study locations for rice, potato, shrimps, mango and vegetables. These interactions revealed that in Vietnam farmers' practice two ways of seeking buyers for their produce; one in which they independently sell to collectors or the local traders and the other in which they engage in contract farming. The

supply chains for rice, potato, shrimps, mango and vegetables cater to both the domestic market and the export market. There is coexistence of both the traditional channel catering to local wet markets and the modern channel catering to supermarkets. Some of the farmers believed that in some cases, it has been possible to increase the bargaining power of producers who sell to supermarkets or companies through organizing into associations or cooperatives

2.3.1. Rice Supply Chain

We studied the existing rice supply chains in the Red River Delta region and the Mekong River Delta Region (Figure 5). In both the regions farmers decide which rice variety to grow either on the advice of the provincial agriculture office or under a system of contract with a commercial company, where they prescribe which variety of rice to grow and promise a buy back of the entire produce. Certain companies like 'Bayer', also provide the farmers with seeds and chemiclas. Bayer provides input suppplies to farmer on credit, the price for which is deducted during buy back of harvest. If the farmers do not use the company provided seeds, they at least need to use certified seeds from other source. The farmers sign contract with a company either as a farmer group or as a member of farmer cooperatives.

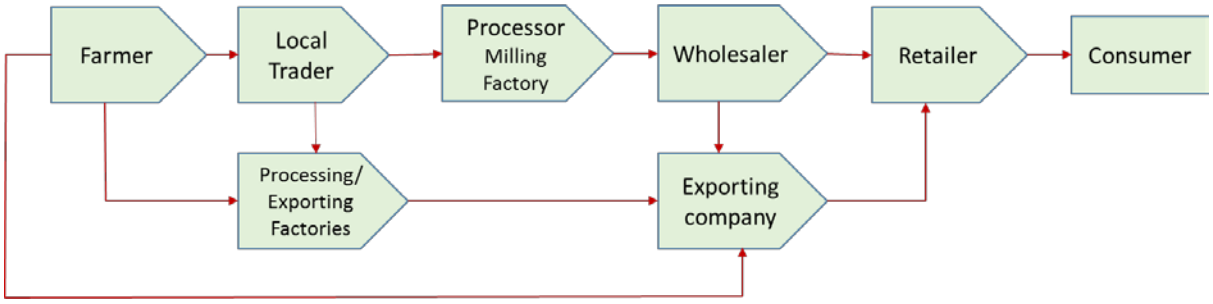


Figure 5: Rice Supply Chain

Case Study of Thai Binh Province, in the Red River Delta region

In Thai Binh province we found the following actors active in the rice supply chain

1. Farmers
2. Farmer groups
3. Local collector /traders
4. Small millers or processors
5. Big collecting/ processing and exporting company
6. Wholesalers

7. Retailers

Paddy gets picked up at farm gate either by small collectors or big collector/processors. The small collectors also eventually sell to the big collector/processor companies. The big collector/ processor sells it to several actors: wholesalers, commercial rice companies and exporters.

Lien Hanh Company is one the biggest rice exporter in North Vietnam (Figure 6). They supply paddy both to domestic market and to the export market. They procure paddy from many provinces from North, Central, and South Vietnam. They either buy from the collector companies in various province or they sign contracts with farmers groups in the provinces. They buy fresh paddy from north and central Vietnam but procure single time processed rice from South Vietnam. They have well-equipped storage facility where they store paddy and milled rice for 6 to 8 months before selling at suitable price.

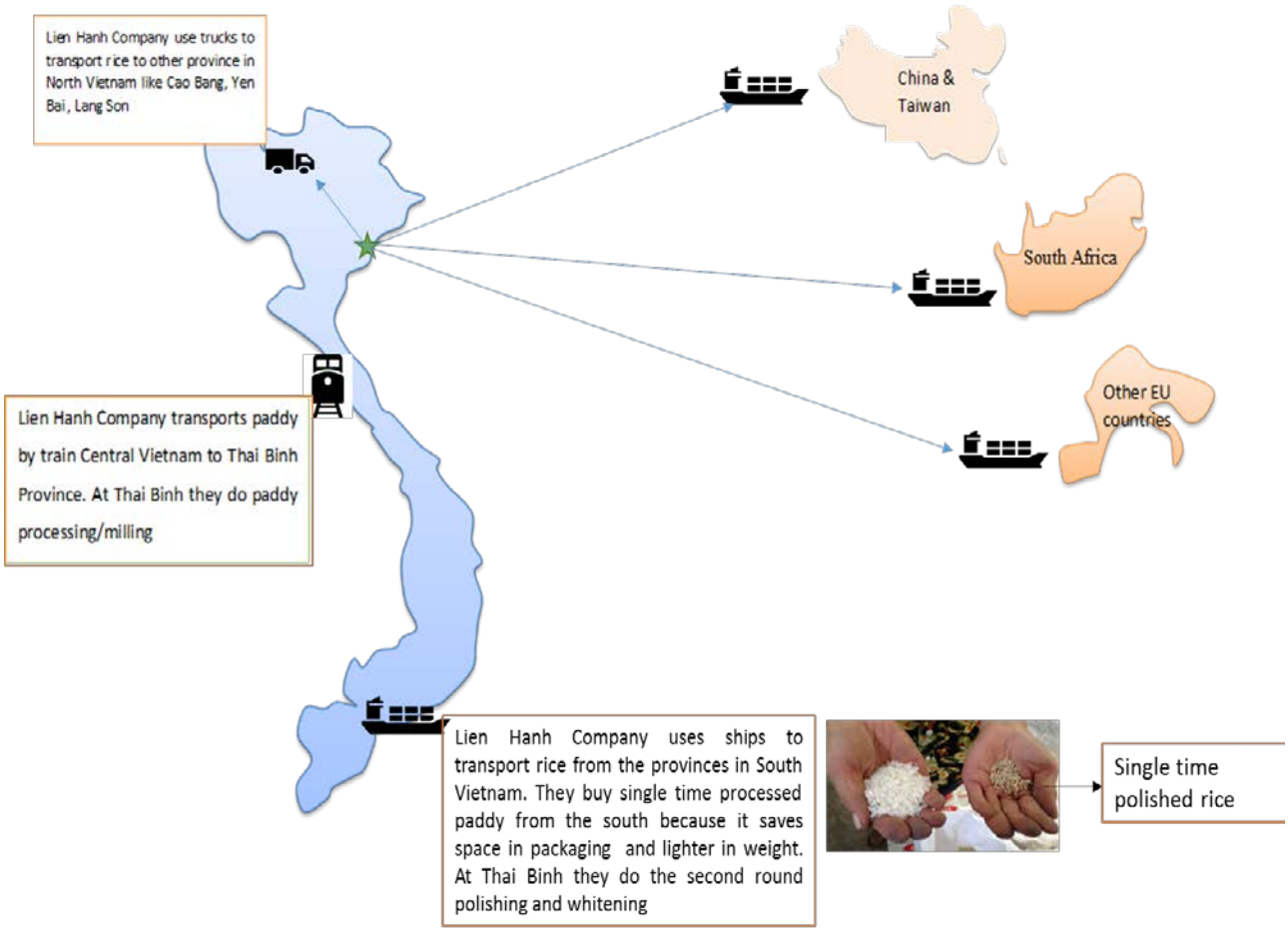


Figure 6: Supply Chain of Lien Hanh Export Company

Picture 1: Rice Storage of Lien Hanh Company

Case Study of Bac Lieu Province, in Mekong River Delta

In the Bac Lieu Province, we found the following actors active in the rice supply chain

1. Farmers
2. Farmers Cooperatives
3. Farmer groups
4. Local collector /traders
5. Small millers or processors
6. Big collecting/ processing and exporting Company
7. Wholesalers

Picture 2: Milled and Polished Rice Packaged and Stored by Vinh Loc Food Company

Paddy in Mekong Delta is manily grown under predecided contracts given by exporting or processing companies to farmers either through farmer cooperative or through farmer groups. Vinh Loc Food Company is a company of Loc Troi Group (Loc Troi Group has 5 companies with the size is as big as Vinh Loc Food Company) and is one such company that works using the contract system. Vinh Loc Food Company acts as collector, processor and wholesaler. They collect paddy and sell rice after processing. They purchase paddy from Bac Lieu Province, Hau Giang Province, Soc Trang Province, Kien Giang Province and Ca Mau Province in Mekong River Delta region. They pack paddy in 50 kg bags and store for a period of 6 months to 1 year, waiting for the best price.

Under the contract system, the price and the rice variety to be grown is pre-decided between the company and the farmer. The company also provides prescription to farmers about what and how much fertilizer and pesticide to use. The Vinh Loc Food Company has a group of agronomist and field technicians who guides farmers with production practices. The mother company of the Vinh Loc Food Company, which is Loc Troi Group is located in Ho Chi Minh City. All the milled and packaged rice is sent by Vinh Loc Food Company to Loc Toi Company in Ho Chi Minh City. From Ho Chi Minh City the packaged rice gets exported to China, Japan and other EU countries (Figure 7).

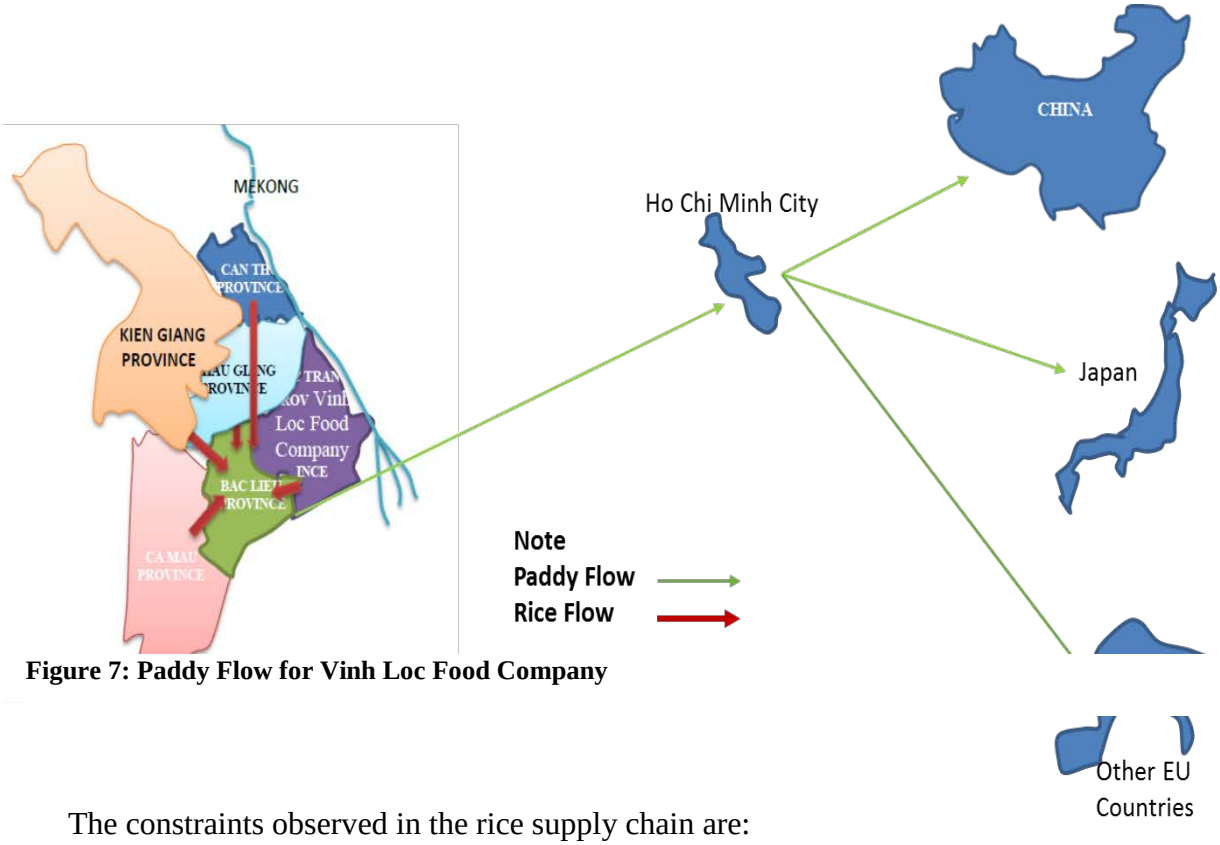


Figure 7: Paddy Flow for Vinh Loc Food Company

The constraints observed in the rice supply chain are:

- Rice collectors are in general small private enterprises operating on small margins. Constraints felt by collectors include deficit of credit, capital and information. Collectors suffer from the negative effects of spatial distribution of rice producers and are unable to take advantage of the economies of scale in collecting activities.
- The current system of "double milling" causes a large number of small private dehuskers to participate in the marketing chain, who mill paddy that is then sold as brown rice to larger private millers and provincial food companies for final milling. This multiple milling practice substantially affects the quality and standardization of rice, which in turn affects value and the opportunities to export higher-quality and higher value rice. The large number of small private millers makes it extremely difficult to ensure rice quality and standards.
- Storage is also a constraint to millers, especially small millers because it limits their ability to purchase and store paddy and wait for higher prices. High moisture content, due to poor and inadequate drying facilities and storage, also results in substantial losses during milling.

2.3.2. Potato Supply Chain

We studied the Potato supply chain only in the Red River Delta region (Thai Binh and Bac Ninh provinces). The potato collector or the local trader collects the harvested potato directly from the farmers' field. They then pack it in 25 kg bags to transport to the wholesale market (Figure 8). The collectors or the farmers in Red River Delta region do not have access to any cold storage facility, so they do not practice storage. Both collector and farmers negotiate the selling price based on the current market price. Collectors/ traders check the quality of the potatoes (shape, size, free from insect bite and disease) when deciding on the price before buying. Collectors can freely decide how much amount that they want to buy. Potato collectors or traders do not operate under any predefined or signed contract system in this region. They assess the market demand through feedback from their retailer networks and decide on the quantity they would prefer to collect in a particular potato harvest season. Wholesaler mostly collect the potatoes from the collectors using their own transport. Also, they have a better bargaining power as the collectors have no storage or cold storage facility and therefore are always in a hurry to sell off their collection before any decay or damage occur. The wholesalers pack the potatoes in plastic bags for selling to the retailers.

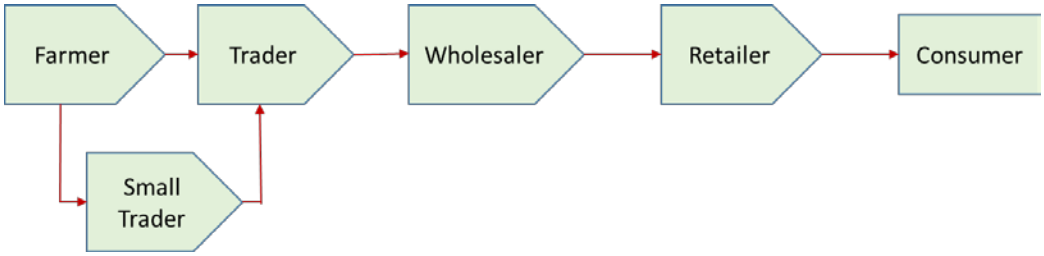


Figure 8: Potato Value Chain

Constraints in the potato supply chain:

- The biggest constraint in the potato supply chain is at the production stage itself. Vietnam does not yet have a viable system of seed potato production and supply. Consequently, the lack of good quality seed has been considered the most important constraint to improving both the productivity of potato crops and the area of potato.
- The second constraint is that of cold storage facility. Cold stores are still too expensive for most farmers in Vietnam.

2.3.3. Shrimps Supply Chain

We studied the shrimp supply chain in the Bac Liu Province of Mekong River Delta region. We found three types of shrimp farming in Bac Liu province. The first type is intensive

commercial farming of shrimps, which is a monoculture using high level of inputs and equipment, the second type is alternating agriculture-aquaculture system with rice-shrimp farming and the third type is brackish water polyculture of rice and shrimp.

At present, the shrimp supply chain has too many middlemen, particularly traders. Traders are a barrier between farmers and businesses because they suggest low prices while buying from farmers whereas they sell it at a higher price to exporters or wholesalers. The wholesaler usually places a verbal order to the traders/collectors, specifying the amount they would buy. The most important requirement of the shrimp supply chain is to keep the shrimps alive as they travel from the farmers to the consumers. Consumers prefer to buy live and fresh shrimps and so all the actors of the in the supply chain try to keep the shrimps alive by using oxygenating machines. Hence, the supply route of fresh shrimps are also relatively short. The vast majority of shrimps from Bac Lieu province are sold at Bac Lieu City Market and nearby Ho Chi Minh city. The bulk of globally traded shrimp is exported in whole or with minor processing. This further processing refers to peeling, beheading, deveining and cutting, which are labor-intensive manual activities. The major disadvantages in the shrimp supply chain include over 70% of farming households cultivating on an area of less than 0.5 ha and not adopting modern farming practices, legislature constraints in terms of production development on a large scale and lack of working capital

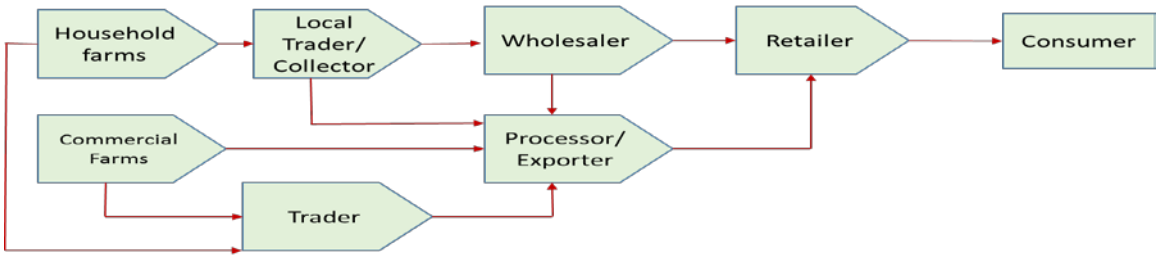


Figure 9: Shrimp Value Chain

Picture 3: Transfer of Shrimps from Collector to Wholesaler to be taken to Ho Chi Minh City

Picture 4: Commercial Shrimp Farm

2.3.4. Mango Supply Chain

We studied the mango supply chain in the Tra Vinh Province of Mekong River Delta region. The farming of mango has been listed as one of the five key sectors in the local agricultural restructuring program. The mango collector or the local trader collects the harvested mangoes directly from the farmers' field. They later pack it in 30 kg bags to transport to the wholesale market. The collectors or the farmers in Mekong River Delta Region do not have access to any cold storage facility, so they do not practice storage of harvested mangoes. Both collector and farmers negotiate the selling price based on the prevailing market price. Collectors/ traders check the quality of the mangoes (shape, size, free from insect bite/disease and preferably without any stain or black spot on the skin) when deciding on the price before buying. The retailers of Tra vinh province shared that, street vendors or small retailers are still the major sellers of fresh fruits and vegetables. Most consumers purchased from the traditional retail market because it was easier to access, they were able to select individual pieces of fruit, and they had established long-term relationships with the vendor.

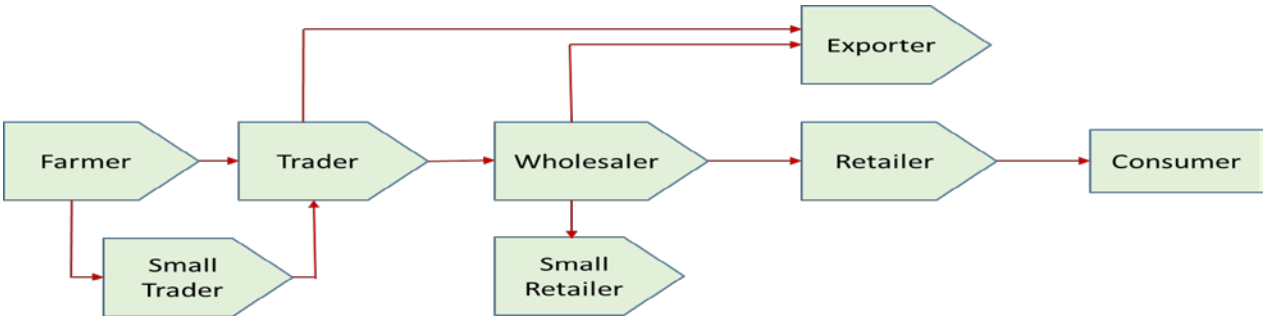


Figure 10: Mango Supply Chain

2.3.5. Vegetable Supply Chain

We studied the vegetable supply chain in both Red River Delta Region and the Mekong River Delta region. Vegetable plays very important role in Vietnamese's diet. It is the second most important foodstuff after rice. Currently, national production is mainly for domestic consumption. The major actors in general circulation and distribution of fresh vegetables in Vietnam are producers, collectors, wholesalers and retailers (Figure 11). Each marketing actor can take over one or more functions such as transportation and distribution. Sometimes the collectors are even vegetable producers. At harvest time, the producers may sell their own products or they engage in marketing activities to increase their families' income. They can collect vegetables from producers who often live in the same villages or communes to retail on market places or directly to the final consumers. Wholesalers can be divided into 3 types:

wholesale traders, wholesale producers and wholesale collectors. Wholesale traders (big wholesalers) serve as intermediaries between collectors and retailers. At present, these actors are still small and un/under specialized. They mainly trade on fruits and vegetables. Trading is still a subsidiary activity that mainly focuses on luxury vegetables. There are two groups of retailers; fixed retailer in markets and the other is the moving retailer on street.

The challenges or constraints in vegetable production and marketing are:

- Vegetable production is scattered and small-scaled
- Farmers complain of poor quality of vegetable seeds.
- The greatest challenges in the production and marketing of vegetables is ensuring food safety measures in application of chemicals and fertilizers – which is a contradiction between immediate economic benefit of producers and food safety.
- Lack of post-harvest facilities
- Lack of formal wholesale market system

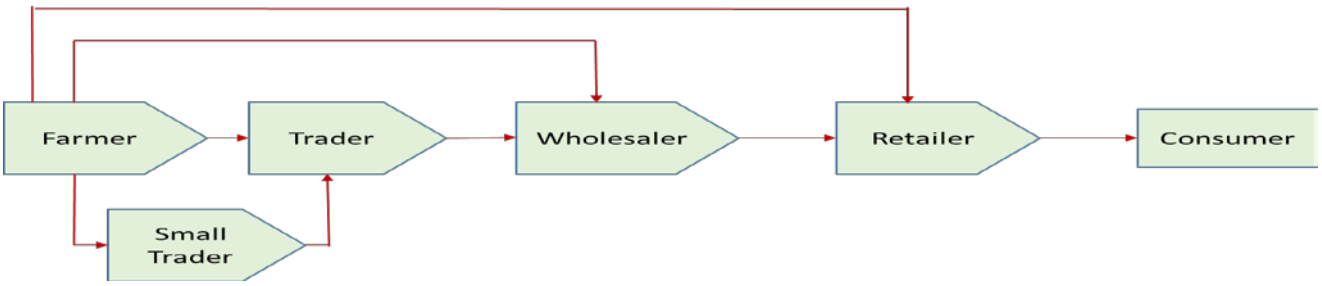


Figure 11: Vegetable Supply Chain

2.4 Consumer Behavior

In Vietnam, the gross domestic product (GDP) is projected to reach around US$500 billion in 2030 as compared to US$200 billion in 2018, more than double in the next ten years (Henry and Pomeroy 2018). Similarly, the proportion of population living in urban setting is also expected to increase from 37 percent in 2020 to 45 percent in 2030 and by 2050, more than half of the country's population is expected to live in urban areas (Jiang and O'Neill, 2017). The income growth, urbanization, and changes in population demographics such as more educated people, more working age people are in the labor market (Minh 2009), and women in the labor force (Banerji et al., 2018) are likely to accelerate the changes in food consumption patterns in Vietnam. In this study, we estimate a complete food demand system for rural and urban Vietnam using multiyear Vietnam Living Standard Survey (VLSS) data. For Vietnam Hoang (2018) recently estimated rural and urban food demand for Vietnam

using cross-section data, which does not capture changing consumption pattern over time. Mottaleb et al. (2018) estimated a food demand system for rural and urban households in Bangladesh, using multiyear household income and expenditure survey data. However, they estimated only five major food items, which is not a complete demand system, so substitution effects of the remaining food items are unknown. They used time as dummy variables to capture rural-urban migration and the evaluation of food consumptions over rural and urban households in Bangladesh. For China, Zheng et al. (2018) projected changing food consumption pattern for rural and urban households in 2030 using a complete food demand system.

Since Vietnam is going through rapid structural transformation such as due to high-income growth, rural outmigration and greater integration with the world economy, the findings from our study will be useful for policy–makers and researchers in reforming the food system to meet the upcoming challenges including changing consumer preference and climate change. This will inform policymakers and researchers about how consumer food demand is going to evolve in the future and thus help policymakers design effective food and nutrition security policy.

2.4.1. Findings from the survey data

Table 1 presents patterns of income, expenditure, and demographic profiles of the rural and urban households in Vietnam. Findings indicate that per capita income and expenditure in both rural and urban households increased during 2012-2016, almost at the same rate (1.5 times). In contrast, expenditure share on food decreased, which is consistent with the economic theory y, Engle law, as household income increases the share of expenditure spent on food decreases. Findings also indicate that education level of the household heads increased, especially college and higher levels, for both rural and urban residents in Vietnam during the sampled period. Finally, the urban population increased due to outmigration of rural people in search of better economic opportunities.

Figure 1 and Table 2 show the structure of the food demand during 2012-2016. Vietnamese food basket (food at home) contains eight major categories such as rice, other cereals, fish, meat and eggs, fruits and vegetables, edible oil, beverages, and miscellaneous items. Findings indicate that a Vietnamese spend an average of two-third of the total food budget on three food items, rice, fish, and meat & eggs. However, in terms of quantity, rice is the primary staple. For rice consumption, urban residents spend around 8 percentage points less than rural households (20% vs 28%) (Figure 1). Conversely, urban residents spend more on fish and

meat & eggs consumption compared to their rural counterparts. Over the past years, share of food expenditure spent on rice declined for both rural and urban households. In contrast, the budget share for meat and eggs increased. For instance, in 2012, the expenditure share on rice consumption foe rural household declined from 34 percent in 2012 to 28% in 2016. Similar decline was also witnessed for urban households where the expenditure share on rice consumption declined from 25 to 20 percent during the same period. In contrast, the expenditure share on fish increased by 6 percent and 8 percent, respectively, for rural and urban households. Most importantly, from 2012 to 2016, the expenditure shares on meat and eggs increased remarkably at the household level by 14% for rural households and 7 percent for urban households. Finally, significant increase is observed in miscellaneous food items, which may be because of strong consumption growth of dairy products, as it is included in this category.

2.4.2. Econometric results

In order to avoid biased parameters due to endogeneity of expenditure variable, we estimated expenditure equation using income as an instrument. Price and other demographic variables are also used in the expenditure equation. The parameter estimates are presented in Tables 3-6. As shown in the table 3, commodity prices are positively and significantly correlated with food expenditure. This indicates that consumers respond when commodity prices increase, and thus adjust their choices. Education is negatively correlated with expenditure, implying that education is expensive. A time index variable was included in the demand equations, as a proxy for changing taste and preferences. Positive value of time index coefficient indicates preferences toward the food item, and vice versa. As shown in tables 4-6 (rows 18), coefficients related to rice are negative and statistically significant for both rural and urban households (–0.015 vs. –0.025). This implies that preferences towards rice are decreasing in Vietnam. On the other hand, time coefficients related to meats and eggs are positive and highly significant (+0.016 vs. +0.009), indicating more preferences toward these products.

The role of demographic variables such as on household head's age, sex, education, and household size differences on food consumption by urban and urban households are presented in Tables 5 and 6. The estimated coefficients related to age (in years) variable suggest that older people spend more on rice and less on beverages and miscellaneous items in both urban and rural areas. However, in rural areas, households spend significantly less for fish, meats and eggs. It is also found that male-headed households spend more on rice consumption compared to the female headed households who spend more on high value

nutritious food produce such as fish, meat and eggs, and fruits and vegetables. Education also plays an important role in food consumption of Vietnamese households. We included education as two dummy variables, diving education into three groups, no education (base), primary and secondary levels of education, and college and above levels of education. The results suggest that household heads who are more educated spend more on animal protein (fish, meats and eggs), and less on cereal consumption (rice and other cereals) and beverages compared to non-educated household heads. These results are consistent with the fact that educated households are likely to have more income and awareness concerning their requirements for animal protein, and thus spend more on nutritious food.

2.4.3. The Estimated Expenditure and Price Elasticities

Table 7 presents the expenditure (income) elasticities across time and rural-urban landscape. Results show that the estimated expenditure elasticities for all food items are positive and statistically significant, except for rice in urban households. In general, rice and other cereals are considered to be inferior goods whereas food items such as fish, meat and eggs, fruits and vegetables are considered to be normal goods. Results also show that the magnitude of the expenditure elasticity of demand for rice is the smallest among the entire food items, 0.21 for rural vs –0.06 for urban residents. This implies that rice is still a normal good for rural population but becoming an inferior good for urban residents. Rice expenditure elasticity for urban consumers has been negative since 2014.

We also estimated expenditure elasticities across income groups over time (Table 8). The main finding is that rice is becoming an inferior good for all the income groups in urban areas, except poor. It means that as income increases in the future, rice consumption in urban households will decline. On the other hand, consumption of other food items such as fish, meat, vegetable, beverages and other food items will rise. This trend is also observed across all income groups in rural households where expenditure elasticities for rice over time is declining. Even for the rural poor households, expenditure elasticity for rice declined from 0.381 in 2012 to 0.257 in 2016. The largest decline was witnessed in the upper middle-class households where expenditure elasticity declined from 0.197 to 0.006 over the same time. Mottaleb (2018) also observed similar trend among Bangladeshi households where rice, the staple food, is becoming an inferior good over time across income groups. Finally, overall the expenditure elasticities reveal that demand for foods are likely to be less elastic at higher levels of income and for urban households, which is similar to the findings of (Hoang 2018) for Vietnam.

The compensated (Hicksian) and uncompensated (Marshallian) own-and cross price elasticities for Vietnam and separately for urban and rural households are presented in Tables 9a to 9c. Note that compensated price elasticity assumes that consumers are compensated for price changes through expenditure (income) changes, so compensated elasticities will be smaller than uncompensated elasticities. The own-price elasticities of all food items are found to be negative, which is consistent with the economic theory that the demand for a commodity is reduced in general with the increase in price. The results of uncompensated price elasticities indicate how much demand for the sampled food items will be reduced by a 1% increase in prices. For example, a 1% increase in rice price will reduce the demand for rice by 0.18% for the rural households. Although it is to be positive but insignificant for urban households, indicating a likely transformation within rice commodity, such as normal vs. quality rice. Further results reveal the own-price elasticity to be the lowest for rice among the food items, smaller than the estimates by (Gibson and Kim 2013; Hoang 2018), which confirms that rice is the most basic and necessary food item for Vietnamese and its consumption does not change with price fluctuations.

Similarly, Cross-price elasticity reflects changes in demand for a particular commodity when prices of other products change. These elasticities are very important tool for designing policies in that relative shifts in prices due to various policy reforms that can affect demand for other products that are not regulated (Andreyeva, Long, and Brownell 2010). Moreover, higher the cross-price elasticity, the greater shift in purchase as prices change. Our results show that rice and other cereals are substitute for both rural and urban residents, but other commodities are complements.

2.4.4. Implications

Expenditure elasticity estimates indicate that rice is already an inferior good for middle class and rich urban populations. These households are consuming more high value food products such as meat, dairy products, fruits, and vegetables. The positive and declining expenditure elasticities of rural population suggest that as income grows rural households will eventually start consuming less rice and more other food products. Since the Vietnam's economy continues to grow with doubling of GDP in the next decade, per capita rice consumption both in urban and rural and across different income will continue to decline. The demand for other high value products will rise, on the other hand. This changing consumption pattern will have significant impact on the current food system. In addition, climate change further complicates

the situation because Vietnam is one of the most vulnerable to climate change and will be severely affected in coming years due to its consequences.

Finally, education, aging, urbanization, and taste and preferences are found to be the important drivers of food demand, which could reshape the future food demand structure in Vietnam. Therefore, findings from our study will inform policy makers and researchers about how consumer food demand is evolving in the future and thus help policymakers design effective food security and nutrition policy for the Country.

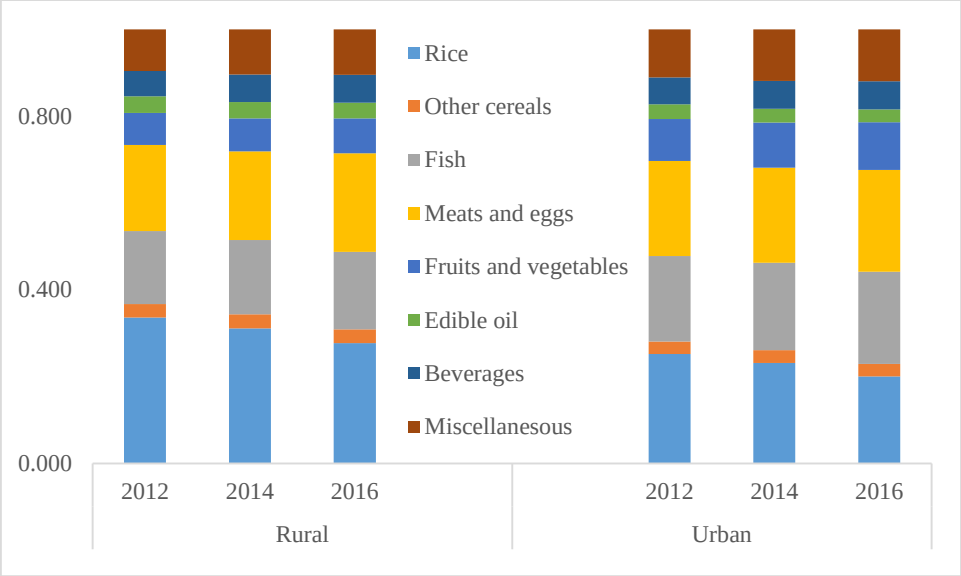


Figure 12: Changes in composition of food basket (expenditure shares) across rural-urban landscape in Vietnam. Source: Authors' estimation based on VHLSS data.

Table 1. Household income, expenditure, and demographic profiles: 2012-2016

Variables	Rural			Urban			All
	2012	2014	2016	2012	2014	2016	
Real per capita income (1000 VND/year)	18,836	23,878	29,089	30,696	38,070	49,578	28,279
Real per capita expenditure (1000 VND/year)	13,807	18,228	19,901	21,674	27,597	31,348	19,992
Food expenditure share	0.61	0.55	0.55	0.58	0.54	0.53	0.56
Age of household head (years)	49.50	50.59	51.38	51.01	51.19	52.36	50.77
Gender of household head (male = 1)	0.80	0.79	0.80	0.67	0.65	0.67	0.76
HH had no schooling (yes = 1)	0.28	0.27	0.26	0.16	0.16	0.15	0.24

HH had primary and secondary education (yes = 1)	0.70	0.71	0.71	0.70	0.70	0.69	0.70
HH had college and above education (yes = 1)	0.02	0.03	0.03	0.14	0.14	0.16	0.06
Household size (no.)	3.90	3.80	3.80	3.83	3.75	3.73	3.82
Urbanization rate (urban = 1)							0.30

Source: Authors' computation based on the VHLSS data.

Table 2. Composition of food basket in Vietnam

Food groups	Sub-group composition	Mean budget share (%)			
		2012	2014	2016	All
Rice	Plain and sticky rice	0.302	0.272	0.236	0.270
Other cereals	(1) Maize (2) Wheat grains, bread, and wheat powder (3) Flour noodle and instant rice noodle/porridge (4) Fresh and dried rice noodle (5) Vermicelli	0.030	0.031	0.029	0.030
Fish	(1) Fresh fish (2) Dried and processed fish (3) Other aquatic products and seafood (e.g., crabs and snails)	0.167	0.170	0.179	0.172
Meats and eggs	(1) Pork (2) Beef (3) Buffalo meat (4) Poultry (5) Duck and other poultry meat (6) Other types of meat (e.g., goats, dogs, and sheep) (7) Processed meat (8) Eggs	0.201	0.203	0.222	0.209
Fruits and vegetables	(1) Fresh fruits (2) Fresh vegetables	0.078	0.082	0.088	0.083
Edible oil	(1) Lard and cooking oil	0.039	0.036	0.034	0.036
Beverages	(1) Alcohol (e.g., beers and wines) (2) Bottled water, juice, and soda (3) Coffee and tea (4) Cigarettes and waterpipe tobacco (5) Betel leaves, areca nuts, and lime	0.063	0.068	0.070	0.067
Miscellaneous	(1) Milk and dairy products (2) Sugar and molasses (3) Peanuts and sesame (4) Fish sauce (5) Salt, glutamate, and confectionary (6) Other foods and drinks	0.120	0.138	0.141	0.133

Source: Authors' estimation based on the VHLSS data.

Table 3. Parameters estimated from endogenous expenditure function

Dependent variable: log of expenditure	National (All households)		Urban		Rural	
	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Log of rice price	0.337***	0.013	0.261***	0.024	0.362***	0.015
Log of other cereal price	0.0003	0.004	0.013	0.008	-0.004	0.005
Log of fish price	0.122***	0.006	0.143***	0.011	0.116***	0.006
Log of meat and eggs price	0.068***	0.004	0.114***	0.008	0.055***	0.004
Log of fruits and vegetables price	0.031***	0.003	0.008	0.007	0.038***	0.004
Log of edible oil price	0.030***	0.009	0.052***	0.019	0.025**	0.010
Log of beverages price	-0.0001	0.002	0.002	0.003	-0.001	0.002
Log of miscellaneous food price	0.069***	0.004	0.085***	0.009	0.064***	0.005
Log of per capita income	0.172***	0.004	0.160***	0.008	0.174***	0.004
Age of household head	0.008***	0.001	0.004**	0.002	0.010***	0.001
Age squared of household head	-0.0001***	0.000	-0.00002	0.000	-0.0001***	0.000
Male headed household (yes = 1)	0.013**	0.005	0.017**	0.009	0.009	0.007
Primary and secondary education (yes = 1) †	-0.035***	0.006	-0.033***	0.013	-0.034***	0.006
College and above schooling (yes = 1) †	-0.029***	0.011	-0.014	0.017	-0.049***	0.017
Household size (No.)	-0.086***	0.001	-0.087***	0.003	-0.085***	0.002
Time index	0.006**	0.003	0.009*	0.005	0.004	0.003
Urbanity (urban = 1)	-0.004	0.005				
Constant	3.456***	0.050	3.488	0.099	3.461	0.060

Notes: *,**, and *** denote statistical significant levels at 10, 5, and 1 percent, respectively.
† Base level is no education.

Table 4. Parameter estimates from QUAIDS model for all households, 2012-2016

	Rice	Other cereals	Fish	Meats and eggs	Fruits and vegetables	Edible oil	Beverages	Miscellaneous
Log of prices	0.21***	0.0031***	-0.069***	-0.055***	-0.030***	-0.000023	-0.020***	-0.036***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
		0.0078***	0.0013***	-0.0042***	-0.0033***	0.000068	-0.00071***	-0.0040***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
			0.054***	-0.00076	0.011***	-0.0058***	0.0040***	0.0058***
			(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
				0.069***	-0.0021***	-0.0050***	0.0050***	-0.0061***
				(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
					0.028***	-0.0043***	0.0027***	-0.0016***
					(0.00)	(0.00)	(0.00)	(0.00)
						0.022***	-0.0018	-0.0056***
						(0.00)	(0.00)	(0.00)
							0.0094***	0.0017***
							(0.00)	(0.00)
								0.045***
								(0.00)
Log of expenditure	-0.25***	-0.0030*	0.096***	0.071***	0.038***	-0.018***	0.053***	0.016***
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
Log of expenditure	-0.025***	0.0068***	0.035***	-0.035***	0.0050***	0.00085	0.016***	-0.0043**
squared	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Residuals of	0.11***	0.0036**	0.036***	-0.080***	-0.031***	0.0084***	-0.031***	-0.018***
expenditure	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
Age of household head	0.0055***	-0.000092	0.00041	-0.0017***	-0.00083***	0.00027***	-0.00057***	-0.0029***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Age squared	-0.0001***	0.000001	-0.0000021	0.000016***	0.0000077***	-0.000002***	0.0000040***	0.000026***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Male headed	0.021***	-0.00072*	-0.0023	-0.0025	-0.0058***	0.00033	-0.00072	-0.0097***
household (yes = 1)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Primary and secondary	-0.019***	0.00061	-0.033***	0.045***	0.0044***	0.0020***	-0.0075***	0.0075***
education (yes = 1) †	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
College and above	-0.056***	-0.00015	-0.029***	0.064***	0.012***	0.00051	-0.012***	0.020***
schooling (yes = 1) †	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Household size (No.)	-0.010***	-0.0021***	0.0019**	0.0065***	0.00044	-0.0032***	0.00035	0.0066***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Time index	-0.022***	0.00018	0.0014	0.014***	0.00051	-0.00026*	0.0028***	0.0032***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Urbanity	-0.070***	-0.0018***	0.026***	0.016***	0.019***	-0.0028***	0.0065***	0.0077***
(urban = 1)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	0.36***	0.041***	0.13***	0.16***	0.094***	0.027***	0.081***	0.11***
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)

Notes: Standard errors in parentheses. *,**, and *** denote statistical significant levels at 10, 5, and 1 percent, respectively. † Base level is no education.

Table 5. Parameter estimates from QUAIDS model for all urban households, 2012-2016

Variables	Rice	Other cereals	Fish	Meats and eggs	Fruits and vegetables	Edible oil	Beverages	Miscellaneous
Log of prices	0.17***	0.0016	-0.072***	-0.033***	-0.032***	0.0015	-0.011***	-0.025***
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
		0.011***	0.0017**	-0.0041*	-0.0045***	-0.000069	-0.00047	-0.0046***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
			0.062***	-0.0064**	0.012***	-0.0046***	0.00054	0.0072***
			(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
				0.067***	-0.0071***	-0.0049***	0.0019	-0.013***
				(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
					0.039***	-0.0049***	0.0027**	-0.0059***
					(0.00)	(0.00)	(0.00)	(0.00)
						0.021***	-0.0020***	-0.0060**
						(0.00)	(0.00)	(0.00)
							0.010***	-0.0014*
							(0.00)	(0.00)
								0.049***
								(0.00)
Log of expenditure	-0.15***	-0.0056*	0.067***	0.027*	0.035***	-0.017***	0.056***	-0.0092
	(0.01)	(0.00)	(0.02)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Log of expenditure	-0.0013	0.00034	0.026***	-0.033***	-0.0036	0.00084	0.017***	-0.0065*
squared	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
Residuals of expenditure	0.048***	-0.00071	0.067***	-0.050***	-0.036***	0.0088***	-0.038***	0.0013
	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Age of household head	0.0041***	-0.00014	0.00059	-0.00062	-0.00048	0.00022**	-0.00063**	-0.0031***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Age squared	-0.000037***	0.0000015	-0.0000044	0.0000070	0.0000048*	-0.0000017*	0.0000035	0.000027***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Male headed household	0.019***	-0.00048	0.0019	-0.010***	-0.0067***	0.00079*	0.0014	-0.0060***
(yes = 1)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Primary and secondary	-0.023***	0.0024***	-0.034***	0.047***	0.0076***	0.0014**	-0.0092***	0.0072***
education (yes = 1) †	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
College and above	-0.052***	0.0011	-0.035***	0.068***	0.016***	0.00057	-0.016***	0.017***
schooling (yes = 1) †	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Household size (No.)	-0.0059***	-0.0023***	0.0020	0.0020	0.00041	-0.0030***	0.0011	0.0057***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Time index	-0.015***	0.000030	0.00046	0.0088***	0.00056	-0.00046*	0.0019**	0.0034***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	0.31***	0.040***	0.12***	0.17***	0.10***	0.027***	0.10***	0.11***
	(0.02)	(0.00)	(0.02)	(0.02)	(0.01)	(0.00)	(0.01)	(0.01)

Notes: Standard errors in parentheses. *,**, and *** denote statistical significant levels at 10, 5, and 1 percent, respectively. † Base level is no education.

Table 6. Parameter estimates from QUAIDS model for all rural households, 2012-2016

	Rice	Other cereals	Fish	Meats and eggs	Fruits and vegetables	Edible oil	Beverages	Miscellaneous
Log of prices	0.22***	0.0034***	-0.067***	-0.063***	-0.028***	-0.00083	-0.023***	-0.039***
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
		0.0067***	0.0012**	-0.0043***	-0.0028***	0.000088	-0.00078	-0.0035***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
			0.051***	0.0010	0.0094***	-0.0061***	0.0053***	0.0053***
			(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
				0.070***	-0.00070	-0.0049***	0.0055***	-0.0034***
				(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
					0.024***	-0.0041***	0.0028***	-0.00051
					(0.00)	(0.00)	(0.00)	(0.00)
						0.023***	-0.0016***	-0.0054***
						(0.00)	(0.00)	(0.00)
							0.0089***	0.0027***
							(0.00)	(0.00)
								0.044***
								(0.00)
Log of expenditure	-0.28***	-0.0015	0.10***	0.083***	0.040***	-0.018***	0.049***	0.024***
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
Log of expenditure squared	-0.033***	0.0099***	0.038***	-0.036***	0.0080***	0.0010	0.015***	-0.0039*
	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Residuals of expenditure	0.13***	0.0050***	0.026***	-0.087***	-0.030***	0.0081***	-0.025***	-0.025***
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
Age of household head	0.0063***	-0.000036	0.00024	-0.0023***	-0.00098***	0.00029***	-0.00048***	-0.0030***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Age squared	-0.00005***	0.00000050	-0.00000062	0.000020***	0.0000090***	-0.000003***	0.0000036**	0.000027***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Male headed household (yes = 1)	0.021***	-0.00088*	-0.0043*	0.0026	-0.0054***	0.000040	-0.0017*	-0.011***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Primary and secondary education (yes = 1) †	-0.016***	0.00033	-0.033***	0.043***	0.0032***	0.0021***	-0.0070***	0.0074***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
College and above schooling (yes = 1) †	-0.066***	0.00058	-0.023***	0.064***	0.0069***	-0.00068	-0.0059**	0.024***
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
Household size (No.)	-0.011***	-0.0020***	0.0016	0.0073***	0.00062*	-0.0033***	-0.000094	0.0069***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Time index	-0.025***	0.00022	0.0019*	0.016***	0.00046	-0.00018	0.0032***	0.0033***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	0.34***	0.039***	0.14***	0.17***	0.100***	0.026***	0.074***	0.11***
	(0.02)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)

Notes: Standard errors in parentheses. *,**, and *** denote statistical significant levels at 10, 5, and 1 percent, respectively. † Base level is no education.

Table 7. Expenditure elasticities for food items consumed by Vietnamese

Food groups	2012		2014		2016		All	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Rice	0.271***	0.053*	0.227***	-0.046	0.110***	-0.250***	0.209***	-0.066*
Other cereals	0.695***	0.650***	0.699***	0.651***	0.699***	0.648***	0.698***	0.650***
Fish	1.387***	1.316***	1.370***	1.301***	1.359***	1.292***	1.372***	1.303***
Meat and eggs	1.476***	1.462***	1.463***	1.446***	1.429***	1.419***	1.455***	1.441***
Fruits and vegetables	1.448***	1.329***	1.427***	1.314***	1.398***	1.301***	1.424***	1.315***
Edible oil	0.497***	0.404***	0.466***	0.360***	0.444***	0.331***	0.470***	0.366***
Beverages	1.624***	1.584***	1.600***	1.559***	1.570***	1.534***	1.598***	1.559***
Miscellaneous	1.198***	1.177***	1.194***	1.173***	1.181***	1.165***	1.191***	1.172***

Notes: Authors' estimation based on VHLSS data and QUAIDS model. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

Table 8. Expenditure elasticities across different income-groups in Vietnam

Food commodities	2012					2014					2016				
	Poor	Lower-middle	Middle	Upper-middle	Rich	Poor	Lower-middle	Middle	Upper-middle	Rich	Poor	Lower-middle	Middle	Upper-middle	Rich
Rural															
Rice	0.381	0.301	0.242	0.197	0.104	0.342	0.247	0.213	0.159	0.027[a]	0.257	0.138	0.083	0.006[a]	-0.107
Other cereals	0.658	0.687	0.703	0.719	0.742	0.668	0.696	0.698	0.714	0.750	0.668	0.694	0.701	0.712	0.747
Fish	1.348	1.383	1.397	1.402	1.412	1.330	1.366	1.376	1.390	1.401	1.326	1.354	1.363	1.371	1.389
Meat and eggs	1.587	1.500	1.452	1.430	1.388	1.570	1.481	1.452	1.415	1.371	1.515	1.447	1.418	1.391	1.352
Fruits and vegetables	1.472	1.457	1.448	1.433	1.419	1.448	1.426	1.426	1.421	1.402	1.418	1.401	1.395	1.384	1.382
Edible oil	0.547	0.508	0.483	0.471	0.428	0.518	0.471	0.453	0.436	0.403	0.495	0.446	0.435	0.407	0.398
Beverages	1.605	1.619	1.625	1.631	1.634	1.574	1.590	1.604	1.617	1.615	1.554	1.565	1.567	1.575	1.590
Miscellaneous	1.228	1.200	1.191	1.186	1.174	1.217	1.197	1.189	1.186	1.174	1.201	1.181	1.178	1.172	1.169
Urban															
Rice	0.241	0.204	0.145	0.066	-0.114	0.200	0.127	0.042[a]	-0.028	-0.239	0.117	-0.011[a]	-0.135	-0.219	-0.560
Other cereals	0.647	0.631	0.638	0.646	0.667	0.629	0.636	0.641	0.645	0.670	0.617	0.630	0.641	0.643	0.667
Fish	1.304	1.300	1.306	1.317	1.325	1.266	1.286	1.293	1.301	1.314	1.253	1.277	1.288	1.288	1.304
Meat and eggs	1.561	1.550	1.505	1.465	1.411	1.592	1.516	1.480	1.448	1.399	1.544	1.484	1.444	1.425	1.373
Fruits and vegetables	1.347	1.344	1.339	1.331	1.317	1.327	1.331	1.322	1.318	1.302	1.319	1.311	1.307	1.303	1.291
Edible oil	0.495	0.459	0.444	0.412	0.337	0.441	0.423	0.391	0.366	0.299	0.441	0.377	0.370	0.339	0.262
Beverages	1.549	1.555	1.570	1.586	1.599	1.506	1.536	1.547	1.553	1.581	1.486	1.508	1.518	1.537	1.552
Miscellaneous	1.210	1.191	1.186	1.177	1.166	1.199	1.187	1.178	1.176	1.163	1.194	1.178	1.171	1.165	1.154

Notes: Income levels for poor, lower–middle–, middle–, upper–middle–income, and rich are defined as: VND 10,000 and below, VND 10,001–17,999, VND 18,000–27,000, VND 27001–50,000, and VND 50,000 and above, respectively.

All elasticities are statistically significant, except the elasticities are labeled with [a].

Table 9a. Estimated own and cross price elasticities for food items consumed at home by all households (2012-2016)

	Rice	Other cereals	Fish	Meats and eggs	Fruits and vegetables	Edible oil	Beverages	Miscellaneous
Uncompensated								
Rice	-0.131***	0.033***	-0.059***	0.028***	-0.015***	0.019*	0.007**	-0.029***
	(0.017)	(0.005)	(0.007)	(0.005)	(0.004)	(0.009)	(0.002)	(0.005)
Other cereals	0.157***	-0.726***	0.109***	-0.060***	-0.081***	0.010	0.002	-0.099***
	(0.034)	(0.010)	(0.015)	(0.010)	(0.008)	(0.020)	(0.005)	(0.012)
Fish	-0.404***	-0.001	-0.787***	-0.101***	0.017**	-0.038**	-0.014***	-0.011
	(0.024)	(0.007)	(0.011)	(0.007)	(0.006)	(0.014)	(0.003)	(0.009)
Meat and eggs	-0.315***	-0.030***	-0.101***	-0.821***	-0.056***	-0.034**	-0.017***	-0.080***
	(0.017)	(0.005)	(0.008)	(0.006)	(0.004)	(0.010)	(0.002)	(0.006)
Fruits and vegetables	-0.375***	-0.048***	0.029**	-0.131***	-0.725***	-0.058***	-0.008**	-0.066***
	(0.020)	(0.006)	(0.009)	(0.006)	(0.005)	(0.012)	(0.003)	(0.007)
Edible oil	0.073***	0.016*	-0.037***	0.008	-0.064***	-0.326***	0.001	-0.096***
	(0.022)	(0.007)	(0.010)	(0.006)	(0.005)	(0.013)	(0.003)	(0.008)
Beverages	-0.352***	-0.025**	-0.082***	-0.087***	-0.027***	-0.038*	-0.915***	-0.046***
	(0.030)	(0.009)	(0.013)	(0.009)	(0.007)	(0.017)	(0.004)	(0.011)
Miscellaneous	-0.347***	-0.041***	0.010	-0.107***	-0.035***	-0.056***	-0.002	-0.605***
	(0.018)	(0.006)	(0.008)	(0.005)	(0.005)	(0.011)	(0.003)	(0.006)
Compensated								
Rice	-0.091***	0.037***	-0.032***	0.062***	-0.002	0.024**	0.016***	-0.013**
	(0.013)	(0.005)	(0.007)	(0.005)	(0.004)	(0.009)	(0.003)	(0.005)
Other cereals	0.340***	-0.705***	0.234***	0.098***	-0.022**	0.033	0.046***	-0.025*
	(0.027)	(0.010)	(0.014)	(0.011)	(0.009)	(0.019)	(0.006)	(0.011)
Fish	-0.047*	0.038***	-0.544***	0.206***	0.133***	0.008	0.073***	0.134***
	(0.019)	(0.007)	(0.010)	(0.008)	(0.006)	(0.014)	(0.004)	(0.008)

Meat and eggs	0.072***	0.013*	0.163***	-0.488***	0.070***	0.016	0.077***	0.078***
	(0.014)	(0.005)	(0.007)	(0.006)	(0.004)	(0.010)	(0.003)	(0.006)
Fruits and vegetables	-0.007	-0.007	0.280***	0.185***	-0.605***	-0.011	0.082***	0.084***
	(0.016)	(0.006)	(0.008)	(0.007)	(0.005)	(0.012)	(0.003)	(0.007)
Edible oil	0.186***	0.029***	0.041***	0.105***	-0.028***	-0.312***	0.029***	-0.050***
	(0.017)	(0.007)	(0.009)	(0.007)	(0.006)	(0.013)	(0.004)	(0.007)
Beverages	0.067**	0.021*	0.203***	0.273***	0.109***	0.015	-0.813***	0.125***
	(0.024)	(0.009)	(0.012)	(0.010)	(0.008)	(0.017)	(0.005)	(0.010)
Miscellaneous	-0.032*	-0.007	0.225***	0.164***	0.067***	-0.016	0.075***	-0.476***
	(0.014)	(0.006)	(0.008)	(0.006)	(0.005)	(0.011)	(0.003)	(0.005)

Notes: Standard errors in parentheses. *,**, and *** denote statistical significant levels at 10, 5, and 1 percent, respectively.

Table 9c. Estimated own and cross price elasticities for food items consumed at home by urban households (2012-2016)

	Rice	Other cereals	Fish	Meats and eggs	Fruits and vegetables	Edible oil	Beverages	Miscellaneous
Uncompensated								
Rice	0.019	0.039***	-0.049***	0.048***	0.002	0.018	0.012***	-0.026***
	(0.020)	(0.006)	(0.009)	(0.006)	(0.005)	(0.011)	(0.003)	(0.007)
Other cereals	0.149***	-0.708***	0.127***	-0.055***	-0.078***	0.009	0.004	-0.100***
	(0.034)	(0.011)	(0.017)	(0.011)	(0.009)	(0.021)	(0.005)	(0.013)
Fish	-0.340***	-0.000	-0.815***	-0.093***	0.010	-0.032*	-0.013***	-0.012
	(0.020)	(0.007)	(0.011)	(0.007)	(0.006)	(0.013)	(0.003)	(0.008)
Meat and eggs	-0.277***	-0.028***	-0.109***	-0.837***	-0.063***	-0.031**	-0.018***	-0.082***
	(0.016)	(0.005)	(0.008)	(0.006)	(0.004)	(0.010)	(0.002)	(0.006)
Fruits and vegetables	-0.287***	-0.039***	0.017*	-0.111***	-0.779***	-0.046***	-0.007**	-0.057***
	(0.016)	(0.005)	(0.008)	(0.005)	(0.005)	(0.010)	(0.002)	(0.006)
Edible oil	0.040	0.017*	-0.025*	0.018*	-0.060***	-0.238***	0.003	-0.102***

	(0.023)	(0.007)	(0.012)	(0.008)	(0.006)	(0.016)	(0.003)	(0.009)
Beverages	-0.304***	-0.023**	-0.092***	-0.089***	-0.036***	-0.034*	-0.918***	-0.049***
	(0.027)	(0.009)	(0.014)	(0.009)	(0.007)	(0.017)	(0.004)	(0.011)
Miscellaneous	-0.308***	-0.038***	0.005	-0.101***	-0.036***	-0.050***	-0.002	-0.639***
	(0.016)	(0.005)	(0.008)	(0.005)	(0.004)	(0.010)	(0.002)	(0.006)
Compensated								
Rice	0.005	0.037***	-0.062***	0.034***	-0.005	0.016	0.008*	-0.033***
	(0.016)	(0.006)	(0.008)	(0.006)	(0.005)	(0.011)	(0.003)	(0.006)
Other cereals	0.287***	-0.690***	0.259***	0.101***	-0.010	0.029	0.047***	-0.023*
	(0.028)	(0.011)	(0.015)	(0.012)	(0.009)	(0.020)	(0.006)	(0.012)
Fish	-0.065***	0.035***	-0.553***	0.216***	0.146***	0.007	0.072***	0.141***
	(0.017)	(0.007)	(0.009)	(0.007)	(0.005)	(0.013)	(0.004)	(0.007)
Meat and eggs	0.030*	0.012*	0.184***	-0.492***	0.088***	0.013	0.077***	0.088***
	(0.013)	(0.005)	(0.007)	(0.005)	(0.004)	(0.010)	(0.003)	(0.006)
Fruits and vegetables	-0.010	-0.003	0.282***	0.201***	-0.642***	-0.007	0.080***	0.098***
	(0.013)	(0.005)	(0.007)	(0.006)	(0.004)	(0.010)	(0.003)	(0.006)
Edible oil	0.114***	0.027***	0.045***	0.101***	-0.023***	-0.228***	0.026***	-0.061***
	(0.019)	(0.007)	(0.010)	(0.008)	(0.006)	(0.015)	(0.004)	(0.008)
Beverages	0.024	0.019*	0.221***	0.279***	0.126***	0.012	-0.816***	0.134***
	(0.023)	(0.009)	(0.012)	(0.010)	(0.007)	(0.017)	(0.005)	(0.010)
Miscellaneous	-0.060***	-0.005	0.242***	0.178***	0.087***	-0.015	0.075***	-0.501***
	(0.013)	(0.005)	(0.007)	(0.005)	(0.004)	(0.010)	(0.003)	(0.005)

Notes: Standard errors in parentheses. *,**, and *** denote statistical significant levels at 10, 5, and 1 percent, respectively.

Table 9b. Estimated own and cross price elasticities for food items consumed at home by rural households (2012-2016)

	Rice	Other cereals	Fish	Meats and eggs	Fruits and vegetables	Edible oil	Beverages	Miscellaneous
Uncompensated								
Rice	-0.177***	0.031***	-0.062***	0.021***	-0.020***	0.019*	0.005*	-0.030***
	(0.016)	(0.004)	(0.006)	(0.004)	(0.004)	(0.008)	(0.002)	(0.005)
Other cereals	0.159***	-0.732***	0.103***	-0.061***	-0.082***	0.010	0.001	-0.099***
	(0.034)	(0.010)	(0.015)	(0.009)	(0.008)	(0.019)	(0.004)	(0.011)
Fish	-0.436***	-0.002	-0.773***	-0.105***	0.021***	-0.041**	-0.015***	-0.011
	(0.026)	(0.008)	(0.012)	(0.007)	(0.006)	(0.015)	(0.004)	(0.009)
Meat and eggs	-0.332***	-0.031***	-0.098***	-0.814***	-0.053***	-0.035***	-0.016***	-0.079***
	(0.018)	(0.005)	(0.008)	(0.006)	(0.004)	(0.011)	(0.002)	(0.006)
Fruits and vegetables	-0.422***	-0.053***	0.036***	-0.141***	-0.695***	-0.064***	-0.008*	-0.070***
	(0.023)	(0.007)	(0.010)	(0.007)	(0.006)	(0.013)	(0.003)	(0.008)
Edible oil	0.084***	0.016*	-0.040***	0.004	-0.066***	-0.357***	0.000	-0.094***
	(0.022)	(0.006)	(0.009)	(0.006)	(0.005)	(0.013)	(0.003)	(0.007)
Beverages	-0.373***	-0.026**	-0.078***	-0.086***	-0.023**	-0.040*	-0.914***	-0.044***
	(0.031)	(0.009)	(0.013)	(0.009)	(0.007)	(0.018)	(0.004)	(0.011)
Miscellaneous	-0.365***	-0.043***	0.012	-0.109***	-0.035***	-0.058***	-0.002	-0.588***
	(0.020)	(0.006)	(0.009)	(0.005)	(0.005)	(0.011)	(0.003)	(0.006)
Compensated								
Rice	-0.116***	0.038***	-0.025***	0.069***	-0.004	0.026**	0.019***	-0.008
	(0.012)	(0.004)	(0.006)	(0.005)	(0.004)	(0.008)	(0.002)	(0.005)
Other cereals	0.362***	-0.711***	0.224***	0.097***	-0.027**	0.035	0.046***	-0.026*
	(0.026)	(0.010)	(0.013)	(0.011)	(0.008)	(0.019)	(0.005)	(0.011)
Fish	-0.042*	0.039***	-0.538***	0.201***	0.128***	0.008	0.073***	0.132***
	(0.020)	(0.008)	(0.011)	(0.008)	(0.006)	(0.015)	(0.004)	(0.008)

Meat and eggs	0.089***	0.013*	0.154***	-0.486***	0.062***	0.017	0.077***	0.073***
	(0.014)	(0.005)	(0.008)	(0.006)	(0.005)	(0.010)	(0.003)	(0.006)
Fruits and vegetables	-0.013	-0.010	0.281***	0.178***	-0.583***	-0.014	0.083***	0.078***
	(0.018)	(0.007)	(0.009)	(0.008)	(0.006)	(0.013)	(0.004)	(0.007)
Edible oil	0.215***	0.030***	0.038***	0.106***	-0.030***	-0.341***	0.029***	-0.047***
	(0.016)	(0.006)	(0.009)	(0.007)	(0.005)	(0.012)	(0.003)	(0.007)
Beverages	0.085***	0.021*	0.196***	0.270***	0.102***	0.016	-0.812***	0.121***
	(0.024)	(0.009)	(0.012)	(0.010)	(0.008)	(0.017)	(0.005)	(0.010)
Miscellaneous	-0.022	-0.007	0.218***	0.158***	0.059***	-0.016	0.075***	-0.464***
	(0.015)	(0.006)	(0.008)	(0.006)	(0.005)	(0.011)	(0.003)	(0.006)

Notes: Standard errors in parentheses. *,**, and *** denote statistical significant levels at 10, 5, and 1 percent, respectively.

Opportunities and Challenges in the Existing Food Systems

3.1. The Red River Delta (RRD) region

The food items we studied for the Red River Delta (RRD) region were rice, potato, maize and vegetables. According to the data gathered through the 7 FGDs conducted in Thai Binh and Bac Ninh provinces, three main crops of the region are rice, potato and maize (table 10). Farmers shared that they usually follow the prescription provided by the Department of Agriculture's office at district level for the list of crops suitable to grow in each district. They cannot freely shift to a new crop without the suggestion of the Department of Agriculture. Farmers can change or choose a new variety for better production more easily then changing to a new crop. There is a people's committee[6] appointed by the government for every province, which takes the decisions on all the schemes of crop production for a particular season.

The FGD results in the region, showed that the farmers have been receiving low price for rice and potato and hence are not interested to increase the area under these crops. They want to increase the area under vegetable production, but the challenge is about selling the vegetables in the shortest possible time from the farm gate, as they do not have access to any cold storage or preserving facility. Irrigated rice is the dominant crop in the RRD region with two main seasons: a winter crop typically planted during January-February, and a spring crop planted in late-June or July (Figure 13, Seasonal Calendar). Other than rice they practice three seasons of maize, two seasons of potato and four seasons of vegetables. A small number of farmers also grow one season of sweet potatoes and bananas.

[6] Decision No. 1092/QĐ-UBND about the scheme on crop production in the Spring – summer season and winter-spring season crop of 2018 in Thai Binh province;
https://thuvienphapluat.vn/van-ban/Linh-vuc-khac/Quyet-dinh-1092-QD-UBND-2018-de-an-san-xuat-vu-mua-vu-dong-Thai-Binh-389493.aspx
Decision No: 2654/QĐ-UBND about the scheme of spring season and winter season in 2018;
https://thuvienphapluat.vn/van-ban/Linh-vuc-khac/Quyet-dinh-2654-QD-UBND-2017-De-an-san-xuat-vu-Xuan-vu-He-Thai-Binh-366687.aspx

Table 10: Production Priorities of RRD Region

Thai Binh And Bac Ninh Province				
Rank	Name	Reason for preference	Variety	Challenges
1	Rice	"Security Crop", most important staple Production can be done for 2 seasons in 1 year Farmers keep rice for family consumption and sale in the market	BC 15 Bac Thom T 10	Cost of inputs are high Erratic rains High cost of farm machinery
2	Potato	Additional Income	Maraben – variety from Germany Sohara – variety from Netherlands Bennazola -variety from Germany	Untimely rains during or after harvest Humidity can create more pest and diseases Lack of cold storage to save seeds
3	Maize	Additional Income	HN 88 NK 4300	Cost of inputs are high

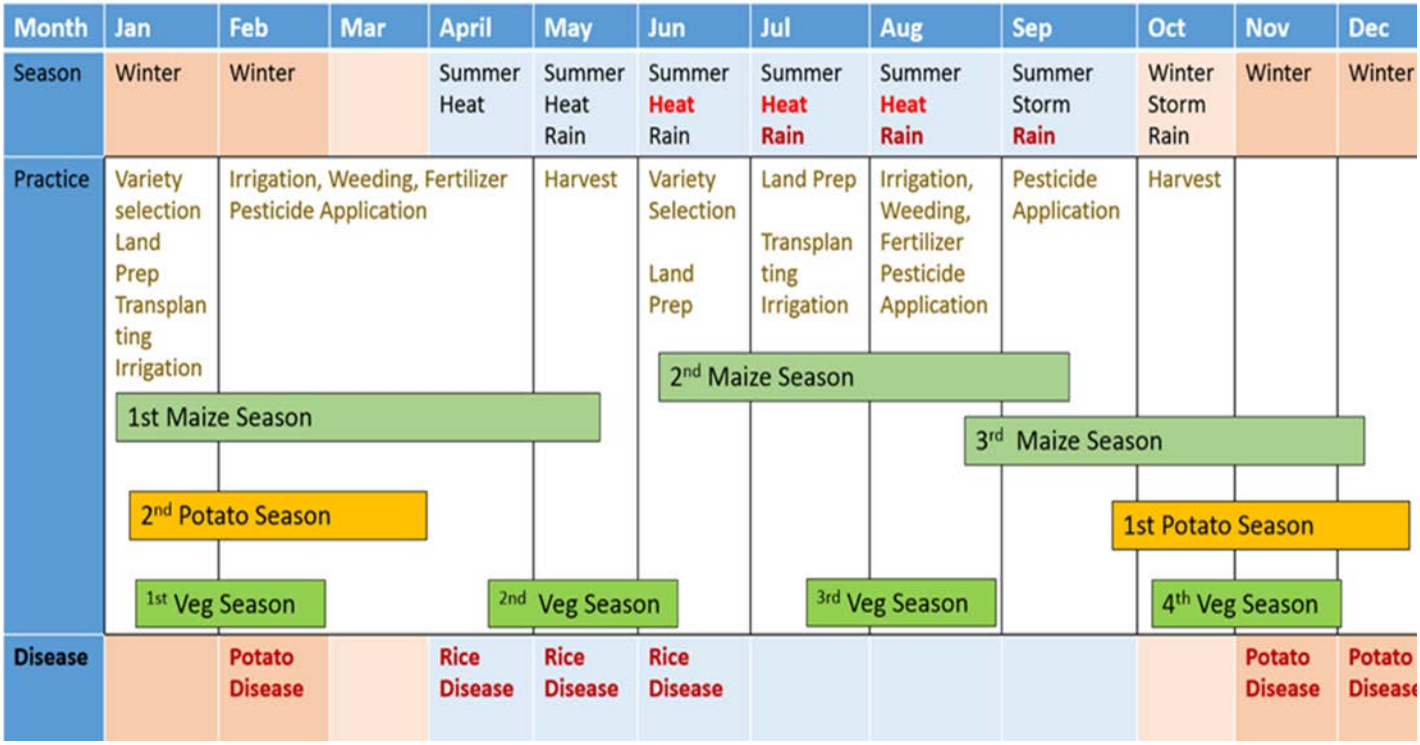


Figure 13: Seasonal Calendar, RRD Region

3.1.1. Irrigation and Water Availability

This region has sufficient water resources, with an irrigation system connected to the Red River and the Thai Binh River. The farmers here use pumps to irrigate their fields through concrete canal system connected to the river. The communes (villages) have common electric pumps to irrigate water from rivers. Farmers also use rainwater for paddy cultivation. Farmers have built both concrete canal lining and soil canal lining in this region. The cooperatives in the region also own electric hydraulic pumps that provide sufficient water for the member farmer, also each commune (village) have two electric pump stations. 30% household in the communes have small gas pumps, used for irrigation of their fields. Overall water accessibility is well planned for the farmers of RRD region and it is not difficult for the farmers to assess water.

3.1.2. Climate and its impact on the region

The FGD data reveals that climate is getting warmer and hence it is getting difficult for farmers to grow crops like Potatoe in winter. In the recent years on-setting of winter has been delayed compared with previous years. Farmers also feel that because of changing climate the incidence of pest and disease in potato and rice, has increased and hence farmers need to buy more pesticides and spent more time on spraying. They said, they do not like to put pesticide in their crops but when in a particular year the rains are heavy and more than normal, there is always outbreak of disease and that is when farmers apply a lot of pesticides. Also, they shared that the incidence of drought has increased in the dry season (November-February, Figure 13). This affects the production of maize, potato and vegetable. In order to avoid the climate induced challenges such as drought and storm, with suggestion from the agriculture office, farmers have changed the varieties of rice from long duration to short duration. The months June and July are warmer than before (in comparison to what it used to be 10/15 years before) which is followed by heavy storms in August and September (Figure 13). Heavy rains are one of the biggest climatic challenges in the RRD region. Heavy rains during paddy harvest months in May and October can cause large losses.

3.1.3. Rice in RRD

Irrigated rice is the dominant crop in the RRD region with two main seasons: a winter crop typically planted during January-February or Vu Xuan Season, and a spring crop planted in late-June or July or Vu Mua season (Figure 13, Seasonal Calendar and Table 11). The average yield

of Vu Mua season (spring crop) is less than Vu Xuan Season (winter crop) because the duration of Vu Mua season is short and paddy gets harvested in short time span.

TABLE 11: RICE SEASONS IN RED RIVER DELTA REGION

No.	Name of season	Start	End	Average yield (Tons)
1	Vu Xuan Season (winter)	January	June	7 ta/ha
2	Vu Mua Season (spring)	June	October	6 ta/ha

TABLE 12: VARIETAL PREFERENCE FOR RICE IN RRD

Season	Preferred varieties	Properties
Vu Xuan (winter) season	BC 15 (80 % farmers opt to grow this variety)	Plant height is about 110 - 115 cm; well adaption to pest such as brown plant hopper, average productivity is about 7 to 7.5 ton/ha, maximum 9 to 10 ton/ha. High yield, high quality of rice, good taste and good market demand for sale
	T 10	It is a 130 to 135 days variety. The average productivity is about 5.5 to 6 ton/ha, maximum to 7 - 7.5 ton/ha. The variety adapts very well to drought and cold temperature. HIGH QUALITY OF RICE, GOOD TASTE, GOOD SMELL, NOT TOO SOFT WHEN COOKED.
	Bac Thom	The height of Bac Thom Rice is from 90 - 95 cm. The rice grain is small and yellow color. The length of grain is about 5.86 mm. The productivity is in-between 4 to 4.5 ton/ha. The maximum 5 ton/ha. Adaption to cold or very cold weather is low
	Sticky Rice	Local cuisine and food preference requirement
Vu Mua season (spring crop)	BC 15 (80 % farmers opt to grow this variety)	Plant height is about 110 - 115 cm; adapts well to pest such as brown plant hopper, average productivity is about 7 to 7.5 ton/ha, maximum 9 to 10 ton/ha. High yield, high quality of rice, good taste and good market demand for sale
	TBR225 (Another very popular rice variety for spring crop)	This is a short duration spring crop of 105 - 110 days. Plant height 110 - 115 cm, with healthy and strong stems. Resistant to infection of blast and blight. The average yield of 7 to 8 ton / ha. High percentage of milled rice (72-74%); Good quality rice, white rice, clear rice, soft rice, bold taste, characteristic aroma.
	Sticky Rice	Local cuisine and food preference requirement

The Department of Agriculture recommends planting high-quality rice varieties for the region: Bac Thom 7, T10, RVT, N97, sticky rice varieties, Japanese rice, BC15, TBR1, TBR225, Thien uu 8. Out of this entire list, the most popular variety in the region is BC15, due to its high yields (Table 12). Farmers follow the suggestion of the district agriculture officer in choosing which

variety to grow and they buy the seeds from private seed company or from the cooperative. The most popular and known seed company in the RRD region is “Thai Binh Seed”. Cooperatives usually organize a meeting with farmers to tell farmers about the price and help the farmer to decide, if they want to buy from the cooperative. The cooperative then approaches the seed companies to buy seeds, which they then resell to farmers.

Transplanting in the region is mainly done by method of sowing and hand transplanting. A very small number of farmers practice mechanical transplanting using machines. Farmers use machines mainly for soil preparation and harvesting (Table 13). Farmers buy input supplies from the shops in commune (village) or from the cooperative (Table14).

Table 13: RICE FARMER CATEGORISATION

Farmer scale	Average Land Size	Machines Used	Tools used	Fertilizers and chemicals used	Labor type used
Large-scale farmers	2.500 m2	For soil preparation and harvesting (Cost for soil preparation is 150.000 VND/360m2) Most of large scale farmers have their own machines	Transportation motorbike. Tools: hoe, sickle, shovel	NPK Farmers apply fertilizers twice in one rice season	Both family labor and hired labor Hired labor is used for soil preparation
Medium-scale farmers	1.500 m2	For soil preparation and harvesting (Cost for soil preparation is 150.000 VND/360m2)	Transportation motorbike. Tools: hoe, sickle, shovel	NPK Farmers apply fertilizers twice in one rice season	Both family labor and hired labor Hired labor is used for soil preparation
Small-scale farmers	360 m2	For soil preparation and harvesting (Cost for soil preparation is 150.000 VND/360m2)	Transportation motorbike. Tools: hoe, sickle, shovel	NPK Farmers apply fertilizers twice in one rice season	Both family labor and hired labor Hired labor is used for soil preparation

TABLE 14: INPUTS USED IN RICE FARMING AND ITS SOURCE

Inputs	Source
Seed	Seed company and /or Farmers’ cooperative

Fertilizer Herbicide Pesticide	1. Cooperative buys from company and then resell to farmers 2. Farmers buy from input supply shops in the commune
Manure	Gathered from the commune or self-kept animals
Agricultural working tools	Farmers buy from the market
Machine	Hire from service provider
Labor	Hired labor and family labor

Rice farmers in the RRD region, apply chemicals/pesticides/ herbicides to cope or prevent from pest and disease either on the suggestion of the agriculture officer of the commune (village) or on the suggestion of the cooperative or on their own instinct and experience. The results from the FGDs show that every rice cropping season the farmers apply two rounds of insecticides and molluscicides and one round of herbicides and fungicide. For preventing rice crops from rodent damage, the cooperatives have trained people for hunting rodents in the field. Farmers in the RRD usually perform certain post-harvest activities like drying and storage before selling off their harvested paddy at a satisfactory price.

Climatic challenges like, storms, heavy rain and high temperature in the summer affects the rice crop at all stages from sowing to harvest in this region.

3.1.4. Potato in RRD

Table 15: Potato Season

No.	Name of season	Start	End	Average yield (Tons)
1	Vu Dong	October	January (Next year)	15 -16 tons/ha
2	Vu Xuan	December	March (Next year)	

The two main potato varieties grown across the region are Sorala and Maraben from Germany. Most of the potato production is for sale and a very small amount is kept for family consumption (Table 17). Around 30% gets damaged or broken, after harvest, which the farmers are unable to

sell or store for seed of next season, farmers use these broken or damaged potatoes as livestock feed, mainly for pigs.

Table 16: Potato Varieties Grown in RRD

Main Varieties	Why	% of this variety in total potato production
Sorala from Germany	High productivity Less pest and disease issues Easy to keep seed potatoes for next season	70 -80 %
Maraben from Germany	High productivity Difficult to keep seed potatoes for next season due to high proportion of water in the potatoes	20- 30%
Mac Ki and Sorogon from Netherlands	Big potato size, high productivity but long duration cycle, it takes more time for harvesting, and the skin of potato is not attractive to sell.	Very few
Bennazola from Germany	Short duration variety of about 70 days	Very few

Table 17: Potato Usage

Purposes	Percentage
Livestock feed (Pigs)	30% (damaged after harvest)
Seed potatoes for next season	15%
Selling	65%
Home consumption	5%

Unlike rice farmers, the potato farmers cannot choose themselves which potato variety to grow. They need to follow the instruction of Department of Crop Protection. Department of Agriculture and Rural development will select certain varieties of potato and conduct trials to check the adaption, quality of the potato and the productivity. Once they are satisfied, they introduce the variety in the district offices and they disseminate the information to the farmers. Farmers buy seed potatoes from the Department of Agriculture and not from the market. They can get better

prices if they buy seed potatoes from the department of agriculture as a policy to support for farmers.

Table 18: Inputs for Potato Production

Inputs	Source
Water/Irrigation	River and rain. The commune will irrigate water from river when it is drought.
Seed	Farmers save own seed and also buy from the Department of Agriculture
Fungicides	Input supply shops in the commune
Fertilizer	Input supply shops in the commune or cooperative
Pesticide	Input supply shops in the commune
Manure	Gathered from the commune or self-kept animals
Labor	Both family labur and hired labor (Hired labor for soil preparation and harvesting)
Working tools	Farmers buy from input supplies shops in the communes and district markets.

The potato farmers in the RRD region apply two rounds of fertilizer, three rounds of fungicide and one round of pesticide in one potato season for better yields (Table 19). The farmers use fertilizer from the 'Dau Trau' fertilizer company and 'Lam Thao' fertilizer company along with animal manure. The potato crop is vulnerable to various pests and disease, especially pest and disease under the soil. Pest eat the potato plant when the plant is still small 7-10 cm. Weed is another problem faced by the potato farmers. Farmers have to spray herbicides for weed treatment or pull out weed manually using hands. Heavy and untimely rains are a big problem in potato production, especially after harvesting. Humidity results in more pest and disease attack. Farmers have very short post-harvest engagement. They lay the potatoes outside, in the sun for a few hours after harvesting and prefer to sell immediately, from the field/farm itself (around 70% is always sold immediately at the field) as they do not have cold storage for keeping potatoes at home. They take back home around 30% of the little potatoes harvested. They just lay them on the floor of the house and cover them by some black plastic to keep them protected. The communes (villages) usually have 2 to 3 cold storages for storing seed potatoes for the next season. The farmers can access them for a fee of 3000 VND/kg. Certain cooperatives also have

cold storages for keeping potatoes. The capacity of each cold storage is about 40 ton/cold storage.

Table 19: Input Application for Potato

Type	Frequency of application	Source
Pesticide	1 time/season	input supplies shops
Fungicide	3 times/ season	input supplies shops
Fertilizer	2 times/season	input supplies shops

3.1.4. Maize in RRD

The farmers in RRD region grow maize both to sell for additional income and as feed for livestock. Maize have large, high quality biomass for animal feed. But these days' famers are shifting to vegetable production and the area under maize cultivation is slowly under decline as the income from vegetables is higher. Maize can be grown all-round the year over three seasons. But farmers mainly do maize over two seasons. The first season is from beginning of January to end of May and the second season is from beginning of June to end of August. Farmers buy maize seeds from commune input supply shops. The Department of Agriculture prefers that the farmers use high yield F1 hybrid maize varieties and expand the cultivation area under food corn and fresh corn varieties: sticky corn, high-yield sugar corn. The two most popular maize varieties amongst the farmers are HN88 and NK 4300. Both the varieties are hybrids and are input intensive. HN 88 requires seven to ten times of pesticide application and NK 4300 requires three to four times of pesticide application (Table 20). Farmers sell a good quality production of HN88 at about 15,000 vnd/kg and a low quality production with pest affect at about 5,000 vnd/kg. Farmers sell HN88 maize variety, immediately after harvesting at the farm gate. But the NK4300 variety is brought back home for drying, shelling and then selling.

Table 20: Maize Variety Details

Name variety	Description	Number of fertilizer application
HN 88 maize variety	This is the short duration hybrid glutinous corn with high yield, which remains soft after cooking, good taste and aromatic. Strong maturity; good resistance to : pests, drought and low temperatures	7-10 times
NK 4300	Syngenta hybrid yellow corn	3-4 times

3.2. The Mekong River Delta (MRD) region

The food items we studied for the Mekong River Delta (MRD) region were rice, shrimp, mango and vegetables. According to the data gathered through the seven FGDs conducted in Tra Vinh and Bac Lieu provinces, three main crops of the region are rice, aquaculture, fruit trees and vegetables (Table 21). The government has been trying to motivate the farmers of this region to follow good agricultural practices (through Viet Gap) in this region. The Mekong river basin has a diverse ecosystem because of which some areas are conducive to high yields and others are limited by poor soil and water availability in the dry season. The department of agriculture wants the farmers to convert low quality paddy land to grow fruit trees. Over 10 million hectares of cultivated land is dedicated to rice production in this region. Rice is the most important crop in MRD region. Except in areas unprotected from the annual Mekong flood, 3 rice crops per year is common. The first season starts in April and ends in mid-August. The next season starts in end of August and ends in November and the third season starts in December and ends in March. Farmers shared in the FGDs that paddy fields are just not a key source of subsistence food, but also serve many other functions such as flood mitigation, soil erosion control, and fishery production. Other than rice they practice three seasons of aquaculture (mainly shrimp), three harvest of fruits like mango/dragon fruit/coconut/water melon and four seasons of vegetables. The irrigation system in the Mekong region can provide enough water for crops, but during the dry season when salinization occurs, the commune have to close the gate of water channel and the farmers cannot access fresh water for their crops.

Table 21: Production Priorities MRD

Tra Vinh And Bac Lieu Province				
Rank	Name Of Crop	Reason for preference	Variety	Challenges
1	Rice	"Security Crop", most important staple Production can be done for 3 season in 1 year Farmers keep rice for family consumption and also sell in the market	OM 5451 ML 202 Nang Hoa 9 Dai Thom 8	Cost of inputs are high Drought and Salinity

2	Shrimp	Additional Income Production can be done for 3 season in 1 year	Tiger shrimps White-legged shrimp	High cost for seed shrimp variety Low quality of Aquatic medicines Untimely Rains
3	Fruits	Good additional Inco Coconuts require less input supplies. Coconut can be harvested and sold every month Mangoes also can be harvested 3 times in a year	Chau Nghe – local variety	Heavy rains spoils mango yields. All production will be lost if there is excess and heavy rains specially during the flower blooming season
4	Vegetable	Additional Income Veg. production can be done for 4 season in 1 year	Type: Pumpkin, Zucchini, Bitter gourd and Leafy greens	Cost of inputs are high Difficult to market when the price from collector is low

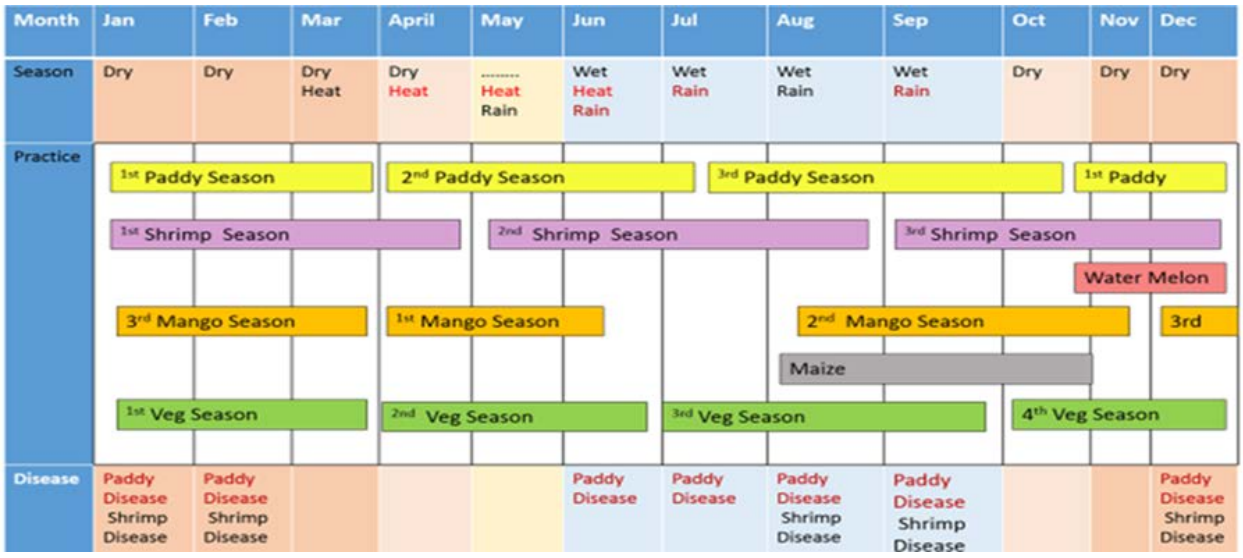


FIGURE 14: SEASONAL CALENDER, MRD REGION

3.2.1 Rice in MRD

Rice is the dominant crop in the MRD region with three main seasons: a winter-spring season, planted between October to March, a summer-autumn season, planted between April to July and an autumn-winter season, planted between July to October (Figure 14, and Table 22). The winter-spring crop is the best, with yields exceeding an average of 7.2 tons/hectare in all three provinces.

Table 22: Rice Seasons in MRD Region

No.	Name of Season	Start (Date)	End (Date)	Average yield (tons)
1	Winter – Spring	October	March	6.9 ton/ha to 7.2ton/ha
2	Summer – Autumn	April	July	5.5 ton/ha
3	Autumn – Winter	July	October	4.5 ton/ha

The Department of Agriculture includes the following varieties as high quality rice varieties for the region: OM 5451, ML 202, OM 6976, OM2517, Jasmine 85, GKG1 etc. Out of this entire list, the most popular variety in the region is OM5451, as it adapts well to both drought and salinization. Farmers follow the suggestion of the district agriculture officer on choosing which variety to grow and they buy the seeds from private seed company or from the cooperative. Cooperative, usually organizes a meeting with farmers to tell farmers about the price and help the farmer to decide, if they want to buy from the cooperative. The cooperative then goes to the seed companies to buy seeds, which they then resell to the farmers. The region mostly practices direct seeding both manual and with machine. Farmers use machines for soil preparation and harvesting. Farmers buy input supplies from the shops in commune (village) or from the cooperative. Increasingly intensive cultivation in the region has resulted in greater propensity to pest and disease loss, pollution due to pesticide use, decreasing soil fertility and the impact of chemical pollution in the environment on crop quality. Farmers shared that they apply fertilizer and pesticide from their own experience and by consulting with other farmers in their farmer groups. They apply fertilizers and insecticides three to four times in one season (Table 23). The Vietnamese government has promoted crop intensification to increase rice exports. However, this practice comes at a price. The farmers shared they apply more than 250 kilograms of

fertilizer per hectare and thus Vietnam has one of the highest fertilizer use density among countries in the region. This explains the relatively high rice yield in Vietnam Economic pressure on smallholders has them increasingly choosing to forego crop rotation in order to maximize annual production. Planting rice two to three times per year on the same parcel of land increases the likelihood of pest and disease

Table 23: Inputs Used in the Rice Production

Type	Frequency of application	Source
NPK Chemical fertilizer	3-4 times/season	Farmers buy from input supply shop, the shop can be in the commune or in the district center
Insecticide	3-4 times/season	Farmers buy all these from input supply shops, the shops are located in the commune or in the district center
Rodenticide	Manage this all season using traps	
Molluscicides	1 time/season	
Nematicides:	2 times/season	
Herbicide / Weedicide:	1 time/season	

Water is very important for paddy cultivation but the dry season in Mekong delta brings drought like situation which gets worsened in an El Niño year. With its long coastline and low topography, the MRD region has been facing seawater intrusion. The seawater mainly intrudes into the canals and river systems during the dry season when rainfall and water levels are low (January to May). The saltwater then seeps into the groundwater and the soil destroying agricultural production. Thus the community has to close the gates of the canals during the dry season, which further creates water shortage.

3.2.2 Mango in MRD

Mango is one of the most important fruits grown in South Vietnam. The main mango growing provinces are found in the Mekong delta region, namely Dong Thap, Tien Giang, Khanh Hoa, Dong Nai, Vinh Long and An Giang. Most are small farmers who grow mangoes in mixed fruit orchards. However, there are advanced farmers with mango holdings of up to 10 ha. Hoa Loc, Cat Chu, Chau Nghe are the popular local varieties grown across the region. The income for mango farmers is about 80,000,000 to 90,000,000 VND/year. The mangoes are sold to Tien Giang, Dong Thap and Ho Chi Minh City. They are also transported to North Vietnam and to China. For transporting to North Vietnam and to China, the mangoes will be packed in carton boxes, and transported using cool trucks. The peak of the mango season in Vietnam is April, although the fruit is available throughout the year through floral manipulation techniques using chemicals,

pruning, and water regime control. Mango farmers receive regular trainings from the crop and plant protection department. The biggest challenge for the mango farmers is untimely rain

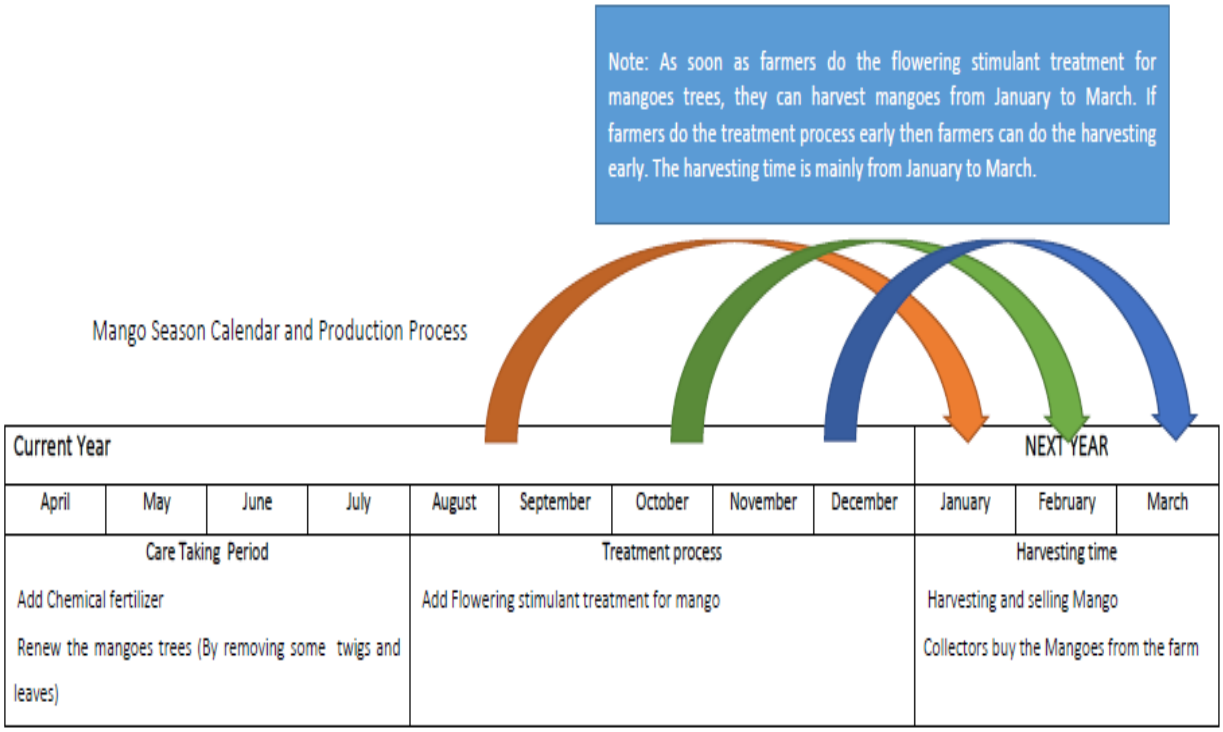


Figure 15: Mango Seasonal Calendar

3.2.3 Shrimp in MRD

Shrimp farming system was introduced in the MDR to manage high salinity during the dry season. When salinity is too high to grow rice, farmers were asked to grow shrimps in MDR. Shrimps are grown in the surrounding ditch and other water compartments on the farm in the dry season when salinity is high, but can be grown during the wet season and also if the shrimp are acclimatized. The farmers in the region mainly grow tiger shrimps and white-legged shrimps (Table 24). The selling price of shrimps is about 150,000 VND to 200,000 VND/kg. If a farmer has a successful season they can have a very good income. Farmers can do four seasons for shrimps every year.

Table 24: Shrimp Species

Main Species	Reason for preference	% of the species
Tiger shrimps	Low cost investment and higher yields and the shrimps are of big size	60%
White-legged shrimp	Easy to grow and farmers can apply high technology for white legged shrimps growing	40%

Farmers of MRD region shared that the price of raw shrimp is not reasonable compared with the export price due to high production cost in Vietnam.

3.3. Challenges for a climate smart food system

3.3.1. Highly intensive cropping system

As seen in the seasonal calendar in the above section (Figure 13 and 14), farmers in both Red River Delta (RRD) and Mekong River Delta (MRD) practice a very intensive cropping system or pattern. For example, farmers in the MRD region practice three seasons of paddy, four seasons of vegetables and three to four seasons of shrimps. The Vietnamese government has promoted crop intensification to increase rice exports. However, this practice comes at a price, Vietnam has the highest fertilizer use density among countries in the region. This explains the relatively high rice yield in Vietnam. Planting rice two to three times per year on the same parcel of land increases the likelihood of pest disease.This kind of cropping system gives no break to the soil to replenish its nutrients naturally. This kind of intensive cropping system with goals of high productivity uses high level of inputs in the form of chemicals, fertilizers, pesticides and growth regulators. FGDs conducted with the farmers reveled that, farmers do not follow any regulated prescription for fertilizer and pesticide application provided by the Department of Crop Protection or Department of Agriculture. With sole intension of increasing yields farmers apply inputs by their own experience, based on what they themselves or fellow farmers consider as the right quantity. Farmers do not have much alertness or interest towards soil conservation practices.

3.3.2. Low Diversification Practices

Most of the farmers we met in our field visits are busy growing a single crop season after season without gap. The practice and promotion of an intensive cropping system leaves very small room for crop rotation, inter-cropping or diversification by individual farmers.The rice farmer is continuously growing rice for three season and the vegetable farmer is continuously growing vegetable for four seasons round the year. Certain farmers do practice multiple crop production but in different designated plots. The area allotted for growing rice is exclusively used only for rice. Economic pressure on smallholders has them increasingly choosing to forego crop rotation in order to maximize annual production. Also government restrictions on land use prevent smallholder farmers from profiting by using the land for other agricultural uses. According to

Decree 69, Articles 6.1 and 10.1, rice farmers must acquire permission from local authorities before diversifying the crops they grow. Decrees 69 have contradictory goals to the needs of promoting crop diversification practices as keeping farmland in rice production will not necessarily improve farmer incomes. Instead, farmers should have the flexibility to choose the most appropriate crops for their parcels of land without governmental interference.Vegetable would be done in some other plots near the homestead. This type of mono intensive cropping on a particular plot may eliminate the natural checks and balances that a diverse ecosystem provides. This inevitably means the use of large quantities of synthetic herbicides, insecticides, bactericides and fertilizers. In attempting to prevent damage to crops by weeds, insects and bacteria; and to provide sufficient nutrients in the soil for the plants to grow and farmers use synthetic chemicals. Not only do these chemicals leave traces on plants that are intended for human consumption and so can enter the food chain, they are also routinely over-used so that a large proportion of the synthetic material remains in the soil, even after the crop has been harvested.

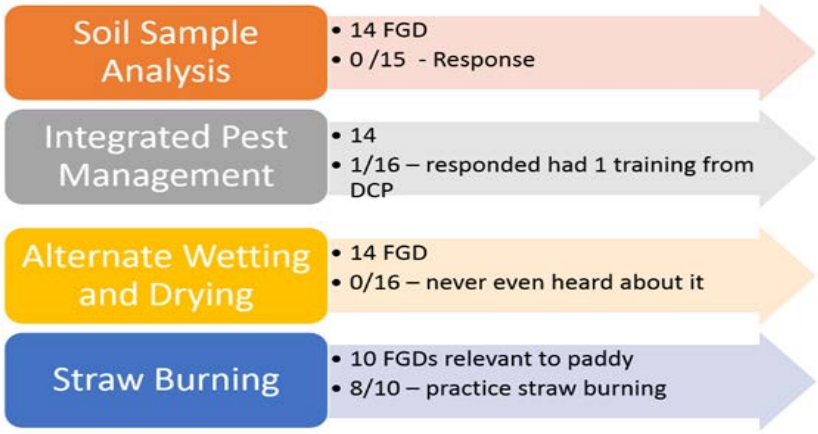
3.3.3. Vertical Integration

A large number of the Vietnamese farmers are small individual scale, operating in small holdings. To address this problem the Vietnamese government has issued several regulations and programs with the end view of improving the value chain by promoting vertical integration under contract farming. This has created an effective value chain model across the country where farmers find an easy access to the market to sell their products for satisfactory prices. But this also means that the contract giving companies decide which variety of a particular crop they would want the farmer to grow for an assured buy back under a mutual contract system. This kind of market driven prescriptive agriculture restricts varietal replacement and adoption suggested by any other agriculture expertise. For example: it would be difficult for a CGIAR research group to promote or replace a stress tolerant rice or maize variety in a community, unless it comes as requirement by a company under a buy back commitment. In such contract farming scenarios farmers also seek input application suggestions and prescriptions from the company assigned extension official working in the commune. Sometimes the companies also act as a input dealer/provider, using the same contract farmers to sell their own fertilizers and pest control chemicals. The input supplies are high cost and some farmers cannot afford to pay

immediately, so under a vertically integrated contract system, they adjust it against their payment by the company after harvest.

3.3.4. Low CSA Awareness

Vietnamese agriculture's potential vulnerability to climate change risks such as shifting rainfall patterns and temperature, and sea level rise, together with the fundamental uncertainty that is intrinsic to climate change, suggest that it is very important to create awareness towards climate smart agriculture practices. The agriculture sector needs to cultivate resilience by strengthening capacity for innovation at every level of society. Improved water resources management and land use will be critical. The FGD and the KI results of this study show that awareness and conviction to adopt CSA practices by farmers found to be almost non-existing under the pressure of an intensive cropping system production goals and contract farming schedules. No farmer interviewed in the 14 FGDs and the 76 KIIs have ever conducted any soil sample analysis, to understand the soil's nutrient supplying capacity. Farmers from only one FGD shared they have attended an integrated pest management training organized by the Department of Crop Protection. Straw burning is a common practice and water saving technologies like alternate wetting and drying (AWD) are not known to the intervened farmer's representative of the four provinces (Figure 16).



3.4. Existing Opportunities for Creating a Climate Smart Food System

3.4.1. Strengthening of the Information Nodes

Access to regular, reliable and timely information is the key to manage increasing climate risks to agricultural production. There are various information nodes already existing in the communes (village), which farmers are habituated to access and which act as a part of the core support system of the commune level production processes (Table 25). These nodes need to be strengthened by supplying with regular, updated and reliable information and training. Table 25, below shows the existing information nodes in Red River Delta region and the Mekong River Delta region. It shows that certain information like regular weather forecast, seasonal forecast, and shifting planting time is regularly available to farmers. But there is information gap when it comes to certain other climate risk mitigation strategies like: information on improved crop management practices, information on integrated pest management, soil health management, and crop insurance and agriculture credit. With access to climate information, including weather forecasting, and training, farmers can understand climate risks and their agroecosystem vulnerabilities, identify and implement mitigating crop, soil and water management measures, and carry out climate-informed planning and decision-making to sustain climate-resilient agricultural production over time. Access to markets and credit is fundamental to sustain the transformational change towards climate-resilient production systems over the years. To ensure lasting adaptation to on-going climate change, Vietnamese farmers must continue to invest in water security and resilient agricultural systems; for which dissemination of regular and reliable agro-climate and market information and advisories is a very important requirement.

Table 25: Information Node Assessment

Sl No	Type of Information	Existing Nodes	Strength of the Node
1	Regular weather forecast	• Agriculture office of the district • Agriculture officer for commune • Farmer's cooperative • Radio – district channel	Regular, timely and reliable information available
2	Seasonal Forecast	• Agriculture office of the district • Agriculture officer for commune • Farmer's cooperative • Radio – district channel	Regular, timely and reliable information available

3	Shifting Planting Time	• Agriculture office of the district • Agriculture officer for commune • Radio – district channel	Regular, timely and reliable information available
4	Improved Seed Varieties	• Agriculture office of the district • Agriculture officer for commune • Farmer's cooperative	Regular information prescribed by the agriculture office of the district
5	Improved Crop Management Practices	• Farmer's cooperative	Irregular and Limited Information
6	Pest Disease Management	• Farmer's cooperative	Irregular and Limited Information
7	Integrated Pest Management (IPM)	• Agriculture office of the district • Department of crop protection	Very limited information available at the Agriculture Office of the district. Out of 14 FGDs, farmer from 1 FGD reported that the department of crop protection had conducted 1 training on IPM in their district
8	Soil Health Management	• Agriculture officer for commune • Farmer's cooperative	Limited information
9	Crop Insurance	• Agriculture officer for commune • Farmer's Cooperative • Television /Radio	Very limited information
10	Agriculture Credit	• Farmer's Cooperative	Limited information
11	Input supplies (price and quality)	• Agriculture office of the district • Agriculture officer for commune • Farmer's Cooperative • Input dealers of the commune	Regular information but farmers are not sure if the information is reliable

3.4.2. Promoting Crop Diversification

Crop diversification is often promoted as a strategy to achieve climate resilience. Crop diversification refers to the addition of new crops or cropping systems to agricultural production on a farm. By diversifying, farmers increase the range of potential food and income sources

available to them. It also serves as an important climate risk management strategy. For example, in the Eastern Visayas region of Philippines farmers grow sweet potato along with their primary rice crop as a risk mitigation strategy to typhoons and storms. Farmers have witnessed that sweet potatoes are resilient crops that can survive flood and typhoons. Climate change-induced rainfall variability and drought are two most common climate change-related challenges that the farmers face in both Red River Delta and Mekong River Delta region (as reported in the 14 FGDs). Hence, farmers need to be trained in resilience building crop diversification practices, as a climate-risk reduction strategy. Also soil management to build resilience to climate variability by enhancing soil fertility and biodiversity, improving soil structure, and limiting soil erosion. As the Department of Agriculture is a key stakeholder in deciding what farmers practice in Vietnam, the Department needs to include - shifting to more resilient crops or crop varieties, intercropping and crop diversification, and iterative methods for improvement of water and soil management based on local conditions and climate projections - in its prescription.

3.4.3. Reduced and Improved use of Fertilizers and Pesticides

Plants need nutrients (nitrogen, potassium, calcium, zinc, magnesium, iron, manganese, etc.) to grow well, which normally can be found in the soil. Sometimes fertilizers are needed to achieve a preferred plant growth, but they are not always used correctly. When over-applied, fertilizers can increase insect and disease problems. Fertilizer-induced rapid growth in plants may lead to weak plants without an adequate root system. The excess application also increases run-off from plots and can contaminate waterways. In Vietnam, as reported in the FGDs and the KIIs farmers apply fertilizer with their own experience or by seeing what fellow farmers in their farmer groups are doing. Farmers also shared that the highly intensive cropping system requires them to apply multiple rounds of fertilizer to their soil season after season. Also, under the vertically integrated contract system, the companies that sign the contract, most often, have fixed prescriptions (for both amount and type) for input application, for the varieties they promise a buy back. Similar is the case of pesticide usage. Unregulated use of pesticide can result in pest resistance to pesticides, and the destruction of beneficial organisms. Pesticides contain chemicals, which can migrate through the ground and be toxic to a number or organisms, including fish and invertebrates. Most pesticides do kill their target pests but they also kill beneficial organisms living in the soil, such as pollinators and pest predators, and pose health

risks to wildlife. To minimize the migration of these toxic chemicals into the natural environment, Vietnamese farmers need to use pesticides with appropriate prescription.

Conclusions

This study examines various elements of food production, consumption, processing and distribution in addition to infrastructure, institutions and markets in Vietnam to identify the challenges and opportunities for propagating a sustainable and climate-smart food system. Both primary and secondary data are used for identifying constraints and opportunities for creating climate-smart food systems along the value chains for (1) cereals, (2) roots and tubers (3) and livestock. The secondary data includes multiple years of (2012, 2014, and 2016) Vietnam Household Living Standard Survey (VHLSS) data collected by the General Statistics Office (GSO) of Vietnam. The primary date included Focus Groups (FGDs) and Key Informant Interview (KIIs) of value chain actors of key commodities in two major food producing pockets of the country, i.e., Mekong River Delta and Red River Delta. The selected provinces in the Red River Delta region were Thai Binh and Bac Ninh and the selected provinces in Mekong River Delta region were Tra vinh and Bac Lieu. Primary data gathering was done using A total of 14 FGDs (7 FGD in Red River Delta region and 7 FGD in Mekong River Delta region) were conducted with farmers. Each FGD comprised of 8 to 12, mixed male and female participants. The KIIs were conducted across the supply chain actors for each crop selected in the study. We conducted a total of 76 KIIs (40 KIIs in Red River Delta region and 36 KIIs in the Mekong River Delta region) across the four selected provinces and for three different crops in each region.

Expenditure elasticity estimated using the VHLSS survey data suggest that rice is already an inferior good for middle class and rich urban populations. These households are consuming more high value food products such as meat, dairy products, fruits, and vegetables. The positive and declining expenditure elasticities of rural population suggest that as income grows rural households will eventually start consuming less rice and more other food products. Since the Vietnam's economy continues to grow with doubling of GDP in the next decade, per capita rice consumption both in urban and rural and across different income will continue to decline. The demand for other high value products will rise, on the other hand.

This changing consumption pattern will have significant impact on the current food system which is already faced with several constraints including climate change. As concluded from the primary data, one of the most significant constraints is that Vietnam has a highly intensive cropping with very low farm level diversification. Farmers in the MRD region practice three seasons of paddy, four seasons of vegetables and three to four seasons of shrimps. This kind of intensive cropping system with goals of high productivity uses high level of inputs in the form of chemicals, fertilizers, pesticides and growth regulators and does not provide any break to the soil to replenish. FGDs conducted with the farmers reveled that farmers do not follow any regulated prescription for fertilizer and pesticide application provided by the department of crop protection or department of agriculture and don't have much alertness or interest towards soil conservation practices.

Most of our surveyed farmers specialize in one crop and grow them season after season without much gap. Because of high degree of vertical integration where farmers find an easy access to the market to sell their products, farmers prefer to specialize only on the crop that has strong buy back program market demand. This system restricts farmers to introduce a non-rice crop in between two rice crops. Instead in many instances, farmers move away from rice and specialize in another crop if there is strong buy back program. At the macro level, this will show up as if farmers are diversifying but there is more specialization in single crop at the farm level. This system also does not allow farmers to switch variety as it might jeopardize their buy back contract with the company. In these contract farming scenarios, farmers also seek input application suggestions and prescriptions from the company assigned extension specialists working in the commune. Sometimes the companies also act as input dealer/provider, using the same contract farmers to sell their own fertilizers and pest control chemicals.

The practice and promotion of an intensive cropping system leaves very small room for crop rotation, inter-cropping or diversification by individual farmers. The rice farmer is continuously growing rice for three season and the vegetable farmer is continuously growing vegetable for four seasons round the year. Certain farmers do practice multiple crop production but in different designated plots. The area allotted for growing rice is exclusively used only for rice. Vegetable would be done in some other plot near homestead. This type of mono intensive cropping on a particular plot may eliminate the natural checks and balances that a diverse ecosystem provides. This inevitably means the use of large quantities of synthetic herbicides, insecticides,

bactericides and fertilizers. In attempting to prevent damage to crops by weeds, insects and bacteria; and to provide sufficient nutrients in the soil for the plants to grow, farmers use synthetic chemicals. Not only do these chemicals leave traces on plants that are intended for human consumption and so can enter the food chain, they are also routinely over-used so that a large proportion of the synthetic material remains in the soil, even after the crop has been harvested.

Vietnamese agriculture's potential vulnerability to climate change risks such as shifting rainfall patterns and temperature, and sea level rise, together with the fundamental uncertainty that is intrinsic to climate change, suggest that it is very important to create awareness towards climate smart agriculture practices. The agriculture sector needs to cultivate resilience by strengthening capacity for innovation at every level of society. Improved water resources management and land use will be critical. The FGD and the KI results of this study shows that awareness and conviction to adopt CSA practices by farmers found to be almost non-existing under the pressure of production goals and contract farming schedule.

Several measures can be taken to improve the sustainability of the farming system and make it climate resilient. First of all, access to regular, reliable and timely information is critical for managing climate risks to agricultural production. There are various information nodes already existing in the communes (village), which farmers are habituated to access and which act as core support system to the commune level production process. These nodes need to be strengthened by supplying with regular, updated and reliable information and training. For example, in Mekong River Delta region, there is regular availability of weather forecast, seasonal forecast, and shifting planting time but there is information gap when it comes to certain other climate risk mitigation strategies like: information on improved crop management practices, information on integrated pest management, soil health management, and crop insurance and agriculture credit. With access to climate information, including weather forecasting, and training, farmers can understand climate risks and their agroecosystem vulnerabilities, identify and implement mitigating crop, soil and water management measures, and carry out climate-informed planning and decision-making to sustain climate-resilient agricultural production over time. Secondly, farm level crop diversification should be promoted as a strategy to improve sustainability and climate resilience. Crop diversification refers to the addition of new crops or cropping systems to agricultural production on a farm.

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