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Agricultural diversification and Land use patterns in Southeast Asia

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Countries in Asia have undergone a process of transformation in the past four decades as both real incomes and the share of populations living in urban areas have increased. Evidence shows accompanying shifts in food consumption as well as production across the region, but how much each country has shifted domestic production and which farmers in particular are shifting is unclear. There has been a noticeable shift in consumption patterns away from staples (mainly rice), toward high-value commodities such as fruits, vegetables, and meat. In response, we see growing diversification in agricultural production with a steady decrease in the share of harvested area growing rice and an accompanying increase in the share of harvested area growing horticulture. In this paper we use household survey data from Cambodia, Vietnam, and Myanmar to explore the extent of crop diversification at the household level, analyze differences between farmers who primarily grow rice and those who choose to diversify, and explore the factors that encourage them to do so.

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1. Introduction

Asia's transformation in the past few decades has been marked by impressive economic growth and increased urbanization. While the average world gross domestic product (GDP) growth from 2013 to 2014 was 1.8 percent, the South Asian region (5.5 percent) and East Asia and the Pacific region (6.9 percent) have consistently reported higher rates of growth (World Bank 2015). Along with increased incomes there has been a steady rise in the share of populations living in urban areas. Whereas in some countries like Indonesia and China, at least half of all people report living in an urban area, there are other cases such as Cambodia where four in five people live in rural areas.

Both income and urbanization shifts have in turn contributed to a change in food consumption patterns. In the 1980s and 1990s cereals, rice in particular, made up a large share of the calories consumed in Asia. Today, rice consumption remains high but has stagnated or decreased even as the total calories consumed have increased. Similarly, people consume more fruits, vegetables, meat, and other proteins, which account for an increasingly sizeable share of diets. On the one hand, part of the driving force behind this shift is an increase in disposable income as households move into higher paying work. On the other hand, increased urbanization, shifts in occupation, and better marketing systems increase exposure to a wider variety of foods including Western products that have shifted tastes from cereal-heavy traditional meals toward a more Western-influenced diet (Pingali, 2007; Huang and Bouis, 2001).

Production has responded to changing consumption patterns by allocating more resources to higher-value commodities such as horticulture. Whereas rice is a dominant crop in production in many countries in the region, a growing trend is a decrease in the share of cultivated area growing rice. Meanwhile, more land is being allocated to fruits and vegetables. The objectives of this paper are to explore this increasing trend of farmers shifting away from growing cereals (mainly rice) toward incorporating horticulture as income and urbanization increase. While many

studies that discuss the trend and pattern of agricultural diversification across countries use macro-level data, we take a unique approach and contribute to the literature by using multiple rounds of household surveys from Vietnam, Cambodia, and Myanmar (Joshi et al. 2004; Dorjee, Broca, and Pingali 2003; Rao et al. 2004). Our objective is to explore the extent of crop diversification at the household level, analyze differences between diversified and nondiversified farmers, and explore the factors that encourage farmers to diversify.The rest of the paper is organized as follows: Section 2 explores the changes in income growth and urbanization as well as the accompanying shifts in food demand and supply for our selected countries of focus, Cambodia, Myanmar, Indonesia, Thailand, and Vietnam in Southeast Asia and China for comparison. Section 3 reviews the links between income and crop diversification and discusses the data and the household-level trends.Section 4 concludes.

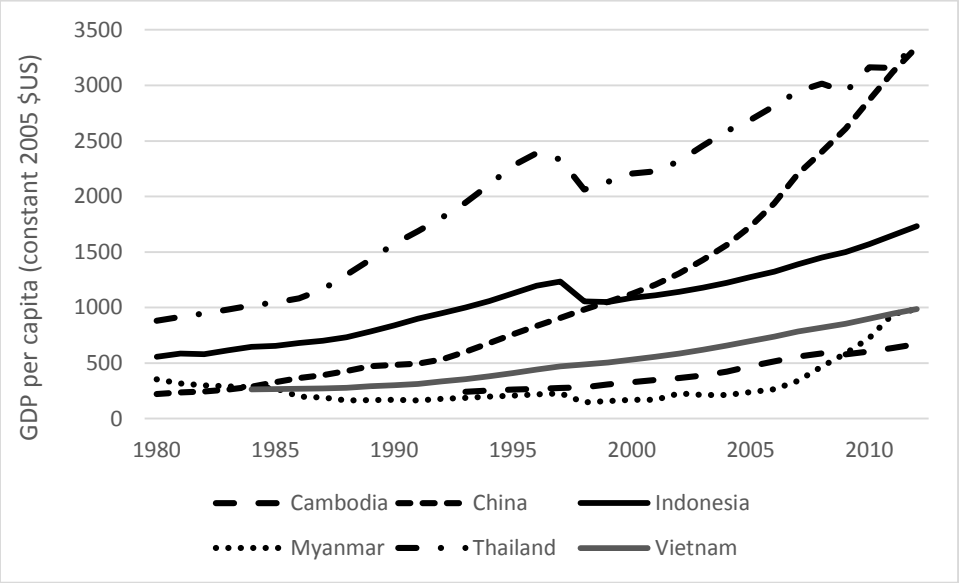
2. Shifted Supply and Demand

Growth and Urbanization on the Rise

Countries in Asia have undergone a remarkable transformation in the past four decades. Real incomes in the region have risen significantly with GDP per capita in 2012 at least twice as high in most countries as it was in 1980 (Figure 2.1a). Thailand, which started with the highest income, quadrupled its GDP per capita between 1980 ($882) [1]and 2012 ($3,901). China, which has dramatically transformed itself from one of the poorest countries in the region and increased its GDP per capita to 15 times its initial value, is a prime example. At the same time, there is a noticeable trend toward increased urbanization (Figure 2.1b). We see this in countries such as Indonesia, Cambodia, and China, where the share of their total populations living in urban areas has doubled in the past 40 years. In both Indonesia and China, this means that more than half of all people live in urban areas. Cambodia, though growing at a fairly rapid rate, still maintains the lowest urban population shares in the region with 20 percent in 2012, from 9 percent in 1980.

[1] Calculated using gross domestic product per capita in 2005 constant US dollars from World Development Index.

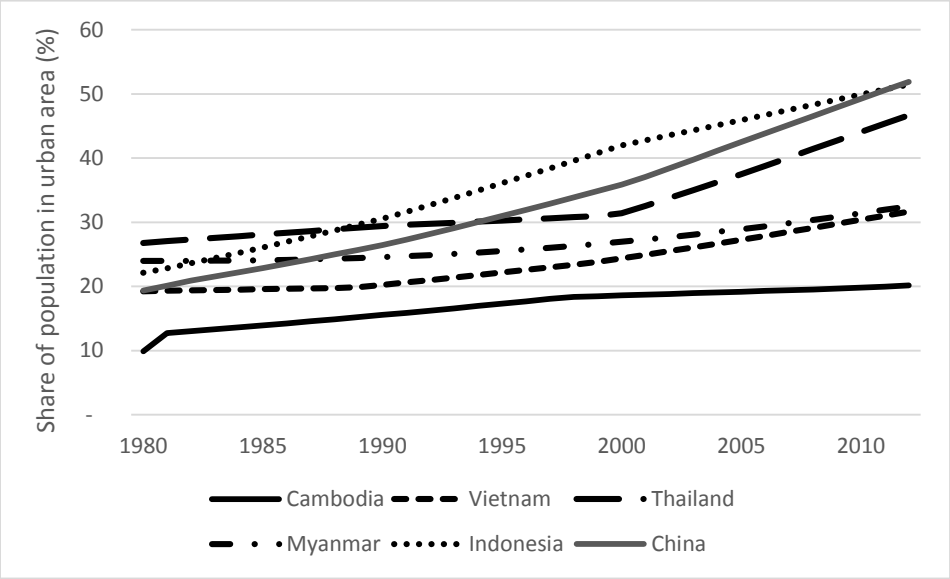
Figure 2.1a Income growth in select Asian countries



Source: Author calculated from World Development Indicators (World Bank, various years).

Note: GDP = gross domestic product. GDP per capita (constant 2005 US dollars) from 1980 to 2012.

Figure 2.1b Urbanization growth in select Asian countries



Source: Author calculated from World Development Indicators (World Bank, various years).
Note: Share of urban population in total population (in percentages).

Changing Consumption Patterns as Countries Grow Richer and Become More Urbanized

As countries grow richer and more urbanized, there are accompanying shifts in consumption patterns away from staples such as cereals (mainly rice) and toward high-value crops and proteins. These shifts occur in two stages as noted by Pingali (2006). At first, as incomes rise, households demand higher quality and a wider array of foods, all while maintaining traditional eating habits. Rice consumption, for example, gravitates toward higher-quality varieties such as Basmati in South Asia (Pingali and Gerpacio, 1997) as rice consumption increases slightly or generally remains the same. In the next phase, more urbanization, globalization, advanced markets, and changes in occupations lead to a change in lifestyle and a fundamental shift in

tastes as households are exposed to nontraditional products such as Western foods (Huang and Bouis 1996; Pingali 2006).Using data from the Food and Agriculture Organization of the United Nations (FAO) we examine changes in food consumed between 1980 and 2010. Table 2.1 summarizes the amount of cereals, fruits, vegetables, meat, and pulses consumed per capita in 2010; the total calories consumed; and the change in each group since 1980. We find people consuming more calories in general. The highest increase is in Myanmar, where the average person consumes more than twice as many calories as he or she did in 1980 and is followed closely by increases in Cambodia (44 percent) and China (41 percent). As expected, cereals make up a majority of diets in the region. In Vietnam, for example, a typical diet for the average person in 1980 included 130 kilograms per year of cereals and only 7 kilograms of meat and 60 kilograms of fruits and vegetables. By 2010, diets still included a lot of cereals (137 kilograms) but changed to incorporate more meat, fruits, and vegetables (37.5 kilograms of meat, 117.1 kilograms of fruits and vegetables) (Table 2.1). There is still, however, a large gap between the amount of cereals consumed and the amount of other food groups consumed, with two exceptions. First, fruit consumption (107 kilograms) in Thailand is almost as high as cereal consumption (137 kilograms) and is growing at ten times the rate. Second, vegetable consumption in China is a particularly interesting exception because it is the only case of a food group with higher consumption than cereals. In fact, people consumed twice the vegetables as rice in 2010.

Table 2.1 Consumption in select Asian countries in 2010

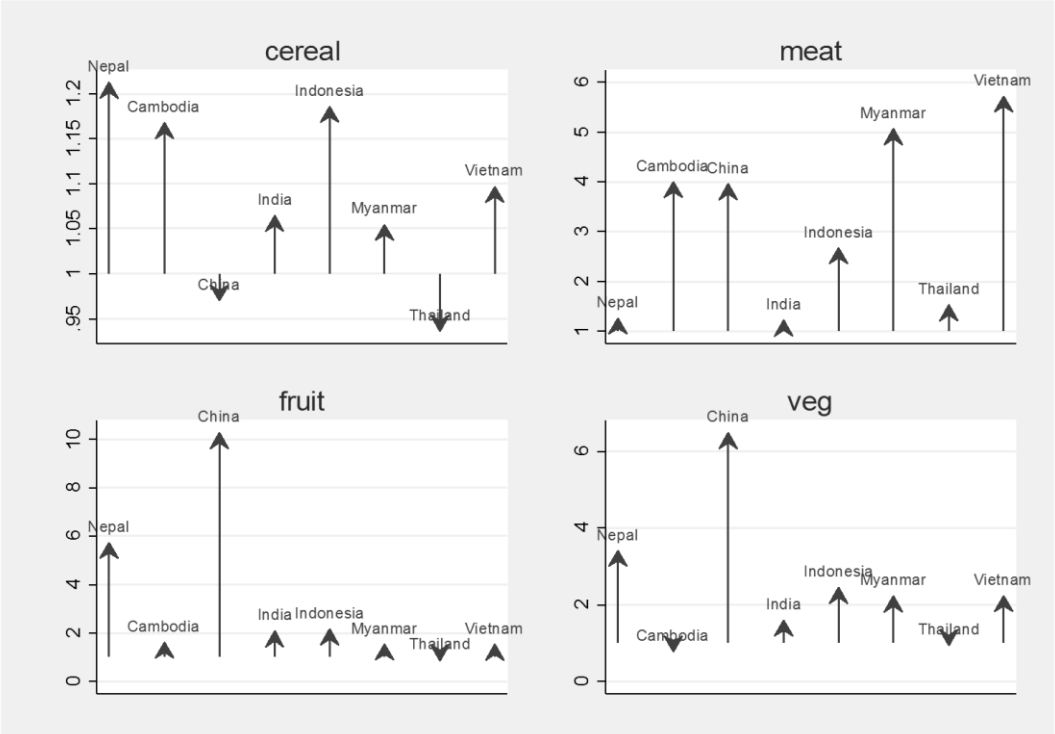
Food Group	Cambodia	Indonesia	Myanmar	Thailand	Vietnam	China
Food consumed (kilograms/capita/year)						
Cereal	174	188	137	137	167	149
Fruit	27	57	35	107	64	75
Meat	15	12	38	28	52	58
Pulses	5	1	16	3	3	1
Vegetables	33	40	82	50	91	327
Change in food consumed between 2010 and 1980 (%)						
Cereal	17	19	5	(6)	10	(3)
Fruit	62	117	54	(13)	53	927
Meat	300	167	407	53	472	296
Pulses	292	(41)	206	50	67	(76)
Vegetables	(22)	146	123	(5)	124	549
Calories consumed (kilocalories/capita/day)						
Total	2,416	2,653	2,499	2,766	2,670	3,041
Change since 1980 (%)	44	19	54	27	38	41

Source: Authors calculated using FAOSTAT consumption data.

Note: Amount for cereal, meat, fruits, vegetables, and pulses are in kilograms per capita per year for 2010. Calories are reported in kilocalories per capita day for 2010. All changes are percentage increases or decreases between 1980 and 2010.

To more clearly gauge the change in diets over time, we look at the ratio of food consumed in 2010 and 1980 for four major food groups (cereals, fruits, vegetables, and meat) (Figure 2.2). While there has been little change in consumption of cereals, the consumption of fruits, vegetables, and meat has increased significantly. The lack of change in cereal consumption mostly is due to the fact that the level of consumption was already quite high in the region in 1980. In addition, as discussed by Pingali et al. (1997) in the case of rice, the levels might be the same, but the varieties of rice consumed might be different in 2010 as people demand higher quality or nontraditional rice. In contrast, China and Thailand, the two countries with the highest GDP per capita actually decreased the amount of cereal in their diets. This might suggest that as populations grow richer, initial cereal consumption patterns are maintained but supplemented with fruits, vegetables, and meats. Once people attain a certain level of wealth and consumption, they begin to substitute away from cereals and derive a larger share of their diets from noncereal items. In China's case, for example, people consume 10 times more fruit and 6 times more vegetables while decreasing cereal consumption. Thailand is slightly different as consumption of fruits and vegetables has also declined along with cereals whereas meat consumption has increased. The biggest change in diets across the region, however, is in meat consumption. Vietnam and Myanmar, in particular, consume at least 5 times more meat than they did in 1980, but even the lowest change (1.5 times) reported in Thailand is higher than changes in cereal consumption.

Figure 2.2 Ratio of 2010 to 1980 consumption, by category



Source: Authors calculated using FAOSTAT's kilograms per capita per year (FAO 1980 and 2010).

Note: veg = vegetables.

Farmers have responded to the changes in consumption patterns by shifting land away from rice and toward fruits and vegetables. Table 2.2 presents the share of rice and horticulture area in total area in 1980 and 2012 for each of the six countries of focus. From this we see that rice dominated crop production in 1980 and continues to do so in many countries today. However, analyzing the change in the share of rice area in total harvested area over time shows either a steady decline or stagnation. Cambodia, for example, which maintained a share of more

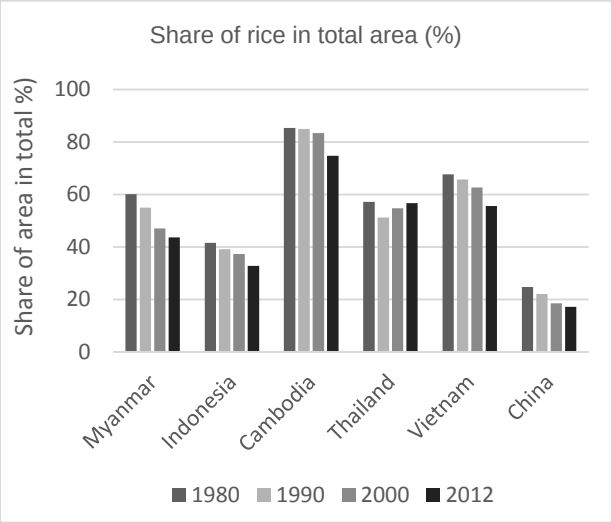
than 80 percent of crop area until the 2000s, had declined slightly to 75 percent by 2012 (Table 2.2). While some changes are similarly small, others dropped by more than 10 percentage points between 1980 and 2012, as seen in Myanmar, Cambodia, and Vietnam. The most notable exception is Thailand, whose share of rice area has increased steadily after a sharp drop in 1990, as seen in Figure 2.3a, which plots the share of rice area in total area between 1980 and 2012. Thailand is a somewhat unique case in that it is also a major world rice exporter so farmers consider both foreign markets and domestic rice consumption patterns in output decisions.

Table 2.2 Rice and horticulture growth in selected Asian countries

Country	Share of rice in total area (%)		Share of horticulture in total area (%)	
	1980	2012	1980	2012
Myanmar	60.1	43.7	4.0	4.4
Indonesia	41.5	32.8	5.1	4.5
Cambodia	85.3	74.7	4.0	3.9
Thailand	57.2	56.8	5.9	7.8
Vietnam	67.7	55.6	6.2	9.8
China	24.7	17.2	4.2	20.7

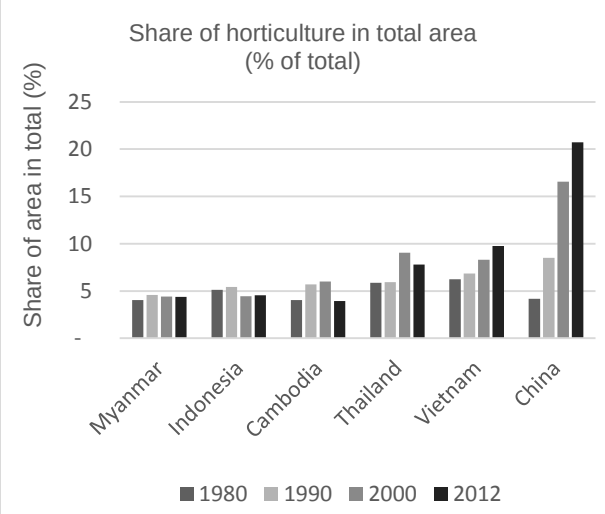
Source: Share of crop area calculated based on figures from FAOSTAT.

Figure 2.3a Share of rice in total area



Source: FAOSTAT.

Figure 2.3b Share of horticulture in total area



Source: FAOSTAT.

In contrast, the share of area growing fruits and vegetables increased for most of the countries between 1980 and 2012. Vietnam and China both maintained a steady upward trend ending with 10 percent and 20 percent of their area growing horticulture, respectively, in 2012. In China's case this means the share of area growing horticulture has increased by a factor of 4. Cambodia and Thailand both steadily increased their horticulture area as well until the 2000s but dropped by 2012 (Figure 2.3b). The biggest exception is Indonesia, which had a drop in the 1990s and never quite recovered its initial area. Further exploring the relationship between increasing incomes, urbanization, and output, we find farmers using less area for growing rice as populations grow richer and become more urbanized. Figures 2.4a and 2.4b show the relationship between income and the share of rice area and horticulture area, respectively, between 1980 (or the earliest available year) and 2010, and Figures 2.4c and 2.4d do the same for urbanization. In general, rice area either stagnated or declined as incomes increased for all

countries but Thailand. At the same time, most of the countries have seen a sharp increase in the share of horticulture area as incomes increased, except in Myanmar, where it largely remained flat, and Thailand, which declined after 2000. International markets also influence farmers' output decisions but vary greatly across the region. Rice imports are low in all six countries while exports are negligible in Indonesia, China, and Myanmar (Figure 2.5). China and Indonesia consume all the rice they produce, in contrast to Thailand and Vietnam, which are consistently net exporters. Cambodia has undergone some interesting changes and moved from a country that consumes everything it produces to a net exporter with higher domestic consumption between 2000 and 2005. Vegetable exports have increased in all countries except Indonesia but have increased at a significantly faster rate than imports. Indonesia is the only net vegetable importer and had an increase in domestic consumption. This explains Indonesia's stagnant vegetable area while vegetable consumption was increasing between 1980 and 2010.

Figure 2.4a Share of rice area and income

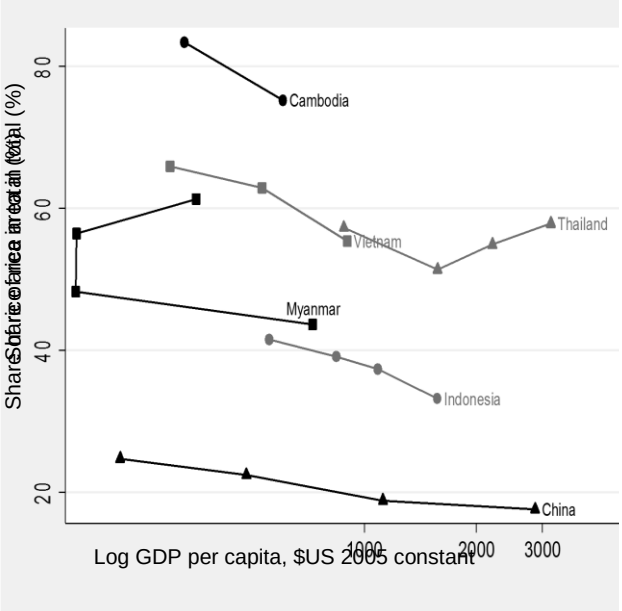


Figure 2.4c Share of rice area and urbanization

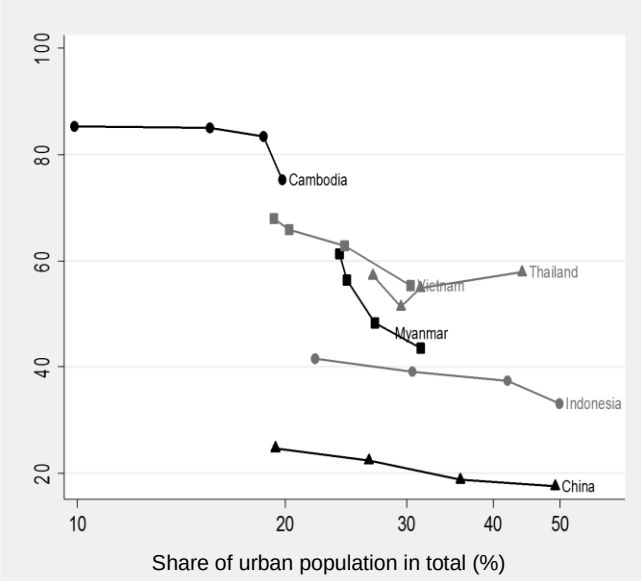


Figure 2.4b Share of horticulture area and income

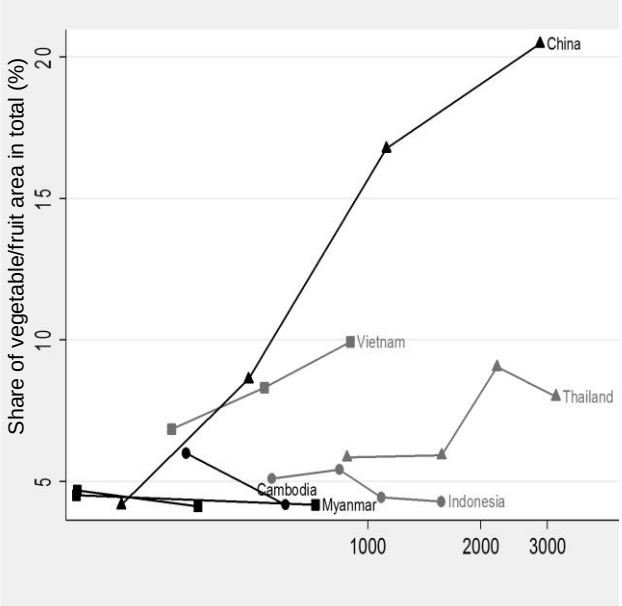
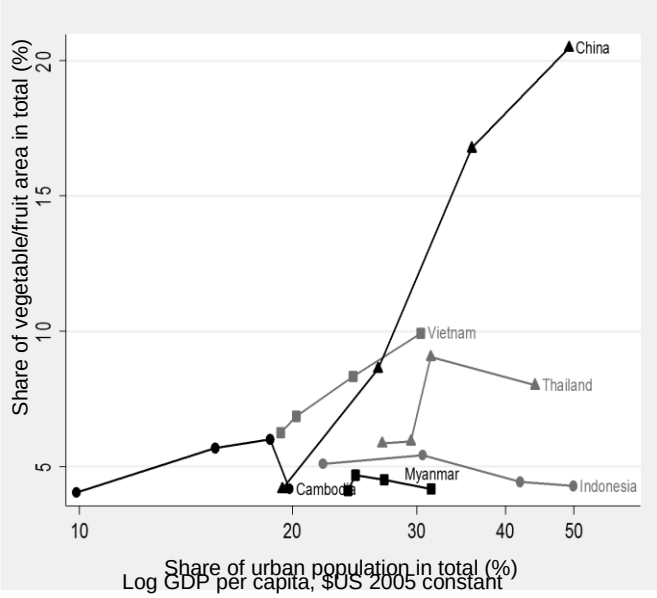


Figure 2.4d Share of horticulture area and urbanization

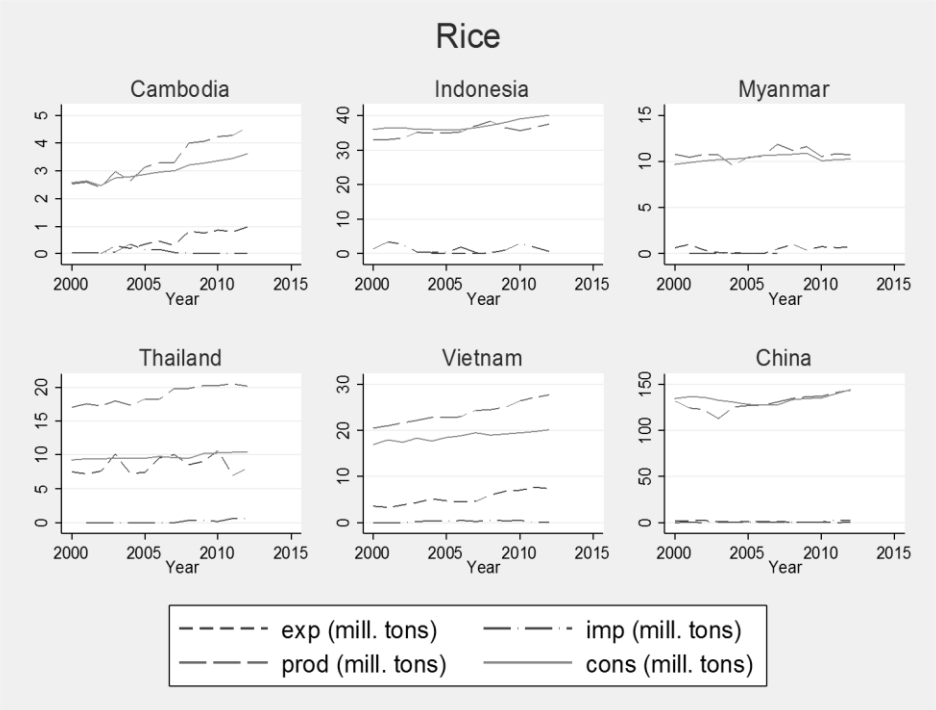


Log GDP per capita, $US 2005 constant

Source: Authors calculated using FAO data.

Note: GDP = gross domestic product.

Figure 2.5 Imports and exports of major crop (groups)



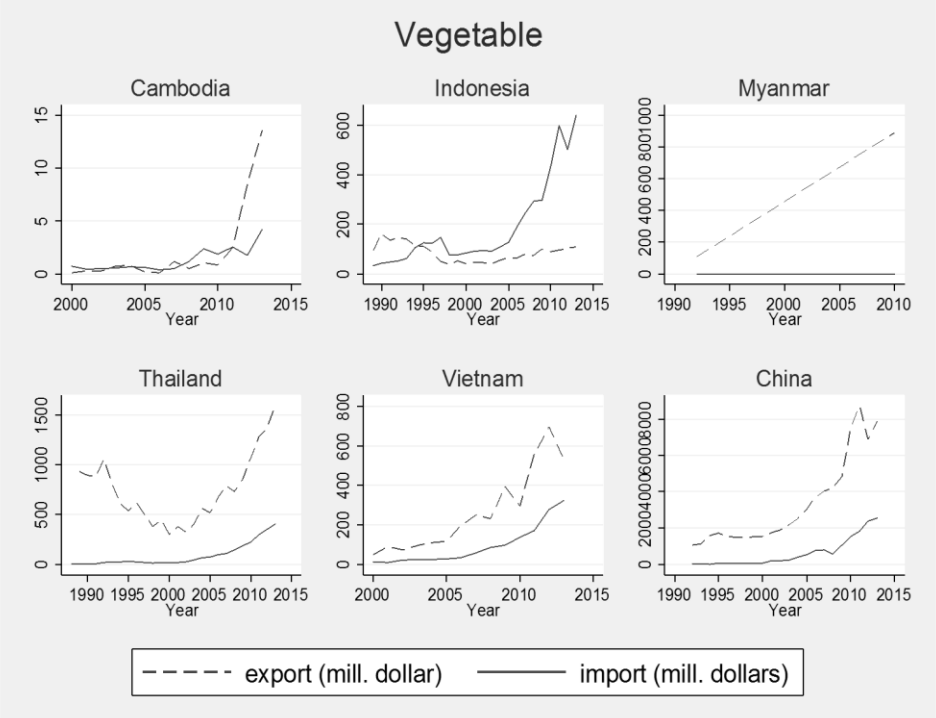
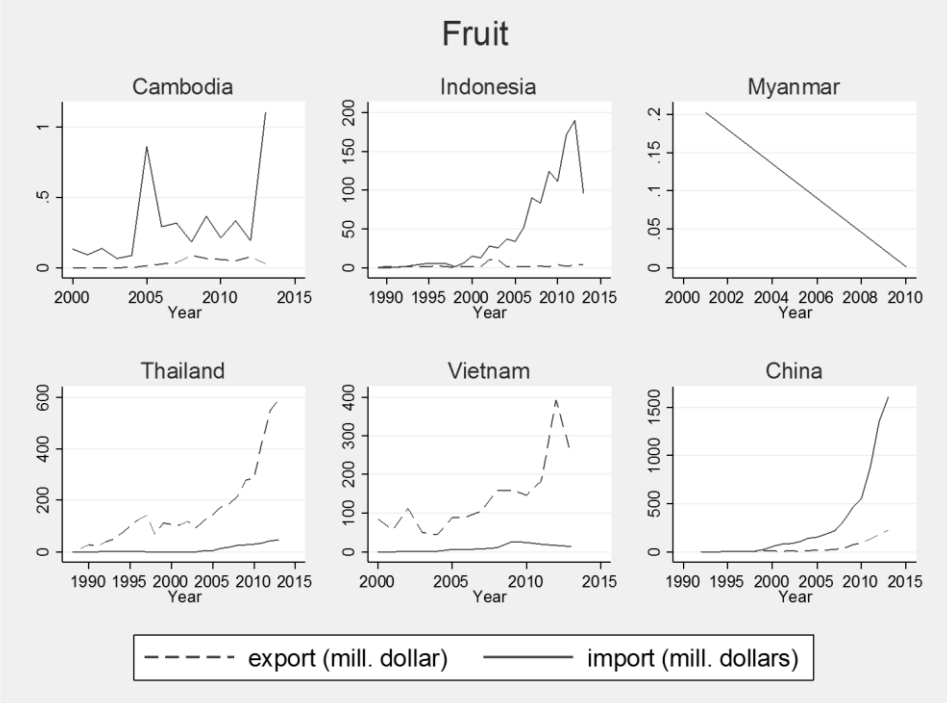

Vegetable
Cambodia
Indonesia
Myanmar
Thailand
Vietnam
China
Year
export (mill. dollar)
import (mill. dollars)

Figure 2.5 Continued



Source: Rice statistics from IRRI (year) and fruits and vegetables statistics from UN COMTRADE (year).

Note: cons =consumption; exp = export; imp = import; mill. = million; prod =production.

3. Literature Review

Literature on Income/Agricultural Diversification and Specialization

There are numerous aspects of diversification discussed in the literature in the context of economic development as outlined by Minot (2006). These include income diversification and the changes to the sources of income as economies grow; agricultural diversification, which includes both crop and livestock farming; and crop diversification, which delves into the crop mix at the farm level. In terms of income, at the macro-level regions appear to grow more diversified with wealth while at the microlevel, households diversify at first before specializing in higher-income activities as wealth increases (Minot 2006). Losch, Fréguin-Gresh, and White (2012) compare the rural development process across seven countries in Africa (Senegal, Mali, Kenya, Madagascar) and Latin America (Mexico, Nicaragua) as part of the World Bank's RuralStruc program and discuss changes in the level of income diversification at both the household and the regional levels. In the early stages, rural regional economies are specialized in agriculture (low regional income diversification), and most households are made up of poor subsistence farmers (low household income diversification). As economies start to transition and markets develop, farm households diversify their risk by having some members seek off-farm work while still maintaining their farms and home food supply (high household income diversification). This continues until a tipping point when households earn enough income from a reliable source that can cover food expenses and consequently pursue specialization in a particular activity (high household income specialization). Regionally, after the tipping point, there is a transition from an agricultural specialized economy to a highly diversified economy with multiple ongoing activities (as households specialize in different activities). Losch, Fréguin-Gresh, and White (2012) represent this inverted-U pattern in Figure 3.1.

Figure 3.1 Household and regional specialization and diversification

Source: Losch, Fréguin-Gresh, and White (2012).

Also looking at countries in Africa and Latin America, Reardon et al. (2007) find evidence supporting increased specialization with higher income. In particular, households in richer regions have a higher rate of specialization as seen in Latin America, while households in poorer regions such as Africa tend to diversify into multiple activities that often combine on- and off-farm work. Using household survey data, Minot et al. (2006) find evidence of this inverted-U-shape pattern of diversification and specialization in Vietnam. Looking simply at the number of sources of income in a household, the poorest region (Northern Uplands) was the most diverse, while the more urbanized and wealthier Southeast region was more specialized.

In this paper we focus on agricultural diversification and, more specifically going forward, crop diversification. In addition to the demand-driven factors of diversification discussed above (increased income, urbanization, and shifts in consumption patterns), there are a number of key supply-side factors mentioned in the literature. Studies show that farmers who do diversify often choose to produce high-value crops and commodities that can then be sold at market (Ashfaq et al. 2008; Dorjee, Broca, and Pingali 2003). Consequently, increasing the

number of markets as well as improving access to those markets promotes diversification. Rural infrastructure development such as building good road networks minimizes transportation costs and makes it easier to sell highly perishable fruits and vegetables before they go bad (Pingali and Rosegrant 1995; Rahman 2009; Joshi et al. 2004). Further, in terms of profitability, Joshi et al. (2004) find the relatively higher profits from horticulture to be a major driver of diversification for farmers in India. In their survey, Joshi et al. (2003) found fruits were 8 times more profitable than cereals while vegetables had 4.8 times higher profits.

Technological changes such as irrigation and fertilizer also appear to affect the decision to diversify. Fruits and vegetables competing with rice for resources are more commonly grown in rainfed areas with limited irrigated land (Joshi et al. 2003; Rao et al. 2004). Bhattacharyya (2008), studying diversification in the rice-dominated West Bengal region of India, finds a higher share of irrigated land decreases the likelihood of horticulture farming because irrigated land typically is assigned to rice production. Rainfed areas are consequently more likely to diversify and grow fruits and vegetables. Taking a different approach and contrasting view, Acharya et al. (2011) look at the role of inputs within crop groups as well as across crop types (cereals, fruits, vegetables, oil crops, and commercial crops). In this case they find that irrigation increases the number of crops grown (diversification) within each crop group for all categories except cereals. That is, irrigation increases the types of fruits and vegetables a farmer chooses to grow but limits the different types of cereals grown. Fertilizer has less mixed results, and in both studies, Acharya et al. (2011) and Bhattacharyya (2008) find fertilizer access encourages diversification in India.

What are the benefits of crop diversification? Evidence suggests it has the potential to alleviate poverty, stabilize income, increase employment, and provide access to nutritious foods (Pingali and Rosegrant 1995; Joshi et al. 2003; Birthal et al. 2014). Growing high-value crops for sale at market provides additional farm income to households, and as discussed, profits from horticulture can be higher than profits from cereals. As more labor is required to produce fruits

and vegetables relative to cereals, diversification also has the potential to increase employment opportunities. By one estimate, substituting wheat for potatoes on a hectare of land requires an additional 145 man-days (Joshi et al. 2003). This increased demand for labor required in horticulture provides farm employment opportunities in a community. This in turn can increase household incomes. Many farmers in the developing world eat what they grow, so increasing the amount and diversity of what is grown can directly affect a household's nutritional status (Ecker et al. 2011). In Bangladesh, several studies of home gardens and nutrition education interventions found an increase in consumption of vitamin- and mineral-rich nutritious foods and livestock products such as dark leafy vegetables and eggs produced at home (Iannotti, Cunningham, and Ruel 2009; Bushamuka et al. 2005). Similarly, Ruel (2001) found home gardens increasing vitamin A and iron-rich vegetables for children in farm households with home gardens. Balancing the appeal of relatively higher profits, farmers have cited price and yield risks as limiting factors to crop diversification (Joshi et al. 2003) along with perishability. As Gulati et al. (2007) argue, contract farming in some contexts might be the best way for small farmers to limit their risk and still produce high-value crops similar to input suppliers who have had profit-and-risk-sharing agreements with farmers in the past few decades in South and Southeast Asia. In Vietnam's case, Minot (2006) agrees that institutions that "facilitate vertical coordination, such as contract farming, farmer associations, market information systems, and so on" would ease some of the constraints related to horticulture and consequently enable more farmers to participate in high-value crop production. In the discussion that follows we will explore the factors related to crop diversification that have been highlighted in the literature as the data allow. Further, we can explore the benefits of diversification by comparing farmers who diversify and those who do not. Some limitations as discussed in the following section restrict how much we can analyze; for example, the lack of data on contract farming means we cannot look at the role it plays in farmers' decisions.

4. Data

Data Sources

We analyze crop diversification and specialization from households' perspectives using household surveys from Vietnam, Cambodia, and Myanmar (Table 4.1). Data used are pulled from multiple rounds of nationally representative World Bank Living Standards Measurement Surveys or surveys in a similar style. Each has multiple modules including data on consumption, migration, assets, and credit. We look particularly at the agricultural production modules that include data on harvest area, input expenses, and output quantities. Each of these variables is collected at varying levels of detail across countries as well as over time within each survey. In addition, we extract information about infrastructure, market access, credit access, education, and household head characteristics as well as community information that may help explain the determinants of diversification.

Table 4.1 List of household surveys

Country	Survey name	Year	Number of households
Cambodia	Cambodia Socio-economic Survey	2004	14,984
		2007	3,593
		2009	11,971
Vietnam	Vietnam Household Living Standards Survey	2004	9,189
		2006	9,189
		2008	9,189
		2010	9,399
Myanmar	Integrated Household Living Conditions Assessment	2009	18,609

Source: Number of households are author calculated from each survey listed.

In Vietnam we use the Vietnam Household Living Standards Survey (VHLSS), which was first undertaken in 1992 in conjunction with the World Bank and has been collected every other year since. Harvest quantity and area are disaggregated at the crop level while expenses after 2002 are reported for rice separately and then for each major crop grouping. In this paper we analyze four rounds of data between 2004 and 2010, with each round including more than 9,000 households where more than half cultivate crops. A particular difficulty with using VHLSS is how trees are measured in the production module. For most crops the survey asks farmers about the area used to grow a particular item but offers the additional option of listing

how many trees are planted for items such as fruit. Because farmers are less likely to plant trees in their homes in a uniform way, it is difficult to precisely calculate the amount of area used for growing trees. In Cambodia we use the Cambodia Socio-economic Survey (CSES) from 2004, 2007, and 2009. The agricultural modules in 2007 and 2009 are similar and have detailed plot-level input and production data while the 2004 CSES collected input expenses at the household level. For comparability all expenses are aggregated to the household level. One thing to note is that the 2007 CSES with 3,593 households is a much smaller sample relative to 2004 and 2009, which each have more than 12,000 households each. CSES 2007 does, however, include a subsample of the 2004 households and allows for panel analysis.

Myanmar's Integrated Household Living Conditions Assessment, conducted as a joint project by the United Nations Development Programme, UNICEF, and the Swedish International Development Authority, was first collected in 2004/2005 and was repeated five years later. Using data from the second round collected in 2009/2010 surveying 18,609 households, we look at household production output and inputs for the 7,306 crop-producing households. The agricultural module includes seasonal crop production for 95 crops and asks farmers about their use of inputs such as fertilizer, purchased seeds, manure, and pesticides for each season.

Data on input quantities are not available consistently across all surveys, so to proxy input use we analyze expenses. Vietnam is unique in that it collects data on input costs as well as different fertilizer quantities for rice and other major crop groups (fruit trees, other staple and food trees, industrial trees). However, even with the VHLSS, fertilizer quantities were not collected before 2006. In addition, we supplemented input expense data with other information when available such as plot-level irrigation status. The level of disaggregation for expenses varies both across countries and over time within surveys, so for comparability, we aggregate to the household level. The number of inputs included in the surveys also varies, but all surveys capture the major expenses: chemical fertilizer, seeds, and irrigation. Other inputs we analyze include manure, electricity/fuel, agricultural chemicals, mechanization, and hired labor.

As a means of validation, national estimates of harvest area from each household survey were compared to both FAO and local statistical agencies. In some cases the estimated area for rice or other crop groups is lower than nationally reported figures, but the trends are generally the same. It's important to note that FAO and national statistical agencies capture the entire agricultural sector including large commercial farms that are not part of the household survey.

Country Profile

Summary statistics for each country are presented in Table 4.2. As seen in the World Development Indicators (WDI) data, urbanization is steadily increasing in both Cambodia and Vietnam, where there has been a 6 percentage point increase in about seven years. In spite of the increase, urbanization in Cambodia remains relatively low, at 18 percent in 2009. In contrast, 45 percent of households in Myanmar's Integrated Household Living Conditions Assessment are in urban areas, which is significantly higher than WDI's estimate of 31 percent. In addition, looking only at crop-cultivating households we find a rising share of farm households in urban areas in Vietnam while the share of urban farm households decreases in Cambodia between 2003 and 2009. The level of literacy is quite high with almost 70 percent of the heads of farm households able to read or write in Cambodia and 93 percent in Vietnam. This is particularly relevant because higher education levels have been linked to increased diversification. We also find that the average harvested area is declining but remains relatively high in Cambodia (1.4 hectares in 2009) relative to Vietnam (0.8 hectares in 2010) but is highest in Myanmar (2.2 hectares in 2009). Last, the level of productivity of rice producers varies greatly. Both Myanmar's and Cambodia's yields are less than 3 tons per hectare, which is much lower than Vietnam's, where yields have grown slightly and are just less than 5 tons per hectare. In spite of higher yields, few households in Vietnam grow rice exclusively, particularly when compared with Cambodia.

Table 4.2 Country profile

	Cambodia			Vietnam				Myanmar
Household type	**2003**	**2007**	**2009**	**2004**	**2006**	**2008**	**2010**	**2009**
All households								
Number of households	14,984	3,593	11,971	9,188	9,189	9,189	9,399	18,609
Urbanization (%)	14.7	12.1	18	24.5	25.1	25.6	28.2	45
Nominal monthly income ('000 local currency)	1,907	1,604	1,624	4,147	5,266	8,276	8,559	
Share of income from agriculture (%)	52.7	38.6	45.9	37.7	35.9	35.9	34.7	
Share of income from crops (%)	27.6	23.5	26.6	22.1	21.3	21.9	21.7	

Table 4.2 Continued

	Cambodia			Vietnam				Myanmar
Household type	**2003**	**2007**	**2009**	**2004**	**2006**	**2008**	**2010**	**2009**
Crop-cultivating households								
Number of households	9,951	2,039	7,733	6,369	6,285	6,122	5,781	7,306
Urbanization (%)	6.1	5.5	4.1	8.4	8.9	8.4	9.4	
Nominal monthly income ('000 local currency)	2,225	623	888	3,404	4,349	6,692	7,075	
Share of income from agriculture (%)	70.6	61.8	64.2	50.9	49.7	50.7	53.1	
Share of income from crops (%)	41.4	41.3	41	31.9	31.1	32.9	35.3	
Household size	5.1	4.9	4.9	4.5	4.3	4.2	4.1	
Household head age	44.9	45	45.4	49	48.9	49.8	48.5	54.6
Household head can read/write? (%)	65.6	70.8	69.3	92.2	92.1	92.7	92.8	
Household harvest area (hectares)	1.7	1.4	1.4	0.9	0.9	0.9	0.8	2.2
Rice yield	2.1	2.4	2.2	4.8	4.9	5	4.9	2.7

Share of rice-only household (%)	70.3	67.7	70.8	12.6	13.4	14.3	16.5

Source: Cambodia Socio-economic Survey (Cambodia, NIS various years); Vietnam Household Living Standards Survey (Vietnam, GSO various years), Integrated Household Living Conditions Assessment (various years).

Also notable from the household survey data, we find that even as GDP and urbanization increase, agriculture continues to be important. In Vietnam, 35 percent of household income still came from agricultural activities in 2010, with 22 percent specifically from crops. While still sizeable, there is a slow decline in agricultural income shares from 2004, when agriculture accounted for 38 percent of household income. For our focus group, crop producers, households rely on agriculture for at least half of all household income on average between 2004 and 2010. Two things are particularly of interest: first, for households that do not grow crops, the already low share of income from agriculture is steadily decreasing, and second, agriculture is becoming even more important for crop producers as the share of both crop and agricultural income is on the rise. In the latter group, agricultural (crop) income has grown from 51 to 53 percent (32 to 35 percent) between 2004 and 2010.There are also significant differences in total household income in households that produce crops and those that focus on other activities. Of the two groups, crop-producing households not only consistently report lower incomes; they also have a slightly lower rate of income growth. In 2010, non-crop-growing households reported an average of 131,163 Dongs, which is 1.5 times higher than crop growers (84,896 Dongs). Between 2004 and 2010, income increased in both groups, but non–crop growers saw a higher increase (52 percent) relative to crop producers (47 percent).

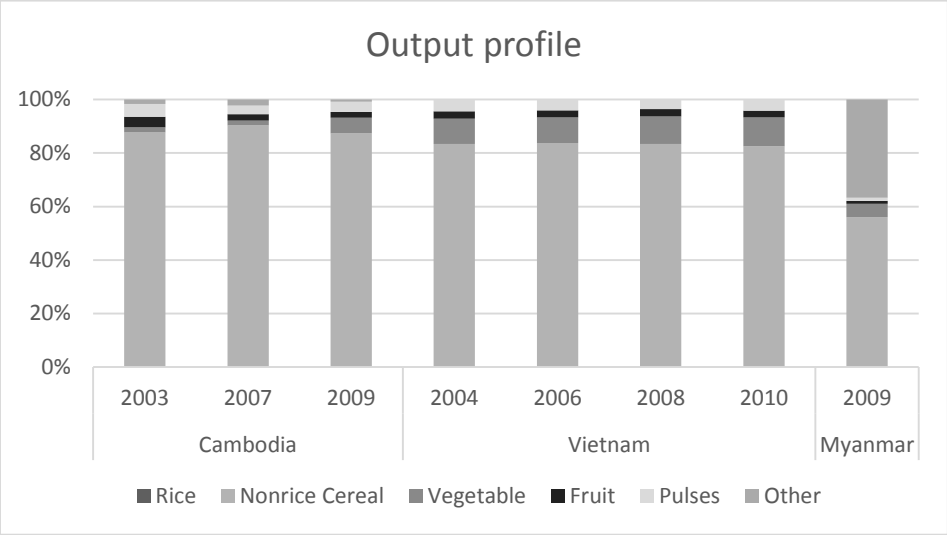
Agriculture is even more important for Cambodian households, though there are some similar trends in income patterns. Households rely on agriculture for almost half of all their income (46 percent), with 27 percent from crops. These shares are significantly higher in crop-

producing households, where crops account for 41 percent of income and almost two-thirds of all income comes from agricultural activities (64 percent). While the share of income from crops has remained steady, agricultural income has decreased from 71 percent in 2004 but clearly remains integral for household survival. Even in non-crop-producing households, the share of agricultural income is decreasing but nontrivial, at 12 percent in 2009.

Output Profile

Though rice is a major crop in each of the three countries, there are differences in the level of rice dominance as well as other major crops grown. Figure 4.1 summarizes the share of harvested area used to grow rice and other key crops at the household level. Cambodia's rice dominance is the most striking as rice has accounted for as much as 86 percent of harvested area in the study period. In Vietnam, the second highest world rice exporter in 2010, at least 60 percent of harvest area is used to cultivate rice. Interesting to note, the share of rice area steadily declined between 2004 and 2010 in Vietnam from 65 percent to 62 percent, but high productivity (yields on average 4.8 metric tons per hectare to 5 metric tons per hectare) has helped maintain high production levels. Further, Figure 4.1 shows that countries vary in what they choose to grow in addition to rice. Noncereals are commonly cultivated across all three countries, with maize in particular accounting for between 4 percent and 8 percent of crop area. Similarly, roots/tubers are cultivated in both Cambodia (4 percent) and Vietnam (5 percent) but are insignificant in Myanmar. Unique to Vietnam is the relatively higher share of area cultivating beverage crops, with coffee in particular cultivated on 5 percent of area. Along the same lines a unique feature in Myanmar is the cultivation of two dominant crops. Together accounting for 75 percent of crop area, rice and pulses make up the lion's share of production. Seasonality is a factor, with farmers tending to focus on paddy production between April and October before switching to pulses in the second season. In addition to pulses, farmers in Myanmar grow oil crops and nonrice cereals.

Figure 4.1 Output profile: Share of area growing major crops



Source: Cambodia Socio-economic Survey (Cambodia, NIS various years); Vietnam Household Living Standards Survey (Vietnam, GSO various years), Integrated Household Living Conditions Assessment (various years).

Horticulture shares observed in the household-level data are lower and more stagnant relative to FAO macrodata. Fruits and vegetables together are a small share of total harvested area for Cambodia (4 percent) and Vietnam (5 percent) but particularly so for Myanmar (2 percent). Vietnam households, for example, allocated 6 percent of crop area to horticulture in 2004 and 5 percent between 2006 and 2010, while at the macrolevel horticulture accounted for 9–10 percent in the same time period. This suggests there are other sectors of the agricultural economy that may be responsible for the increasing trend in the share of area growing fruits and vegetables. It is possible that the relatively higher fruit and vegetable shares and increases observed at the macrolevel using FAO numbers are a reflection of nonhousehold commercial farms.

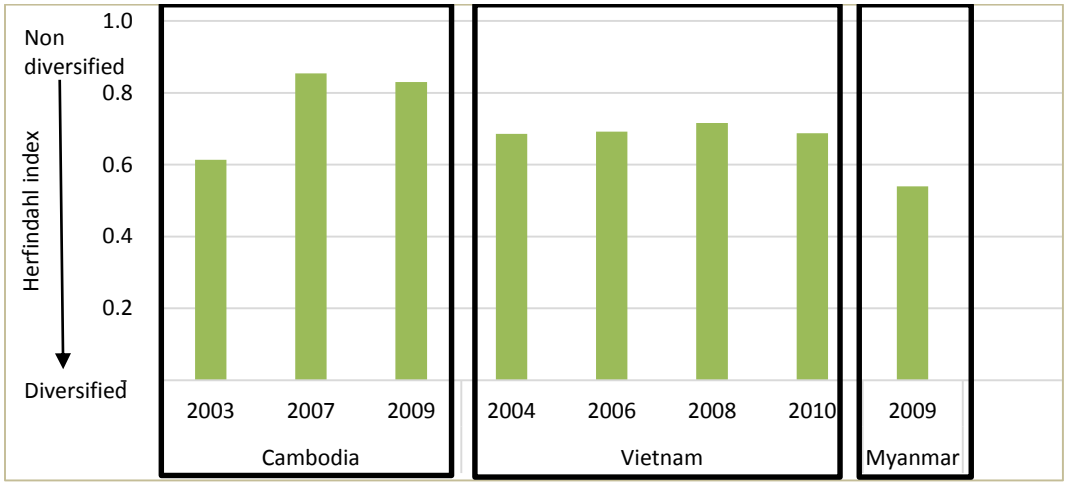
Measures of Diversification

To compare the level of diversification across the three countries we use the Herfindahl index (figure 4.2). Originally a tool measuring market concentration in the marketing industry, it has been used in agriculture to capture levels of crop diversification, specialization, or both (Rahman 2009). Represented in the equation below, the Herfindahl index uses the sum of the squared shares of harvested area for each crop *i* that is cultivated to generate a value between 0 and 1. Higher Herfindahl values translate to more specialized production portfolios, so as the index approaches 1 a farmer gets closer to monocropping. Conversely, a value of zero translates to a perfectly diversified farm.

$$HI = \left(\sum_{i=1}^{n} sharei^2 \right)$$

In the three countries of focus, the level of diversification as measured by the Herfindahl index reflects the variance in rice dominance (figure 4.2). Cambodia, where rice accounted for almost 80 percent of area in 2009 and many farmers report growing solely rice, had the highest Herfindahl value (0.8 in 2009). Likewise, Vietnam's value of 0.7 reflects rice's accounting for 62 percent of area. In contrast, Myanmar has a relatively lower value closer to 0, which reflects a more diversified crop mix (0.5 in 2009). Most consistent over time is Vietnam, where the Herfindahl index holds steadily at 0.7 between 2004 and 2010.

Figure 4.2 Herfindahl index



Source: Cambodia Socio-economic Survey (Cambodia, NIS various years); Vietnam Household Living Standards Survey (Vietnam, GSO various years), Integrated Household Living Conditions Assessment (various years).

A second measure of diversification is used to compare households within a country. For this intracountry, we use the share of crop area growing rice to compare the level of diversification across households. To accommodate differences in production profiles, country-specific thresholds were chosen to categorize households either as diversified or nondiversified. In Cambodia, diversified farmers are defined as those with rice growing on less than a third of crop area (10 percent of households) while in Vietnam it was farmers with rice on less than 20 percent of crop area (28 percent of households in 2010). For Myanmar, a higher cutoff at 50 percent of rice area was used (56 percent of households).

What Do Diversified Farmers Grow?

Table 4.3 shows the share of area for each major crop group in the latest year surveyed for both diversified farmers and the full sample. The nondiversified farmers' column stresses the importance of rice in Cambodia and Vietnam relative to other crops and the dual importance of rice and pulses in Myanmar. Further, consistent with the literature, diversified farmers grow relatively high-value crops and other cereals in place of rice. In Cambodia, rice accounts for a much smaller share of harvest area (4 percent) on diversified farms and is replaced with a higher share of area growing fruits (22 percent), vegetables (17 percent), and roots/tubers (15 percent). In contrast, diversified farmers in Vietnam grow other types of cereals (16 percent), tree nuts (12 percent), and beverage crops (20 percent) while leaving 12 percent of crop area for fruits and vegetables combined. The dominance of pulses in Myanmar is even more evident when we observe farmers whose primary crop is not rice. For this group, almost half of crop area is used to grow pulses, with black grams (13 percent) and pigeon peas (6 percent) making up the lion's share. Other major crops include oil crops (9 percent), rice (10 percent), and nonrice cereals (8 percent).

Table 4.3 Share of crop area in total harvested area (%), country

	Cambodia		Vietnam		Myanmar	
Crop Type	**Diversified**	**Non diversified**	**Diversified**	**Non diversified**	**Diversified**	**Non diversified**
Share of households (%)	10	90	28	72	56	44
Rice	8.0	92.4	3.6	81.6	9.6	83.3
Nonrice cereal	5.5	0.4	15.6	5.5	8.0	0.5
Vegetable	16.9	1.5	3.8	1.2	1.4	0.4
Fruit	23.3	1.9	8.3	1.3	1.8	0.3
Pulses	4.5	0.5	0.0	0.0	49.3	11.7
Roots/Tubers	7.0	0.7	10.5	3.5	0.3	0.1
Fiber/Jute	0.3	0.0	0.1	0.1	1.3	0.1
Tree nut	6.1	0.5	11.8	0.6	3.4	0.3
Oil crops	17.9	1.4	4.2	2.5	8.8	1.7
Beverage crops	0.0	0.0	20.2	0.9	1.2	0.1
Other	10.5	0.5	22.0	2.8	14.9	1.7

Source: Calculated from Cambodia Socio-economic Survey (Cambodia, NIS 2009), Vietnam Household Living Standards Survey (Vietnam, GSO 2010), and Integrated Household Living Conditions Assessment (2009).

Input Use/Environmental Factors

All

In addition to analyzing what farmers grow, we look at the inputs used on their farms. As mentioned earlier, input expenses are primarily used as proxies for input use along with any relevant additional information in the survey. All three countries have information about seeds, fertilizer, irrigation, and manure, while at least one country also reports on hired labor, agricultural chemicals, electricity/fuel, and mechanization. Table 4.4 shows the number of farm households reporting use of a particular input.

Table 4.4 Input use, by country

Share of households reporting use of input (% of households)	**Cambodia**			**Vietnam**				**Myanmar**
	2003	2007	2009	2004	2006	2008	2010	2009
Seeds (purchased)	95	95	97	91	89	89	89	20
Chemical fertilizers	77	80	71	95	95	95	95	54
Manure	54	53	59	62	59	57	49	44
Hired labor	23	31	48	48	46	52	50	
Irrigation	47	54	50	60	58	43	33	48
Electricity/Fuel	14	21	23	26	27	31	33	
Agricultural chemicals				89	88	88	89	44
Mechanization				57	58	60	61	

Source: Authors calculated using Cambodia Socio-economic Survey (Cambodia, NIS various years); Vietnam Household Living Standards Survey (Vietnam, GSO various years), Integrated Household Living Conditions Assessment (various years).

Note: Share of diversified households: Cambodia = 10 percent, Vietnam = 28 percent, Myanmar = 56 percent.

Overall, more farmers in Cambodia and Vietnam report using inputs relative to Myanmar. This is not surprising as both Vietnam and Cambodia were part of the Green Revolution that included, among other things, a big push in the use of seeds, chemical fertilizers, and irrigation. Almost all farmers report using purchased seeds in Cambodia and Vietnam, while only a fifth of farmers in Myanmar do the same. Chemical fertilizers, likewise, are used extensively in Cambodia and almost universally in Vietnam (95 percent), with little more than half of farmers in Myanmar reporting use for the year. Unlike Cambodia, which has similar yields, this means Myanmar has the opportunity to increase productivity by increasing fertilizer and purchasing new and perhaps improved seeds. Irrigation is much more varied across the region, with about half of the farmers in Myanmar and Cambodia reporting use on at least one plot. A change in Vietnam's irrigation policy decreased out-of-pocket irrigation costs for many farmers in 2008 and 2010, which makes it difficult to capture use and makes it appear as though irrigation use has dropped by almost half between 2004 and 2010. More realistically, about 60 percent of farmers use irrigation in Vietnam. Also of note is the increasing trend in hired labor use particularly in Cambodia, where twice as many households report use in 2009 as they did in 2003. About half of all farm households now use hired labor, which is particularly interesting in light of the increased need for hired labor for horticulture.

Diversified Farmers

Across groups, fewer diversified farmers generally report using inputs in both Cambodia and Vietnam (Table 4.5). The greatest differences in Cambodia are in fertilizer, purchased seeds, and manure. We might expect a bigger difference in irrigation use as well; however, most rice in Cambodia is wet paddy, which doesn't require irrigation. Also of interest is the little difference in hired labor use between groups in Cambodia since diversified farmers in Cambodia grow fruits and vegetables, which are relatively more labor intensive than cereals. Similarly, a higher share of diversified farmers use purchased seeds, irrigation, and agricultural chemicals in

Vietnam. In this case we might expect a difference in fertilizer use across groups, but with almost universal adoption, all farmers are using some fertilizer. Less of a pattern emerges in Myanmar, but there is a difference in irrigation with more nondiversified farmers reporting use.

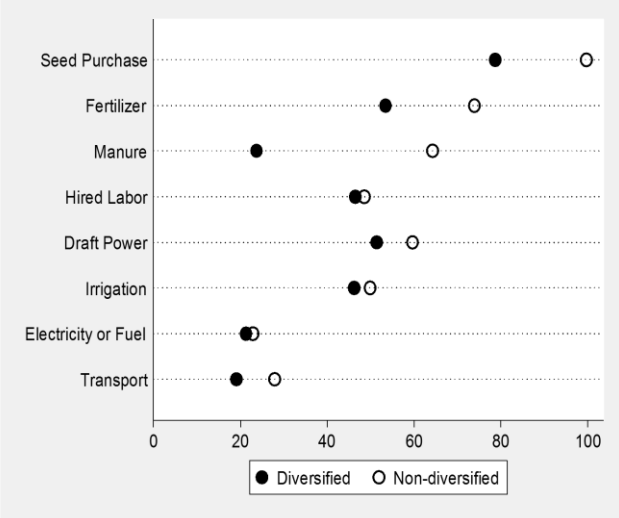
Table 4.5 Inputs and environmental factors, by diversification group

Share of households reporting use of input or access (% of households)	**Cambodia**		**Vietnam**		**Myanmar**	
	Nondiversified	**Diversified**	**Nondiversified**	**Diversified**	**Nondiversified**	**Diversified**
Inputs						
Purchased seed	99.6	78.7	99.9	59.4	15.7	23.8
Chemical fertilizer	73.9	53.4	97.8	91.3	56.6	51.9
Manure	64.2	23.7	52.7	39.5	45.1	42.8
Agricultural chemicals			97	66.1	42.9	44.7
Hired labor	48.5	46.4	54	41.5		
Draft power	59.7	51.3	15.3	5.1		
Irrigation	49.9	46.2	50.8	4.7	57.4	40.3
Electricity and fuel	22.9	21.4	29	41.6		

Transport	27.9	19.1		
Environmental factors				
Credit access	43.9	42	18.3	14.5
Market in commune	11.2	5.8	66.5	69.8
Extension	53.4	58.1	15.2	6.5
Electricity in commune	42.4	27	98.5	99.1
Irrigation in commune	64.8	54.4	72.2	62.4

Source: Authors calculated using Cambodia Socio-economic Survey (Cambodia, NIS 2009), Vietnam Household Living Standards Survey (Vietnam, GSO 2010), and Integrated Household Living Conditions Assessment (2009).

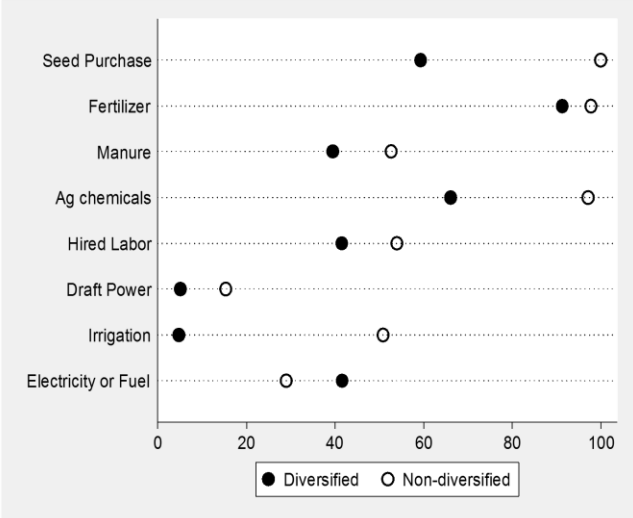
Figure 4.3a Input use by diversification group, Cambodia



Source: Authors calculated using Cambodia Socio-economic Survey; (Cambodia, NIS 2009).

Note: Diversified (<33 percent rice area) and 10 percent of households.

Figure 4.3b Input use by diversification group, Vietnam

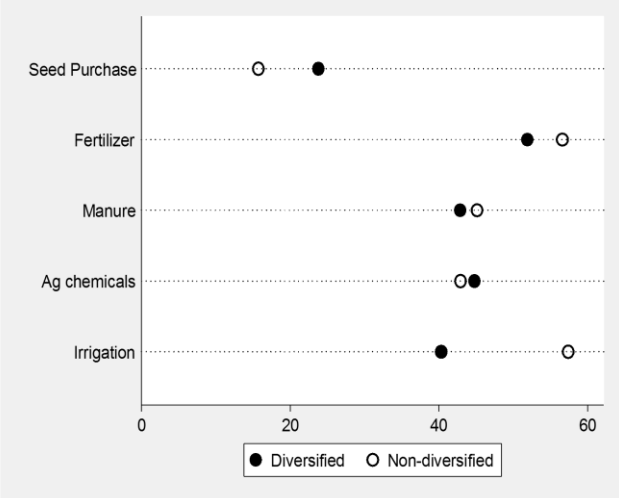


Source: Authors calculated using Vietnam Household Living Standards Survey (Vietnam, GSO 2010).

Note: Diversified (<20 percent rice area) and 26 percent of households.

Figure 4.3c Input use by diversification group,

Myanmar



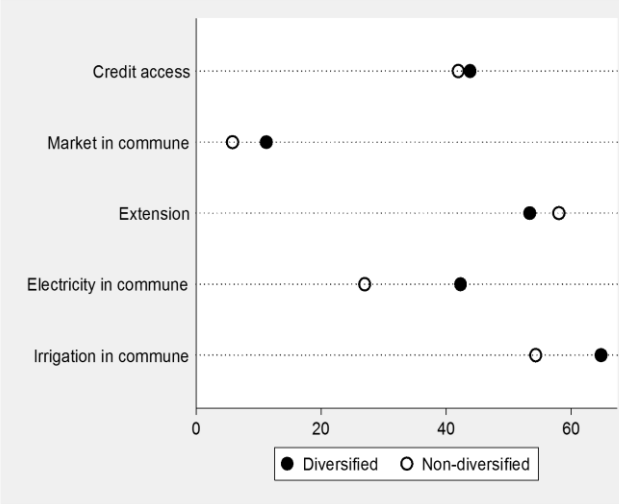
Source: Authors calculated using Integrated Household Living Conditions Assessment (2009).

Note: Ag = Agricultural. Diversified (<50 percent rice area) and 56 percent of households.

Data show environmental factors such as infrastructure and market access have generally improved in Cambodia and Vietnam. This is key because both have been shown to encourage crop diversification. Irrigation, for example, was available in more communities in Cambodia in 2009 (56 percent) than in 2003 (39 percent). Further, there is a marked improvement in the reported availability of extension services, with almost twice as many farmers in Cambodia reporting access in 2009 (43 percent) than in 2003 (24.5 percent). Access to credit remains difficult, with only half of all farmers reporting loans in both Vietnam and Cambodia. In contrast, electricity access is almost universal in Vietnam (99 percent) while access to a market within the village is reported by 70 percent of farmers. The only variable available in Myanmar's survey is credit access, which at least in this sample is still very low at 2.3 percent.

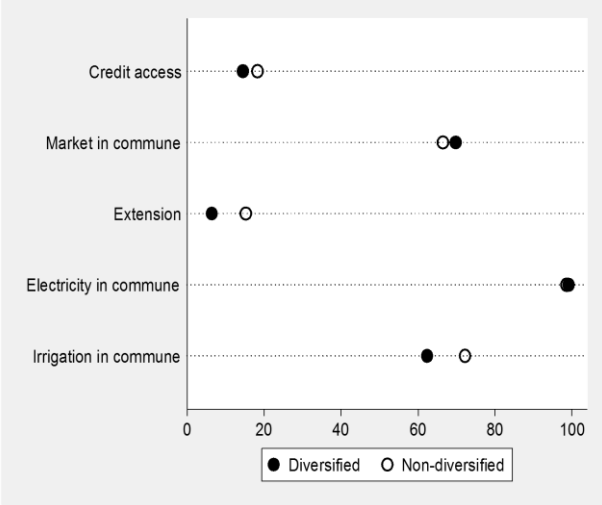
Analyzing environmental factors by diversification groups shows almost no difference in Vietnam and mild differences in Cambodia as seen in Figures 4.4a and 4.4b. Village access to electricity and irrigation are the only variables in Cambodia that have a significant difference across groupings. In almost all cases, diversified farmers have relatively easier access to services and infrastructure, with the only exception being access to extension.

Figure 4.4a Environmental factors in Cambodia by diversification group



Source: Cambodia Socio Economic Survey (2009).

Figure 4.4b Environmental factors in Vietnam by diversification group



Source: Vietnam Household Living Standards Survey (Vietnam, GSO 2010).

5. Conclusion and Discussion

With increased income and urbanization there is an accompanying shift in what populations choose to consume. Diets heavily dominated by rice and other cereals that are high in calories but not necessarily nutritious are evolving to include other high-value food items. Fruits, vegetables, and meat accounted for larger portions of food consumed and grew at a much faster rate than cereal consumption between 1980 and 2012. In response, there is evidence that agricultural production is slowly shifting to accommodate these changes in consumption. In terms of harvested area, the share of rice area has either stagnated or steadily decreased while the share of area used for horticulture at the macrolevel is on the rise.

Household-level production data from Cambodia, Vietnam, and Myanmar highlight varying levels of rice dominance in each country and highlight differences in what farmers diversify into when they shift away from rice. In Cambodia, diversified farmers tend to grow more fruits, vegetables, and roots/tubers, while in Vietnam farmers diversify away from paddy and into other cereal (maize) and beverage crops (coffee). Myanmar's farm households grow mainly rice and pulses, with diversified farmers focusing on pulses, oil crops, and other cereals in place of rice. National FAO data show faster growth of fruits and vegetables relative to the household surveys, which in turn suggests nonhousehold commercial farms may be playing a bigger role in horticulture production.

Input use in the three countries of focus varies over time and across diversification groups. Fertilizer and purchased seed use are already high in both Cambodia and Vietnam, as is the case with many countries in Asia since the Green Revolution, while Myanmar has room to grow, with about half of farmers reporting use in 2009. Fewer diversified farmers report using inputs in Cambodia and Vietnam, with particularly large gaps in seed use, manure, fertilizer, and agricultural chemicals. Myanmar's input use patterns across groups are less consistent, with

diversified farmers using purchased seeds and agricultural chemicals but more nondiversified farmers using irrigation, manure, and fertilizer.

In addition, household survey data suggest varying levels of infrastructure access across diversification groups. In Cambodia, more diversified farmers report access to electricity and irrigation in their communes than do their nondiversified counterparts. While there are no significant gaps across groups in Vietnam, diversified farmers have slightly less access to extension services and irrigation in their communes. Improving infrastructure would in turn likely encourage more diversification.

Future research can look into the implications of trade on diversification and agricultural incomes. Vietnam is a prime candidate for this analysis as it has experienced a steady increase in the share of area used to cultivate horticulture while still maintaining its position as a top exporter in the global rice market. In addition, analyzing the agricultural incomes of each group (diversified and nondiversified) will help determine whether there is an accompanying increase in agricultural income from cultivating high-value crops. Along the same lines, there needs to be further discussion of the general implications of continued structural and spatial transformation for the agricultural sector, particularly for specialization at the farm level, income growth, and possible exits from agriculture.

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