



**Food and Agriculture
Organization of the
United Nations**

Agricultural transformation of middle-income Asian economies

Diversification, farm size and mechanization

ESA Working Paper No. 15-04

October 2015

Agricultural Development Economics Division

Food and Agriculture Organization of the United Nations

www.fao.org/economic/esa

Agricultural transformation of middle-income
Asian economies
Diversification, farm size and mechanization

David Dawe

Food and Agriculture Organization of the United Nations
Rome, 2015

Recommended citation

FAO. 2015. *Agricultural transformation of middle-income Asian economies: Diversification, farm size and mechanization*, by David Dawe. ESA Working Paper No. 15-04. Rome, FAO.

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations (FAO) concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by FAO in preference to others of a similar nature that are not mentioned.

The views expressed in this information product are those of the author and do not necessarily reflect the views or policies of FAO.

© FAO, 2015

FAO encourages the use, reproduction and dissemination of material in this information product. Except where otherwise indicated, material may be copied, downloaded and printed for private study, research and teaching purposes, or for use in non-commercial products or services, provided that appropriate acknowledgement of FAO as the source and copyright holder is given and that FAO's endorsement of users' views, products or services is not implied in any way.

All requests for translation and adaptation rights, and for resale and other commercial use rights should be made via www.fao.org/contact-us/licence-request or addressed to copyright@fao.org.

FAO information products are available on the FAO website (www.fao.org/publications) and can be purchased through publications-sales@fao.org.

Agricultural transformation of middle-income Asian economies

Diversification, farm size and mechanization

*David Dawe*¹

Abstract

The agricultural sector of Asian middle-income countries is changing rapidly in line with an overall structural transformation of the economy brought on by economic growth. This paper discusses the changes in China, Indonesia, Malaysia, the Philippines, Thailand and Viet Nam related to mechanization, farm size and crop and product diversification. Mechanization appears to be proceeding quickly in many, but not all, of these countries, although there are not enough good data to indicate how rapidly it is proceeding. There are also data and conceptual issues with regards to farm size. Despite these issues, there appears to be little evidence to suggest that farm sizes are increasing rapidly, and indeed there are strong reasons to suspect that Asian farm sizes will remain quite small for the foreseeable future. Dietary diversification might seem to dictate crop diversification, but this is only correct at the global level – at the national level, international trade can substitute for crop diversification in achieving dietary diversification. These six countries seem cognizant of their comparative advantage, with international trade expanding rapidly for commodities such as oilseeds and vegetable oils, fruits and vegetables, and dairy products. Thus, crop diversification is taking place in geographically diverse countries such as China, but not at all in smaller countries like Malaysia. Despite the lack of crop diversification in some countries, there has generally been strong product diversification into livestock and aquaculture, especially the latter. In the future, if these countries are to make sure that their farms are competitive and efficient and contribute to poverty alleviation among smallholders, it will be important for governments to provide key public goods and make difficult decisions regarding international trade and the appropriate degree of price and production support for farmers.

Keywords: structural transformation, agricultural transformation, middle-income countries, Asia, mechanization, farm size, crop diversification.

JEL codes: O11, O13, O53, Q10, Q17, Q18.

¹ David Dawe is currently working at FAO's Regional Office for Asia and the Pacific. The bulk of this work was done while he was working with the Agricultural Development Economics Division, Economic and Social Development Department, FAO. E-mail: David.Dawe@fao.org.

Contents

List of figures iii

List of tables iv

Acknowledgements v

1. Introduction 1

2. Economic and agricultural growth in East and Southeast Asia 1

3. Structural transformation and the five key transitions 7

4. Agricultural transformation in East and Southeast Asia 13

 Mechanization 14

 Larger farms? 18

 Crop and production diversification..... 27

5. Future policy challenges..... 37

 International trade and price and production support for farmers..... 40

 Provision of key public goods, both hard (roads, ports, etc.) and soft (education)..... 43

6. Concluding thoughts 48

References 50

List of figures

Figure 1. Growth rates of GDP per capita, constant local currency units, by decade.....	2
Figure 2. “Timmer” diagram of agriculture’s share in GDP, employment and the difference as a function of log GDP per capita, East and Southeast Asia, 1980-2011.....	2
Figure 3. Public expenditures on agricultural R&D as percentage of agricultural GDP	5
Figure 4. Relative rate of assistance to agriculture, by region, 1955-2010.....	6
Figure 5. Agriculture’s shares in GDP and employment, selected countries, 1980-2011.	8
Figure 6. Agricultural trade surplus (+) or deficit (-) as a percentage of agricultural value-added, average 2009-2011.....	9
Figure 7. Urbanization rates, selected countries, 1961-2050.	10
Figure 8. Dietary diversification over time, 1961-2009.....	11
Figure 9. Annualized percentage change in rice consumption by quintile and location, Indonesia, India, and Bangladesh.....	13
Figure 10. Labour use (including family labour) in rice cultivation, various rice bowls in Asia.	16
Figure 11. Labour use (including family labour) in rice cultivation, Central Luzon, Philippines.....	17
Figure 12. Average annual rural population growth in various Asian countries.	18
Figure 13. Average farm size over time, Indonesia, Philippines and Thailand.	19
Figure 14. Scatter plot of percentage change in number and area of farm holdings for provinces between 2003 and 2013, Thailand.	20
Figure 15. Scatter plot of percentage change in number and area of farm holdings for provinces between 1991 and 2002, Philippines.	21
Figure 16. Map of Thailand with provincial boundaries showing various combinations of changes in number of holdings, total area of all holdings, and farm size.	23
Figure 17. Map of Philippines with provincial boundaries showing various combinations of changes in number of holdings, total area of all holdings, and farm size.	24
Figure 18. Crop area harvested in China, 1976-2011.	27
Figure 19. Percentage of additions to total crop area harvested accounted for by different crops, 2000-2011.....	28
Figure 20. Crop area harvested in Indonesia, 1961-2011.	29
Figure 21. Crop area harvested in the Philippines, 1961-2011.	29
Figure 22. Crop area harvested in Viet Nam, 1990-2011.	30
Figure 23. Inflation-adjusted net trade (value of exports minus value of imports) per capita, vegetable oils, 1961-2011.	33
Figure 24. Inflation-adjusted net trade (value of exports minus value of imports) per capita, fruits, vegetables and pulses, 1961-2011.	34
Figure 25. Inflation-adjusted net trade (value of exports minus value of imports) per capita, meat and dairy products, 1961-2011.	35
Figure 26. Change in agriculture’s shares in GDP and employment, selected countries, 2000-2011.....	38
Figure 27. Change in agriculture’s share in GDP, selected countries, 1990-2000 and 2000-2011.....	38
Figure 28. Producer support estimate (PSE) as percentage of gross farm receipts.....	47
Figure 29. General Support Services Estimate (GSSE) as percentage of gross farm receipts.	48

List of tables

Table 1. Growth in agricultural value added (VA) per worker and agricultural VA, percent per annum. 3

Table 2. Agricultural output growth, agricultural TFP growth, and share of TFP in agricultural growth, 2001-2010 (percent per annum). 4

Table 3. Growth in net per capita crop, livestock and aquaculture production, percent per annum, 2000-2013. 31

Table 4. Net trade (2011 US\$ per capita) for various food groups, average 2009-11. 31

Table 5. Net trade (2011 US\$ per capita) for various food groups, average 1999-2001. 32

Acknowledgements

This paper was prepared as part of the World Bank-coordinated “Farm-gate to Market Study”. Grateful acknowledgements are due to Frederick Roche, Peter Timmer and especially Patrick Labaste and Steven Jaffee, who provided numerous helpful comments and suggestions on various drafts of this paper. Hu Chaoran (Michigan State University) and Su-Arjar Lewchalermvongs (FAO) provided excellent research assistance.

1. Introduction

The structural transformation of economies is a global phenomenon, driven primarily by income growth (Timmer, 2014), which has been especially rapid over the past few decades in East and Southeast Asia. Sustained income growth over many decades leads to five key transitions, as elaborated by Reardon and Timmer (2014): urbanization; growth of the rural non-farm economy; dietary diversification; a revolution in supply chains and retailing; and transformation of the agricultural sector; these transitions are alluded to in slightly more detail below.

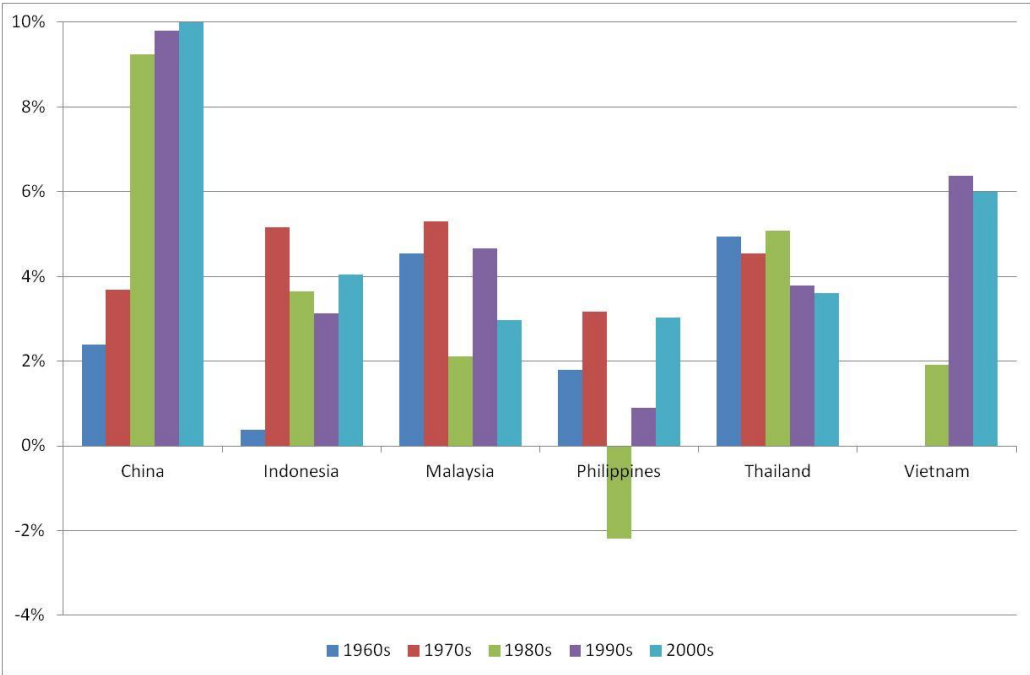
The purpose of this paper is to further understanding of the nature, speed and extent of one of these transitions (the transformation of the agricultural sector) in a group of large rapidly growing Asian middle-income economies (China, Indonesia, Malaysia, the Philippines, Thailand and Viet Nam). The paper focuses on these countries because they are large and because they have experienced substantial economic growth, which means that the transformation should be particularly rapid. Understanding the nature and extent of this transformation can help to guide policies that promote sustainable and equitable agricultural and economic growth, and also help countries to avoid the “middle-income trap.”

After this first introductory section, the remainder of this paper is organized as follows. Section 2 briefly describes the patterns of economic and agricultural growth in Asia in general, including in the six focus economies, because economic growth is the key driver of the structural and agricultural transformations. Section 3 describes the structural transformation brought about by economic growth, and very briefly, the five key transitions that accompany that transformation. Section 4, the main part of the paper, describes the agricultural transformation in detail with respect to three key phenomena: (1) mechanization; (2) increasing farm size; and (3) crop and product diversification. Section 5 discusses future policy challenges related to the agricultural transformation, and Section 6 offers some concluding thoughts.

2. Economic and agricultural growth in East and Southeast Asia

As noted above, economic growth has been rapid in East and Southeast Asia for several decades, with agricultural growth typically playing a key role in kick-starting the process (Timmer, 2002). Despite the Asian economic crisis in the late 1990s and the global food, fuel and financial crises in the late 2000s, rapid economic growth has generally continued (see Figure 1). Over the past decade, most of this growth has been due to growth in the industrial and service sectors of the economy, which tend to grow more rapidly than the agricultural sector in middle-income economies (although this tendency can be reversed for brief periods of time, especially if the terms of trade tilt in favour of agriculture). As a result, the share of agriculture in the overall economy tends to decline as GDP per capita grows (see the open circles in Figure 2).

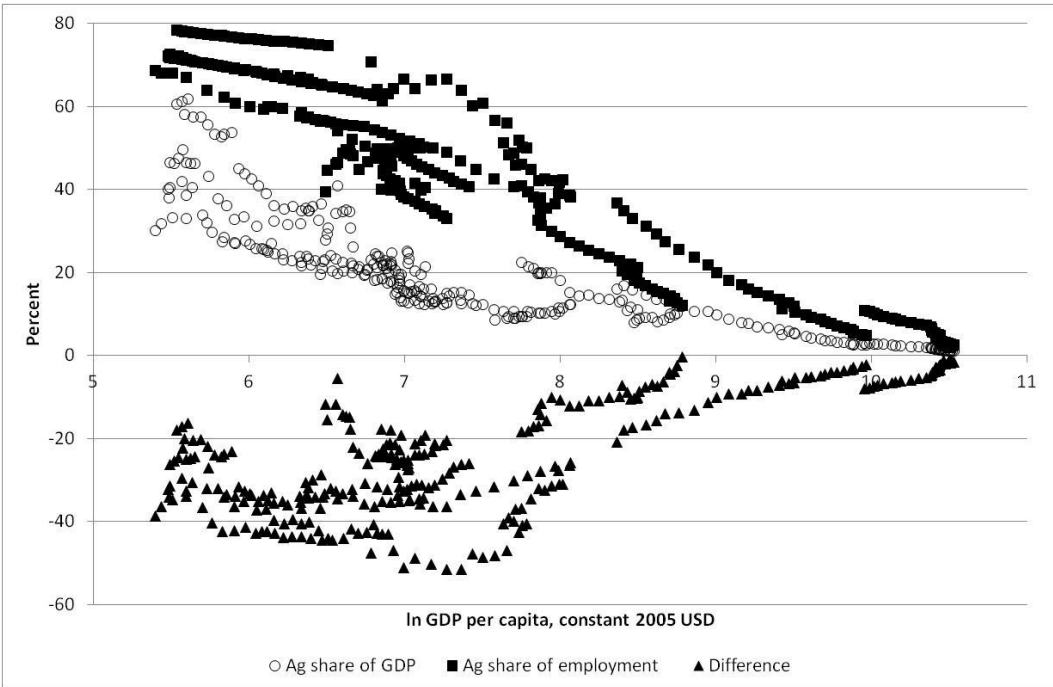
Figure 1. Growth rates of GDP per capita, constant local currency units, by decade



Note: Growth rates for each decade are calculated using linear regression of the log of GDP per capita versus time. For the 2000s, growth rate is calculated for 2000-2012. For Viet Nam, growth rate for 1980s is based on 1984-1989.

Source: Author using World Bank (2014).

Figure 2. “Timmer” diagram of agriculture’s share in GDP, employment and the difference as a function of log GDP per capita, East and Southeast Asia, 1980-2011



Note: Countries included are China, Cambodia, Indonesia, Japan, Korea, Lao PDR, Malaysia, Mongolia, Philippines, Thailand and Viet Nam.

Sources: Author using data on agricultural’s share in employment are from FAO (2014) for all countries except China, Mongolia, and Thailand. All other data are from World Bank (2014).

Along with growth of the overall economy, growth in the agricultural sector has also been robust in recent years; the annual average growth of agricultural value added (VA) per worker from 2000-2012 exceeded 2.4 percent per annum in all countries in East and Southeast Asia other than Lao PDR. Growth in VA per worker was also more rapid during this period than it was in the 1990s in most countries, with Lao PDR and Viet Nam being the only exceptions (see Table 1). The growth rates in this region compare quite favourably with those in South Asia, with Bangladesh being the only South Asian country on a par with East and Southeast Asia.

Interestingly, the most rapid growth in agricultural VA per worker since 2000 was in Japan and the Republic of Korea, despite the fact that these countries had the slowest growth rates of agricultural VA (indeed, Japan's agricultural sector had negative VA growth during this period). The explanation for the difference in growth of agricultural VA and agricultural VA per worker was the rapid decline of the agricultural labour force in these two countries, which led to increased productivity for those left behind. This also led to the share of agriculture in total employment declining more rapidly than the share of agriculture in GDP, thus leading to a narrowing of the agricultural employment-income gap (see the black triangles in Figure 2 on the far right of the diagram, which correspond to Japan and Korea).

Table 1. Growth in agricultural value added (VA) per worker and agricultural VA, percent per annum

	Agricultural VA per worker		Agricultural VA	
	1990-1999	2000-2011	1990-1999	2000-2011
East Asia				
China	3.7	4.5	4.2	4.4
Japan	4.6	5.4	-0.7	-1.2
Korea	6.2	7.5	1.6	1.7
Mongolia	1.2	4.8	0.9	4.0
Southeast Asia				
Cambodia	1.5	3.5	4.2	5.5
Indonesia	0.9	3.2	2.2	3.5
Lao PDR	2.4	1.0	4.7	3.5
Malaysia	0.7	4.8	0.1	3.2
Philippines	0.1	2.4	1.7	3.0
Thailand	1.3	2.7	0.7	2.2
Viet Nam	2.7	2.4	4.2	3.7
South Asia				
Bangladesh	2.3	3.7	2.5	3.7
India	2.0	2.0	3.3	3.2
Nepal	-0.3	0.0	2.4	3.3
Pakistan	2.5	0.4	4.4	3.2
Sri Lanka	1.4	2.2	1.8	3.3

Note: Growth rates are calculated using linear regression of the log of value-added versus time. Growth rate for 2000s for Bangladesh, India, Malaysia, Mongolia, Nepal, Pakistan and Viet Nam are for 2000-2012.

Source: World Bank (2014).

What factors have spurred the growth in Asian agriculture? Fuglie (2012) argues that most of the growth in agricultural output in the past decade has come from growth in total factor

productivity (TFP) – i.e. growth from factors other than additional land, labour, capital and material inputs such as fertilizer. For most East and Southeast Asian countries, he estimates that for the period 2001-2010, more than 70 percent of the growth in gross output was due to growth in TFP (see Table 2). Perhaps surprisingly, this share of output growth due to TFP is not particularly high relative to other countries around the world – the global average was 74 percent during this period of time. It is high, however, compared to the share of TFP in earlier decades, particularly the 1960s, 1970s and 1980s. Thus, for the past two decades, most of the growth in agricultural output has been due to factors other than increased use of the “conventional” inputs noted earlier in the paragraph.²

On the other hand, another author has come up with seemingly different results – “seemingly” because the time periods in the two analyses are different. Ehui (2013) found that TFP growth in India accounted for about one-quarter of total growth in agricultural output between 1981 and 1995, but between 1996 and 2008, the contribution of TFP was actually negative, with input growth being greater than output growth. While the time periods used by Ehui (2013) are not the same as in the decadal analysis by Fuglie (2012), it seems hard to reconcile the two startlingly different conclusions. Given the importance of TFP measurement, this difference should be a serious concern for economists. Most likely, the difference is due to the poor quality of data on input use over time (for example, see the discussion on mechanization below).

Table 2. Agricultural output growth, agricultural TFP growth, and share of TFP in agricultural growth, 2001-2010 (percent per annum)

	Output growth	TFP growth	Share of TFP (%)
East Asia			
China	3.4	2.9	86
Japan	-0.4	2.5	>100
Korea	0.5	2.7	>100
Mongolia	1.6	0.4	23
Southeast Asia			
Cambodia	7.9	5.7	72
Indonesia	4.5	3.1	70
Lao PDR	4.7	1.8	39
Malaysia	3.6	3.3	92
Philippines	3.0	2.3	75
Thailand	2.1	1.7	83
Viet Nam	3.9	2.2	57
South Asia			
Bangladesh	4.4	3.4	77
India	3.5	2.0	57
Nepal	2.8	2.0	73
Pakistan	3.0	0.3	8
Sri Lanka	2.6	1.4	53

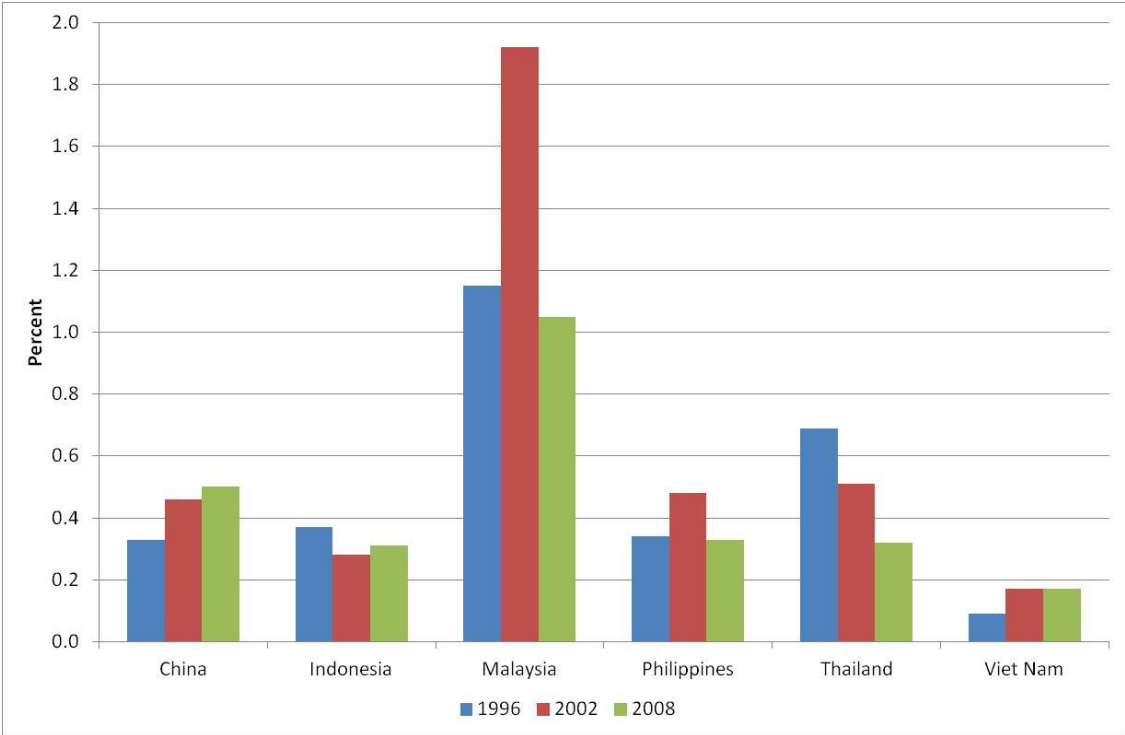
Source: USDA (2014).

² In addition, percentage growth in the use of inputs has slowed down substantially compared with earlier decades.

Two key factors that help to determine growth in TFP are agricultural R&D and pricing policy towards agriculture (pricing policy is to be construed in a broad sense, as anything that affects the prices of outputs, including exchange rates, tariffs and taxes). It is well known that agricultural R&D has exhibited high rates of return in the past, both in terms of agricultural production and poverty reduction (Fan *et al.*, 2000, 2004, 2008a, 2008b; FAO, 2012), as well as high financial rates of return (Pardey and Beintema, 2001). In addition, Fuglie (2012) shows that higher values of an index of “innovation and invention,” based on (i) the number of public-sector agricultural scientists per thousand hectares of arable land and (ii) R&D as a percentage of GDP, led to higher rates of growth in agricultural TFP. Furthermore, he also found that, within Asia, larger increases in innovation and invention were correlated with faster growth of TFP in subsequent decades.

In terms of trends in expenditures on agricultural R&D as a percentage of agricultural GDP over time (Figure 3; this is known as the research intensity ratio), Flaherty *et al.*, (2013) find a mixed picture. The research intensity ratio has been increasing in China, but it has been declining in Thailand and fluctuating in Indonesia, Malaysia and the Philippines. One common feature, however, is that the ratios are low. FAO (2012) finds that the ratios in Asia are lower than those in sub-Saharan Africa and Latin America and the Caribbean, and Flaherty *et al.* (2013) makes the same point when comparing China and India with Brazil. Furthermore, the ratios are well below the recommended level of 1 percent of agricultural GDP for developing countries (Beintema and Elliott, 2011). Malaysia is an exception in this regard, but it also has by far the highest per capita income of the group, so this is less of an exception than it might appear (research intensity ratios are strongly positively correlated with per capita income). The low levels of spending on agricultural R&D represent a clear threat to future agricultural growth and future poverty reduction.

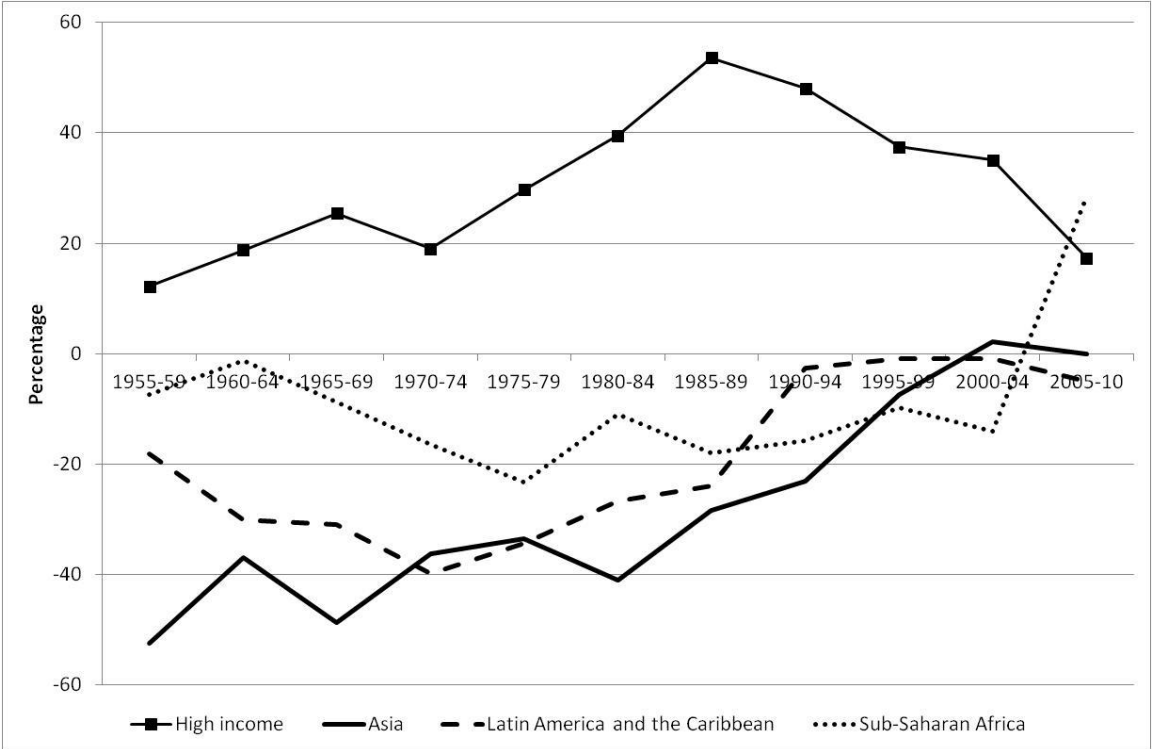
Figure 3. Public expenditures on agricultural R&D as percentage of agricultural GDP



Source: Author using Flaherty, Stads and Srinivasacharyulu (2013).

In terms of agricultural prices, work by Anderson and Nelgen (2012) reported in FAO (2012) shows that the relative rate of assistance to agriculture (RRAA) in Asia has been steadily improving since the 1950s (Figure 4). In 1955-1959, the RRAA was about -50 percent, which implies a strong bias against the sector. As late as the first half of the 1980s, it was still -40 percent. But since that time, it has been steadily increasing, and for the periods 2000-2004 and 2005-2010, it reached zero, which means that the agricultural sector is neither favoured nor discriminated against (relative to other sectors of the economy) in terms of pricing policies. There are of course some differences across countries, but the RRAA improved substantially in all 10 of the Asian countries included in the analysis.³ The enhanced incentives almost certainly played some role in more rapid TFP growth.

Figure 4. Relative rate of assistance to agriculture, by region, 1955-2010



Source: FAO (2012), using data from Anderson and Nelgen (2012).

This pattern of reduced taxation of agriculture as GDP per capita increases is well documented for the wealthiest countries in the region (Anderson and Hayami, 1986). Looking ahead, it seems as though the trend will continue to hold true in the middle income countries of East and Southeast Asia. For example, Dawe (2014) shows that rice prices have been rising sharply (relative to world market prices) in several countries in the region, including China, Thailand, Indonesia and the Philippines.

Higher rice prices will provide incentives for further growth in agricultural TFP to some extent, although it will come at the expense of TFP growth for other crops and agricultural products. Furthermore, higher rice prices (in real terms, and relative to other crop prices) have a range of negative effects. There are a number of studies that show they tend to increase poverty and malnutrition in net-importing middle-income countries (see the review in Dawe *et al.*, 2010), and higher rice prices also hinder production diversification that is needed to

³ China, Indonesia, Malaysia, the Philippines, Thailand and Viet Nam in East and Southeast Asia, and Bangladesh, India, Pakistan and Sri Lanka in South Asia.

meet the demands of dietary diversification and raise farm incomes. Diversification towards higher-value crops is an important part of raising farm incomes, as land scarcity in Asia means that this income problem will not be solved through growth in farm size (see the discussion later in the paper). Higher rice prices can also erode competitiveness in labour-intensive industries, as rice is a large part of expenditures for such workers.

Perhaps most important, enforcing high rice prices and implementing input subsidies can consume substantial government financial resources that could otherwise be used to invest in public goods, including the “invention and innovation” highlighted by Fuglie (2012) as well as rural roads, education and health care. This will be an important challenge to manage going forward. If prices and subsidies rise too fast, expenditures on public goods will be reduced and it is very likely that TFP growth will suffer.

It is perhaps inevitable that domestic rice prices will eventually end up at high levels, as has happened in Japan and Korea. But these two countries are quite wealthy, and their citizens can afford the higher prices without falling into poverty or sacrificing a nutritious diet. And given rice’s small share in workers’ budgets in these countries, high rice prices do not seriously harm industrial competitiveness there. The question then becomes at what stage in the economic development process should countries allow domestic prices to increase substantially above world prices? If the agricultural transformation is hindered by high rice prices, this can contribute to being stuck in the middle-income trap, harming long-term poverty alleviation. Even in the short-term, given the large numbers of people in East and Southeast Asia who are still suffering from poverty, chronic hunger and micronutrient deficiencies, the human costs of allowing rice prices to rise to high levels in middle-income countries should be given careful consideration.

3. Structural transformation and the five key transitions

Increased per capita income coupled with Engel’s Law implies that at the macro-level consumer spending on non-food increases more rapidly than consumer spending on food, which in turn leads to a transformation of the economy away from agriculture, as measured by a declining share of agriculture in GDP – the structural transformation (note that in a rapidly growing economy the agricultural sector continues to grow, albeit at a rate slower than the industrial and service sectors). The declining share of agriculture in the economy is clearly evident from the data (Figure 2).

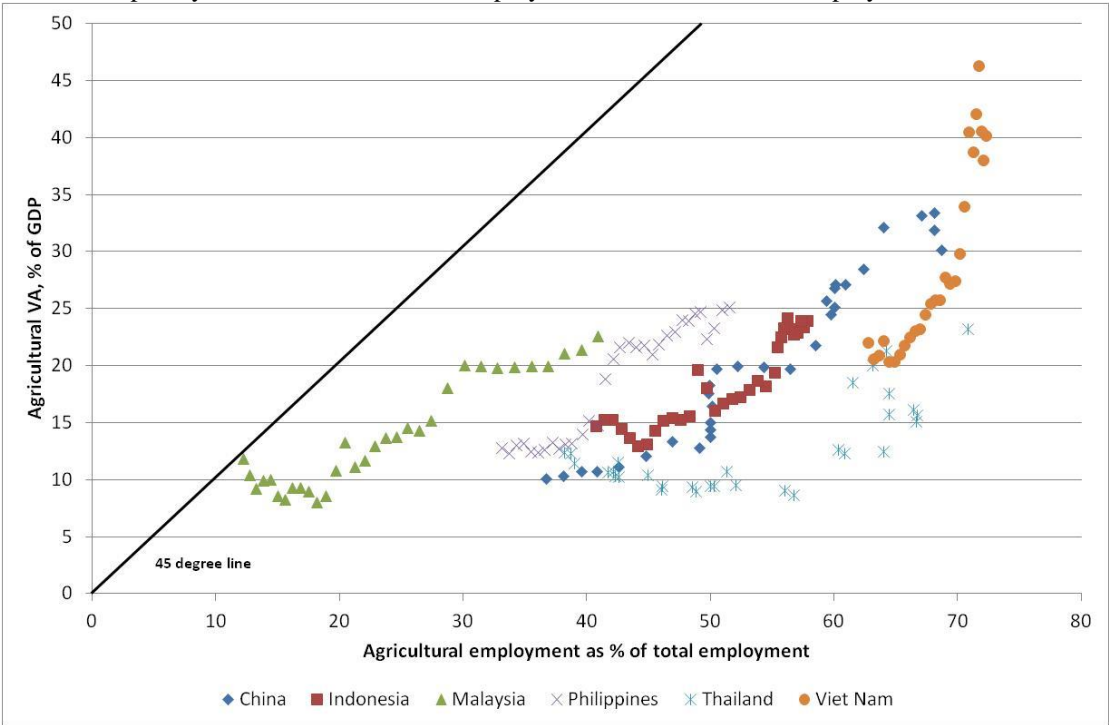
In theory, the importance of agriculture to the economy need not decline with economic growth – a country could have such a strong comparative advantage in agriculture that agriculture’s share of GDP stays constant or even increases as per capita income grows. In practice, this has never been observed over any substantial length of time. That being said, both Malaysia (8.3% to 11.9% from 2005 to 2011) and Thailand (9.0% to 12.4% from 2000 to 2011) have experienced increasing shares of agriculture in GDP over the past few years. But the increases have been small (about 3.5 percentage points) and are most likely due to an increase in the agricultural terms of trade, something that is not likely to continue forever. This temporary reversal of the long-term trend has occurred in these two countries because Malaysia and Thailand have by far the largest agricultural trade surpluses in the region as a share of agricultural value-added, at +47 and +52 percent respectively (Indonesia is next highest at +17 percent; Figure 6). Their agricultural sectors have thus benefited the most from the rising commodity prices on world markets since 2000. It is important to note that a similar

reversal has not occurred for the share of agricultural employment in total employment, which has continued to decline.

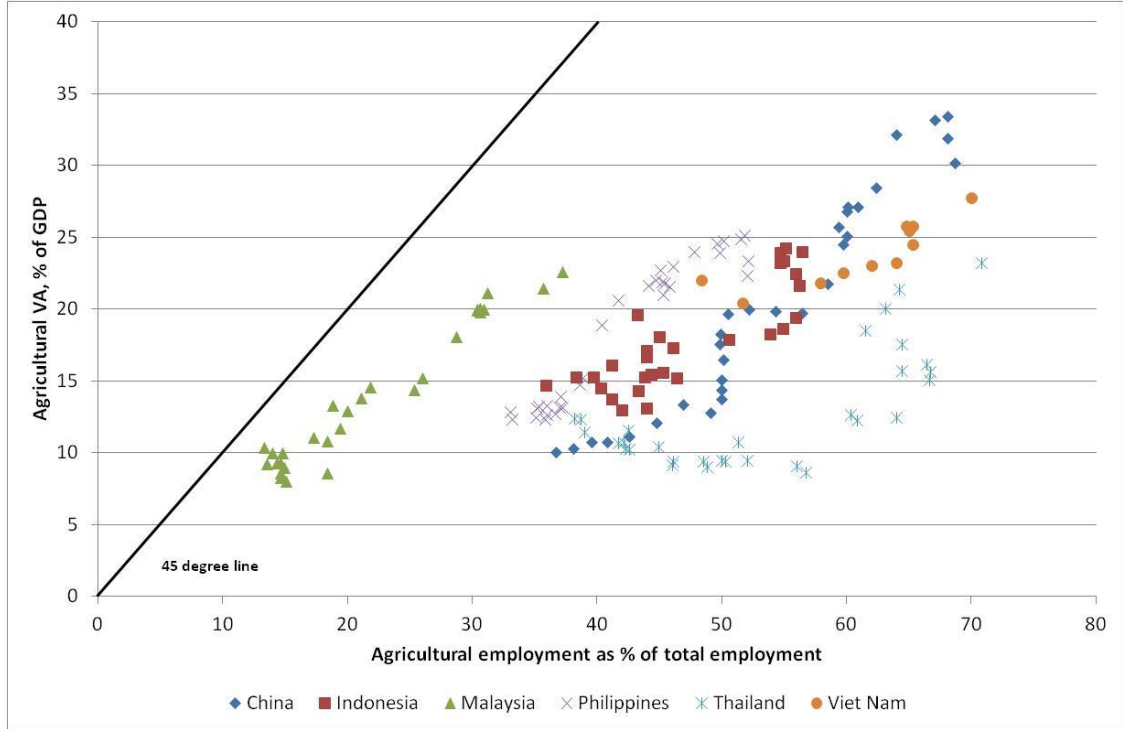
While the trend towards declining shares of agriculture in value-added and employment seems clear, there can also be great heterogeneity in the experience of individual countries. For example, for a 20% share of agricultural value added in GDP, there is a wide range of employment shares for agriculture in different countries at different times, ranging from 30% to 65%. Some of the difference in paths for the different countries is due to different definitions of the labour force, as can be clearly seen by comparing the strikingly different paths for Viet Nam in Figure 5 (Panels A and B), which differ only in the source of the agricultural employment data. Indeed, different definitions and measurement problems could account for most of the difference across these six countries. For example, neither of the employment datasets (FAO, 2014; World Bank, 2014) accounts for the fact that many people who count as employed in agriculture work only part-time in that sector, and earn much of their income outside the sector. Ideally, someone who works only 30 percent of his or her time in agriculture should be counted only as three-tenths of an agricultural worker, but the current datasets are not able to make this distinction. The Thailand Labour Force Survey for 2010 estimates that only 62% of the farm workforce works at least 40 hours per week in farming. If the 38% who do not work full time in farming are excluded, then the share of the labour force in farming declines from the roughly 40% shown in Figure 5 (Panels A and B) to just 27%, a much lower number (Poapongsakorn and Eliste, 2013). Given problems such as these, it is dangerous to read too much into individual country trends, but the general overall direction is clear.

Figure 5. Agriculture’s shares in GDP and employment, selected countries, 1980-2011

Panel A: Source of labour force data is FAO (2014), namely the economically active population in agriculture, which conceptually includes those who are employed and those who are unemployed

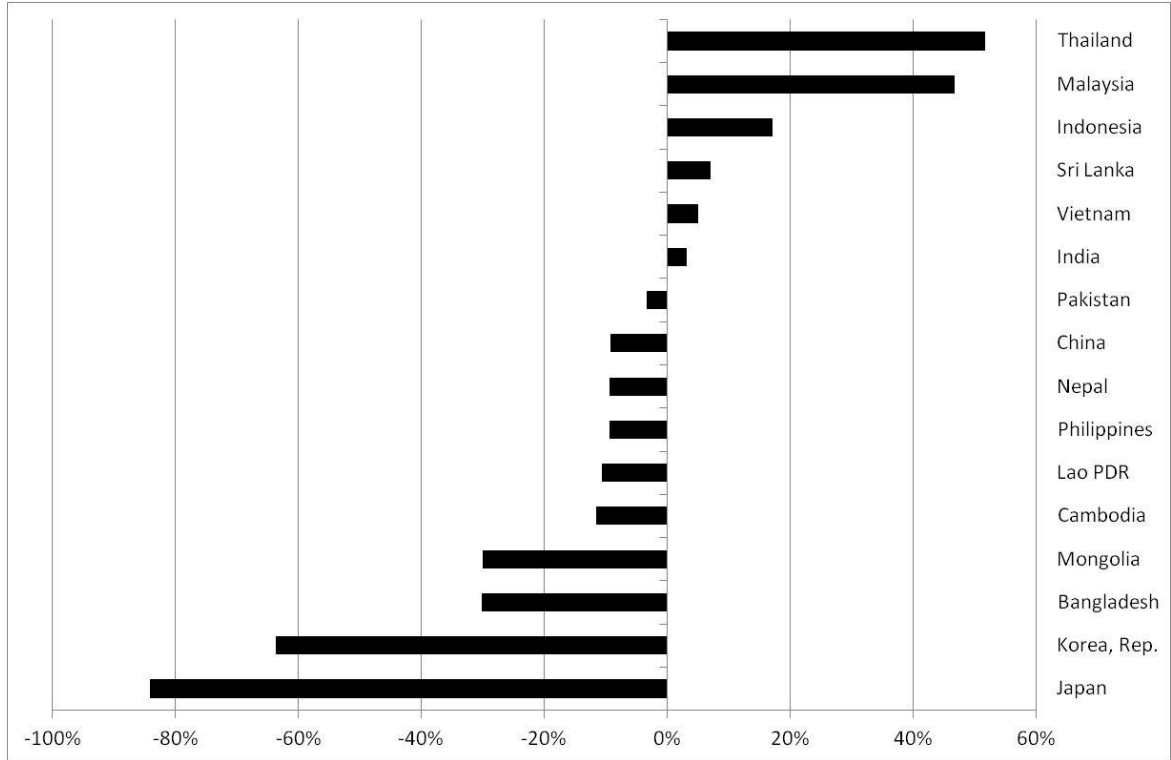


Panel B: Source of labour force data is World Bank (2014), namely employment in agriculture, which includes only those who receive remuneration for working in agriculture, including family labour



Source: Author using World Bank (2014) and FAO (2014).

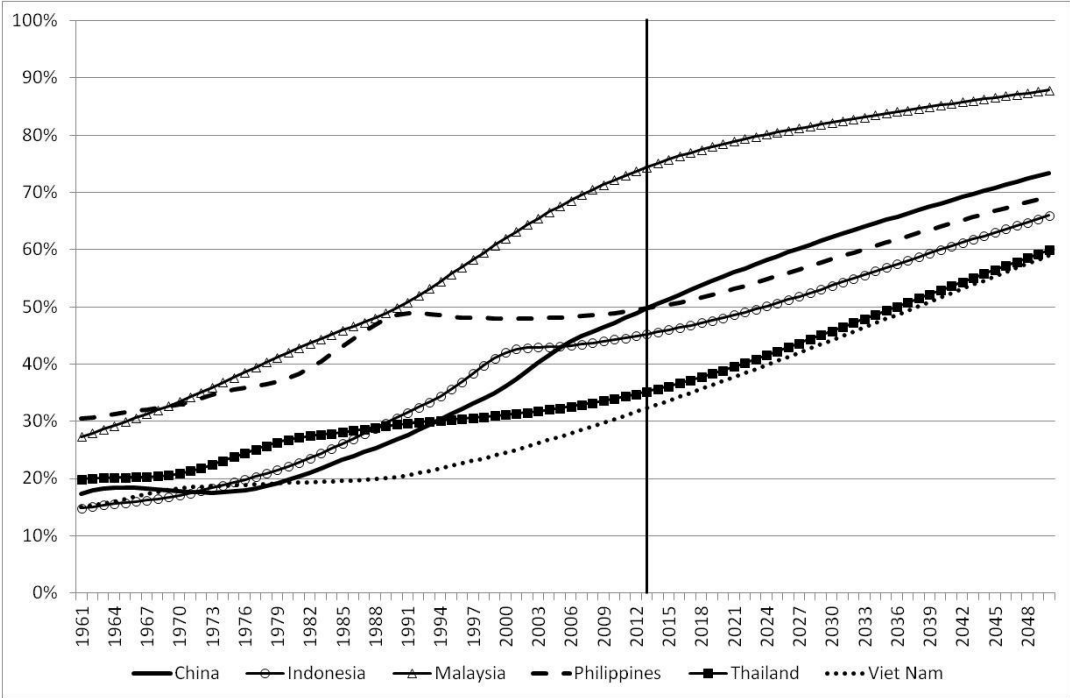
Figure 6. Agricultural trade surplus (+) or deficit (-) as a percentage of agricultural value-added, average 2009-2011



Source: Author using FAO (2014) and World Bank (2014).

This transformation of economic structure is manifested in several important ways, leading to the five key transitions elaborated by Reardon and Timmer (2014). First, as the urban industrial and service sectors grow, **urbanization**⁴ rates increase as people migrate in search of employment (Figure 7). Second, not only in urban areas, but also **within rural areas, the non-farm economy grows in importance.**

Figure 7. Urbanization rates, selected countries, 1961-2050



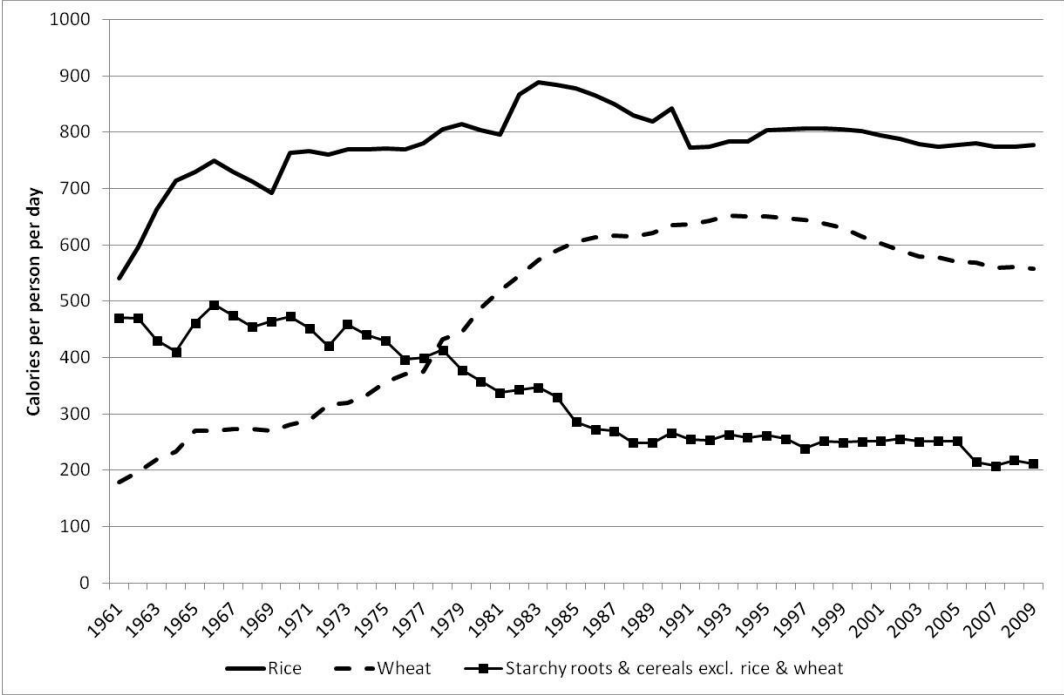
Source Author using FAO (2014).

Higher incomes also drive shifts within food demand, leading to a **dietary transition** (Figure 8). While food expenditures typically continue to rise with per capita incomes, the share of dietary energy that comes from starchy staples falls as income increases (Bennett’s Law). With consumers diversifying their diets into animal products (fish, meats and dairy), fruits and vegetables, and vegetable oils. There is also diversification within the category of starchy staples, e.g. richer Asian consumers tend to switch partially from rice to wheat (the reverse occurs in regions where wheat is the traditional staple, such as northern China and north-western India).

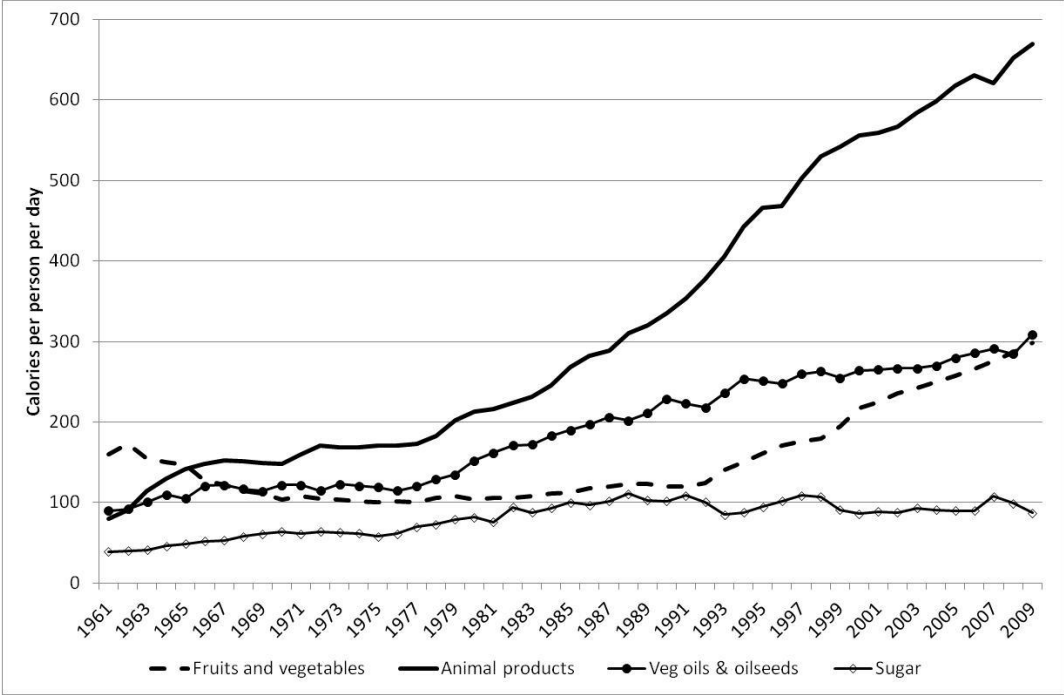
⁴ In this section, the use of bold type indicates one of the five key transitions noted by Reardon and Timmer (2014).

Figure 8. Dietary diversification over time, 1961-2009

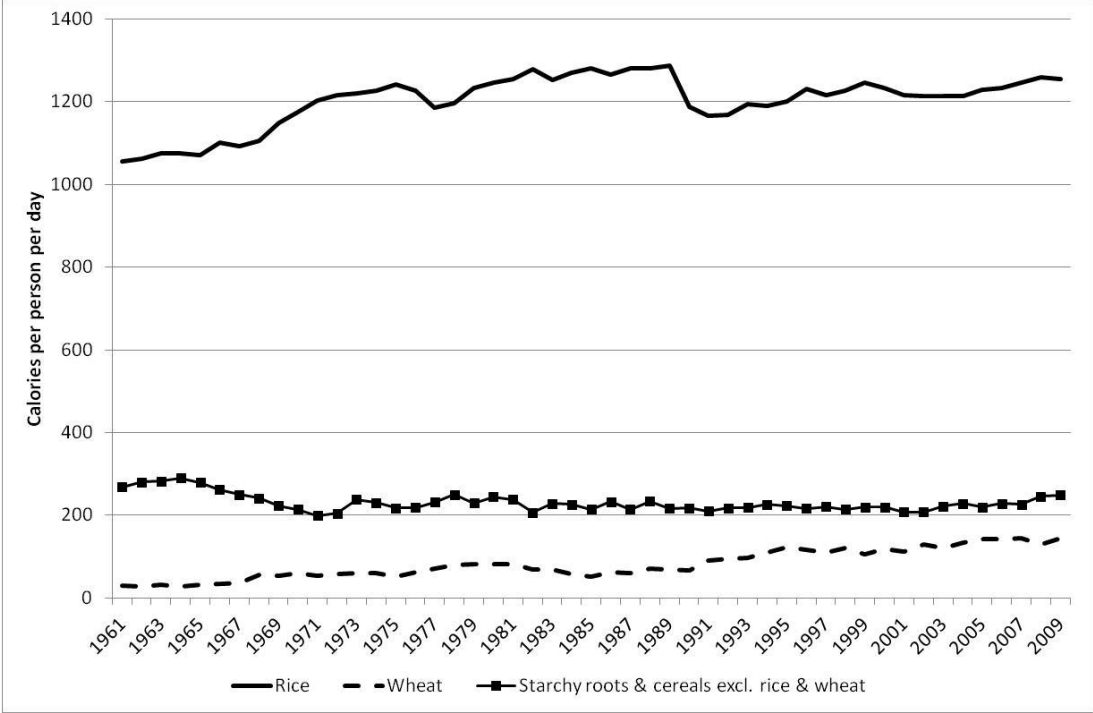
Panel A: Starchy staples, Eastern Asia



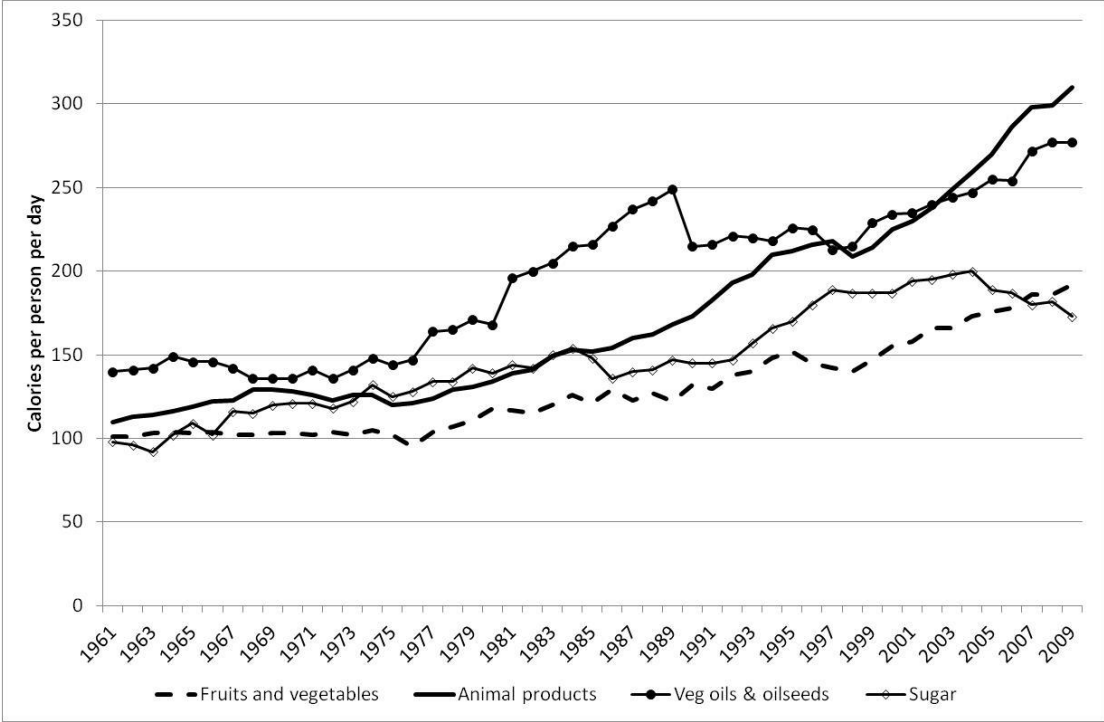
Panel B: Foods other than starchy staples, Eastern Asia



Panel C: Starchy staples, South-Eastern Asia



Panel D: Foods other than starchy staples, South-Eastern Asia

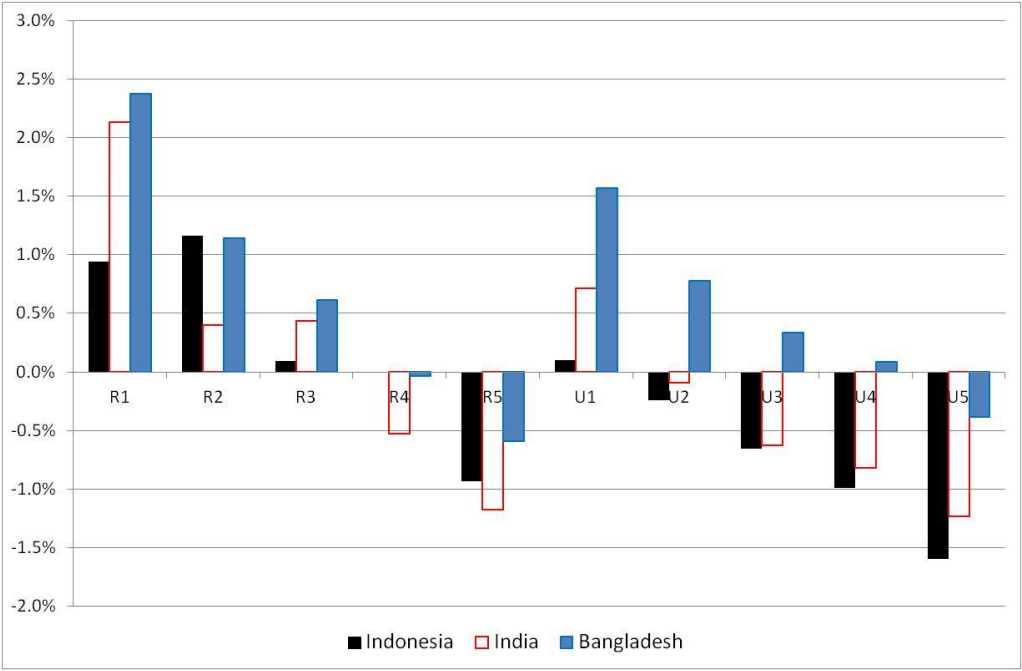


Source: Author using FAO (2014). The scales on each panel are different in order to better show the details of each food group in each region.

Note that, in South-Eastern Asia, based on data from national food balance sheets, diversification away from cereals in general has not occurred in recent years (Figure 8, Panel C). Dietary energy from (1) rice; (2) wheat; and (3) starchy roots plus cereals other than rice and wheat has risen by 41, 12 and 20 calories per capita per day, respectively (between 2004 and 2009; calculated from the FAO food balance sheets underlying Figure 8). The increase in wheat consumption is not surprising, as it represents diversification within the category of

starchy staples and is consistent with the experience of Eastern Asia. For rice, however, the data from the food balance sheets are in sharp conflict with evidence from household surveys (Figure 9). There are problems with both types of data, but the lack of consistency between the two makes it very difficult to understand the magnitude of change. Reconciling these two sources of data should be a high priority for better understanding of the dietary transition.

Figure 9. Annualized percentage change in rice consumption by quintile and location, Indonesia, India, and Bangladesh



Notes: R refers to rural quintiles, U to urban quintiles. 1 is poorest quintile, 5 is richest quintile. Periods over which changes are calculated are 1967-2006 for Indonesia, 1983-2005 for India, and 1983-2005 for Bangladesh. Source: Timmer *et al.* (2012).

Increased per capita incomes bring not only increased diversity in the types of foods, but also the forms in which those foods are consumed (e.g. more processing and packaging). These changes are facilitated by a **revolution in supply chains and retailing**, a trend that has been documented to varying extents around the world in work by Reardon and others (e.g. Reardon *et al.*, 2003; Reardon *et al.*, 2012; Reardon and Timmer, 2014).

Finally, higher incomes and the structural transformation of the economy also drive a **transformation of the agricultural sector**, the main topic of this paper. Key components of this transformation are (1) mechanization; (2) increasing farm size/consolidation; and (3) crop and product diversification. These are discussed in detail in the next section.

4. Agricultural transformation in East and Southeast Asia

There are at least three key changes that might be expected to occur during the agricultural transition: mechanization, increases in farm size, and crop/product diversification. This section will discuss these changes in the regional context. The experience of Thailand will be highlighted at several points in the discussion, as it is a key example that is relevant to the future path of the VIP (Viet Nam, Indonesia, Philippines) countries in the next two to three decades. If the VIP countries continue to grow at the same rate as in the past decade, they will

reach current (2012) Thai per capita GDP levels in 17 (Indonesia), 22 (Viet Nam) and 27 (Philippines) years.

Mechanization

Mechanization of farm operations can have many advantages, including more timely completion of planting and harvesting, reduced post-harvest losses, and others. These advantages are certainly factors in the decision to mechanize, but perhaps the two most important factors are the level of wages and the land/labour ratio: higher wages and land/labour ratios should lead to adoption of labour-saving technologies and greater use of machinery.

In the context of structural transformation, we would expect wages to rise as per capita income rises. Indeed, the correlation at country level between per capita incomes and wages is very strong and robust, with higher wages in developed countries. Predictably, there is substantial migration from poor countries to rich, as the poor seek higher wages than are available in the domestic economy. This migration occurs in spite of the fact that global labour markets are not open – there are many barriers to such movement.

This cross-country correlation between per capita incomes and wages (and mechanization) also seems to hold within the agricultural sector, at least to some extent. For example, Moya *et al.* (2004) examined rice production economics in several key Asian “rice bowls” and found that labour use was highest in the poorer countries, and that wages and mechanization both increased with per capita income.

Wiggins and Keats (2014) have recently compiled data on rural wages in several Asian developing countries. They find that in Bangladesh, China, India and Indonesia real rural wages have increased substantially, and have done so at an accelerated rate in recent years. But the increase in rural wages has not occurred everywhere at all times, even when GDP growth takes place. For example, Christiaensen (2012) also documents a recent increase in wages in China, but notes that rural wages did not increase all that much between 1993 and 2003 during a period of rapid GDP growth.

In Thailand, Poapongsakorn and Eliste (2013) show that real agricultural wages doubled between 1986 and 1997, but subsequently collapsed due to the Asian financial crisis. As of 2010, agricultural wage levels were still below those in 1997 (in real terms), even though real per capita GDP was more than 30 percent higher in 2010 relative to its peak before the crisis. In the Philippines, by 1997, real farm wages had increased 52 percent from a trough in 1984, but between 1997 and 2011 they declined by 10 percent despite an increase in real per capita GDP of 35 percent during that interval.

Evidence on mechanization is less easily available than one might expect. In China, use of large tractors has been growing at ever-faster rates since 2003, when rural wages started to rise (Christiaensen, 2012; Yang *et al.*, 2013). Small tractor use in China also continues to grow, although at much slower rates (but small tractors account for more horsepower than large tractors, see Yang *et al.*, 2013). FAO (2014) has some data on the number of different types of machines in use, but these data are old – there are essentially no data on agricultural tractors in use since 2003 for these six countries. Furthermore, even if these data were more extensive, the number of machines in use is not a particularly good measure of mechanization, because such data would not account for rental markets and the intensity of use (capacity

utilization). For example, if 1000 machines are used for two weeks per year, that implies a very different level of mechanization than 1000 machines being used for 48 weeks per year.

This discussion of data problems is not meant to assert that mechanization of Asian agriculture is not taking place – the number of anecdotes strongly suggest that it is. Nevertheless, it would be nice to have more data that capture the magnitude of the transition that is taking place. Agricultural censuses may be better sources of data for the extent of mechanization, as they can ask large numbers of farmers whether or not they are using machines, and if so, what type. A drawback is that censuses are conducted infrequently, but nevertheless censuses seem like a data source that should be utilized more extensively to gauge the trends.

For example, using data from various agricultural censuses, Dawe (2005) found that the use of harvesting machines grew rapidly for all farm sizes (including those less than 3 hectares) between 1978 and 2003 in Suphan Buri, a province in the Central Plain of Thailand with good roads and irrigation infrastructure. In 1978, just 1 percent of holdings used harvesting machines, but this proportion increased to 24 percent in 1993 and 55 percent in 2003. Nearly all of the adoption was through rental markets – just 2 percent of holdings owned harvesting machines in 2003, even though they were used by 55 percent of holdings. Even for farms larger than 22 hectares, ownership in 2003 stood at just 12 percent. Some of the rental was done through cooperatives and government agencies, but this was relatively rare: 94 percent of holdings that used these machines did so through private rental markets. These data show the crucial importance of private rental markets in the mechanization process.

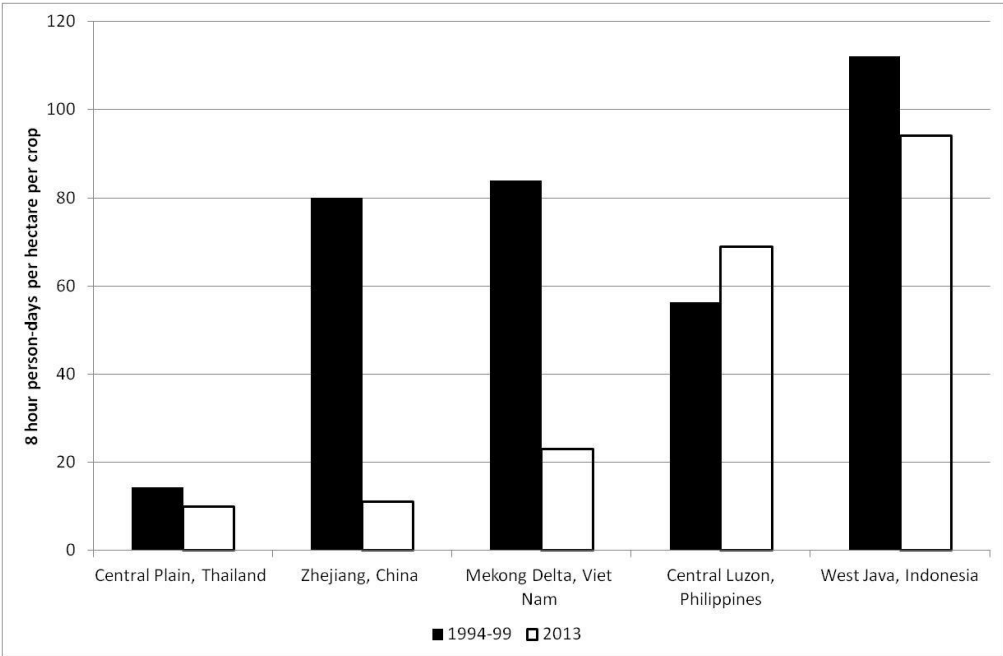
Note that the extent of mechanization did not reverse at the end of the 1990s/early 2000s, despite the decline in wages at this time in the wake of the Asian financial crisis (noted above). Once the initial investment in machinery has been incurred, the incentive to go back to more labour-intensive cultivation methods could be vastly reduced, as the machinery investment costs are now sunk costs. If this is the case, then mechanization could occur in response to wage increases over relatively short periods of time (provided they are sufficiently rapid), and the long-term behaviour of wages would matter less.

Labour use in Thai rice cultivation also declined substantially during this time. Isvilanonda *et al.* (2001) found that labour use per hectare in three different villages in Suphan Buri (representing three different rice production ecosystems) declined between 68 and 86 percent between 1987 and 1998. The decline was less dramatic in Khon Kaen in the Northeast, which is located farther from the capital Bangkok, but even there the decline in three villages ranged from 43 to 46 percent. These changes are quite dramatic for such a short period of time, suggesting that, at least in some cases, the mechanization process might be quite non-linear. Indeed, these data seem to be consistent with a standard logistic “S” curve that is often used to model adoption of new technologies. More recent data from Bordey *et al.* (2014) show that labour use in rice cultivation remains low in the Central Plain of Thailand. Furthermore, combining the data from Bordey *et al.* (2014) with those from Moya *et al.* (2004)⁵ show that a substantial decline in labour use has taken place in China and Viet Nam, following in the path of Thailand (Figure 10). Cambodia has also witnessed a substantial decline in labour use in rice cultivation, from more than 80 person-days per hectare per crop in 2005 to less than 50 in 2013 (Eliste and Zorya, 2015).

⁵ Data collection procedures in Bordey *et al.* (2014) were modelled on those used by Moya *et al.* (2004), and the sites of data collection were the same. Thus, it is reasonable to compare results from the two studies.

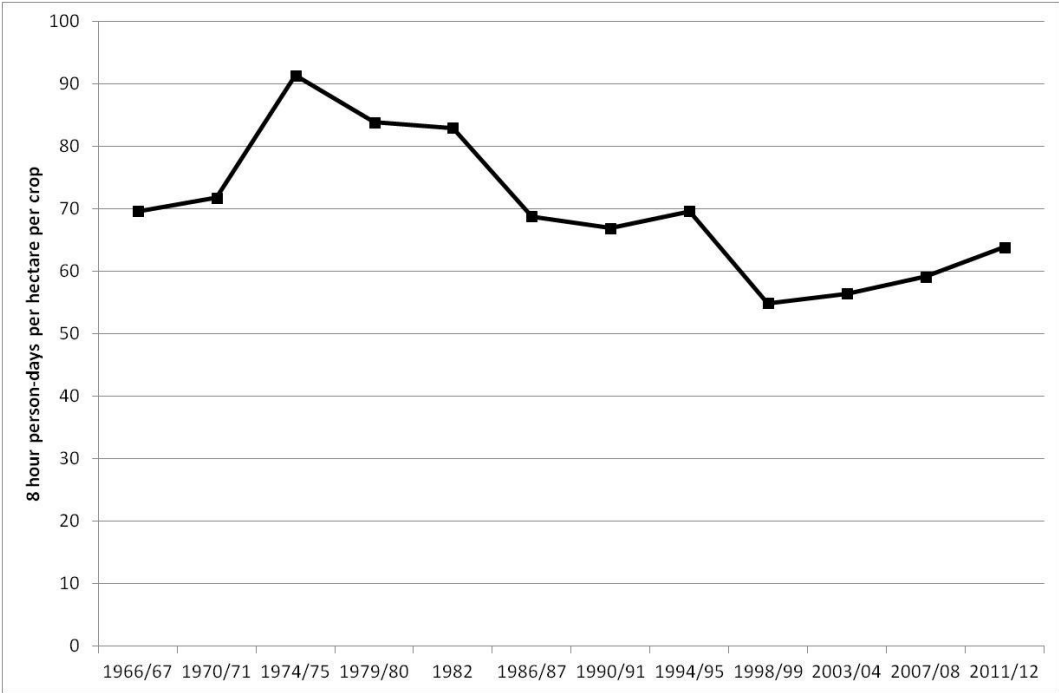
Labour use has also declined in rice cultivation in Central Luzon, Philippines, although the decline has been less dramatic than in Thailand. In Central Luzon, one of the main “rice bowls” of the country, average labour use declined from 91 person days per hectare in 1974/75 to 55 in 1998/1999 (average of wet and dry seasons). Surprisingly, labour use has slowly but steadily increased since then, back to 64 person days per hectare in 2011/12 (Figure 11; Moya *et al.*, 2014). Data from Bordey *et al.* (2014) confirm the stagnant trend in labour use, and show that the decline in labour use has also been relatively slow in Indonesia. Indeed, labour use in rice cultivation in Central Luzon and West Java, two relatively dynamic parts of their respective countries that are close to their respective capital cities, is now greater than in similar areas in Viet Nam, despite the fact that per capita GDP in Indonesia and the Philippines is much greater. It is worth noting that the Philippines and Indonesia have the highest level of rice prices among these countries, due to trade barriers that reduce imports. The resulting higher domestic prices increase the marginal value product of labour, which may be one of the key reasons why labour use in rice cultivation is still so high.

Figure 10. Labour use (including family labour) in rice cultivation, various rice bowls in Asia



Note: Data for Indonesia pertain to 1994-1997. Sources of raw data: Moya *et al.* (2004), Bordey *et al.* (2014).

Figure 11. Labour use (including family labour) in rice cultivation, Central Luzon, Philippines

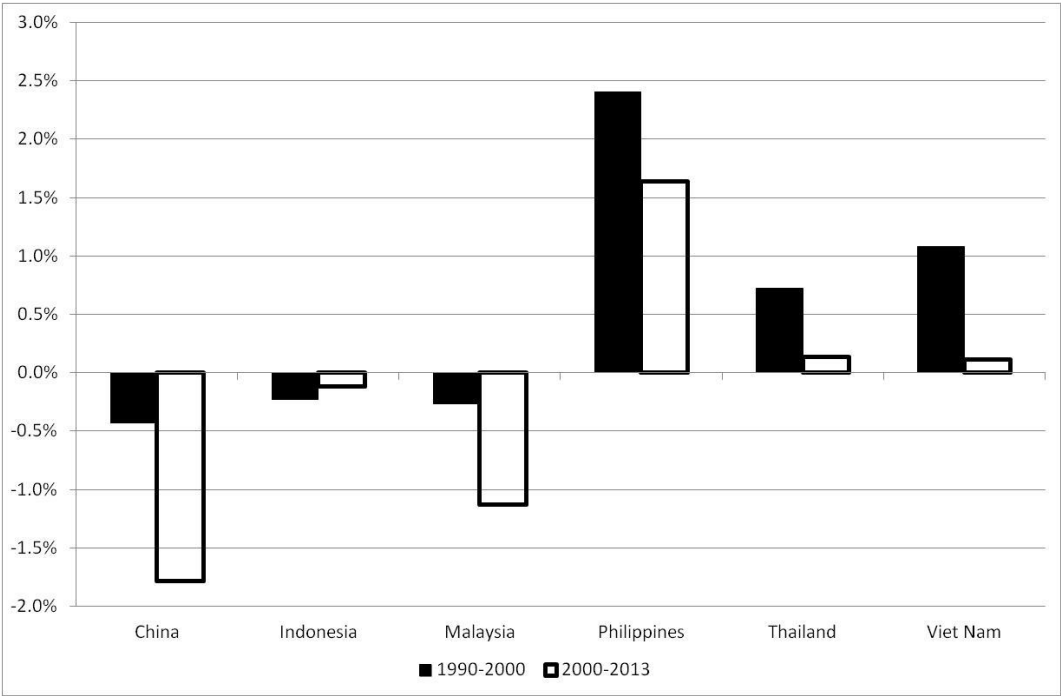


Source of raw data: Moya *et al.* (2014).

These trends in labour use in Indonesia and the Philippines are worrying. On one level, it means that poor people in rural areas have more opportunities for employment, but manual employment in rice cultivation is not easy work, and it also cannot sustain incomes above the poverty line. The trends also suggest that people are having trouble finding employment in the non-farm economy, despite annual average growth of GDP per capita of 3-4 percent in the two countries during the past decade.

Interestingly, real wages seem to be on different trajectories in the two countries – a slight decline in the Philippines, but rapid growth in Indonesia, at least in recent years (Wiggins and Keats, 2014). This difference in real wage trends may be due to broader demographic trends: growth in the rural population in the Philippines has been much greater than in the other middle-income countries of East and Southeast Asia discussed in this paper (Figure 12). The rural population has already peaked in all of these countries except the Philippines, where it is not projected to peak until 2035. In fact, rural population growth in the Philippines has been greater even than in the low-income countries of the region. Basic labour supply and demand suggests that it will be more difficult to achieve rising rural real wages under such conditions, delaying the structural transformation.

Figure 12. Average annual rural population growth in various Asian countries



Source: Author using FAO (2014).

Relative land/labour ratios are another important determinant of mechanization. Thus, for example, use of combine harvesters is already occurring in rice production in Myanmar, despite its low level of per capita incomes and wages. This might also be due to increased migration to Thailand in recent years, which has put upward pressure on wages in Myanmar. Thus, this type of mechanization has occurred much earlier in the development process than in Indonesia or the Philippines. Again, however, there are not good data on the magnitude of the mechanization.

To summarize, mechanization is indeed taking place, but much of the evidence assembled to support this is fragmentary. As a result, there is not a clear picture of the rate at which mechanization is occurring. Data from agricultural censuses might usefully be exploited in order to learn more about how rapidly this transition is occurring.

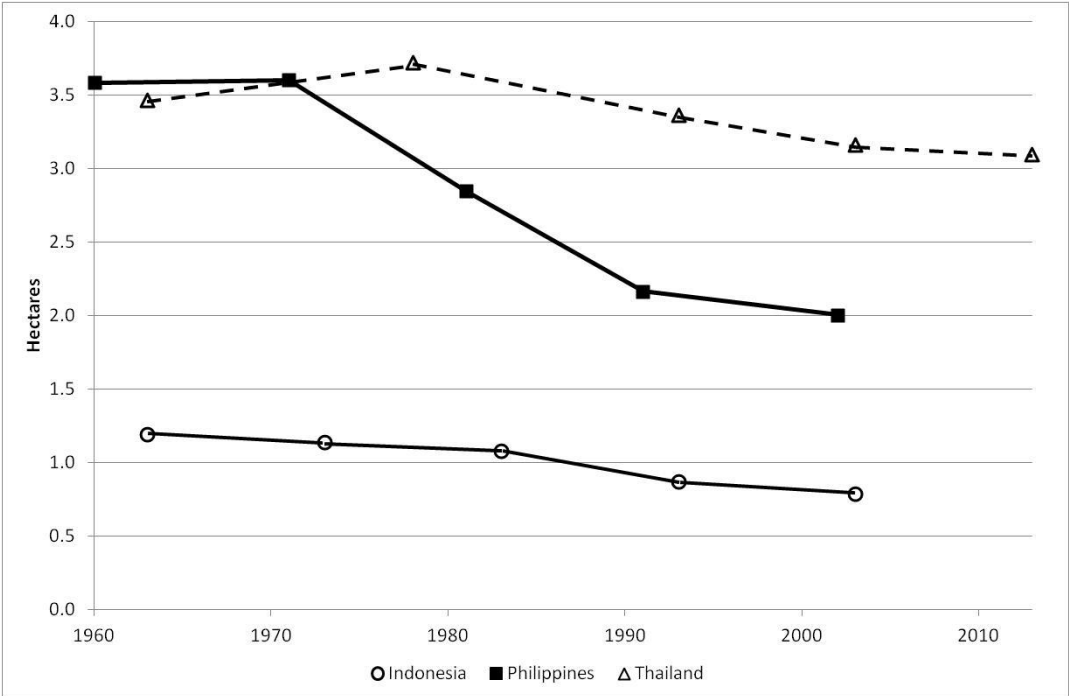
Larger farms?

Average farm size, as a matter of arithmetic, is total farm area in a locality divided by the number of farm holdings in that locality. Over time, if the percentage increase in farm area is less than the percentage increase in the number of farm holdings, then farm size will decrease. This seems likely to hold for developing countries where the absolute size of the farm population is still increasing, because this will probably mean that the number of farm holdings is increasing (although there may be some lags involved depending upon the demographics of the farm population). Furthermore, in Asia at least, land scarcity means that farm area is not likely to increase too rapidly, if at all.

For Indonesia, the Philippines and Thailand, the total number of farm holdings has been continually increasing ever since the first agricultural censuses in each of those countries. In all three countries, the number more than doubled between the early 1960s and the early 2000s. Even in Thailand, the wealthiest of the three and the most advanced in terms of structural transformation, the number of holdings in 2013 was still greater than in 2003 (albeit

by just 2 percent). As a result, average farm size for each of the three countries has continued to decline (Figure 13).⁶

Figure 13. Average farm size over time, Indonesia, Philippines and Thailand



Source: Author using National agricultural censuses.

Over the long-term, as per capita incomes increase and the structural transformation proceeds, the number of farmers will eventually decline (see the black squares in Figure 2⁷). Eventually, the decline in the number of farmers seems likely to be larger than the decline in agricultural area, so that average farm size will probably begin to increase over time at some point.

Thus, for example, in Thailand, 54 percent of its provinces witnessed declining numbers of farms from 2003-2013, compared to just 39 percent in the Philippines from 1991-2002. The greater percentage in Thailand is probably due to the fact that the structural transformation is more advanced in Thailand. Comparing the midpoint between the two censuses in each country, the share of agriculture in GDP was 12 percent in 2008 for Thailand versus 19 percent in 1997 for the Philippines (Philippine census data for 2013 had not been released at the time of writing).

In Thailand, the provinces with a decline in the number of holdings are clustered in specific parts of the country, viz. the Northern and Central Plains Regions, and nearly all of them are contiguous (the provinces that are colored purple, blue or green in Figure 16). There are also several (contiguous) provinces in the center of the Northeastern Region where the number of holdings declined, as well as two small provinces in the Southern Region (the hubs of tourism in this part of the country). Collectively, these provinces tend to have the most dynamic non-farm economies, which leads to a decline in the number of farm holdings as families find

⁶ Indonesia has recently released the results of its 2013 Agricultural Census, but unfortunately the definition of a farm is inconsistent with that used in the censuses conducted in 1963, 1973, 1983 and 1993, so it will be impossible to extend this series forward.

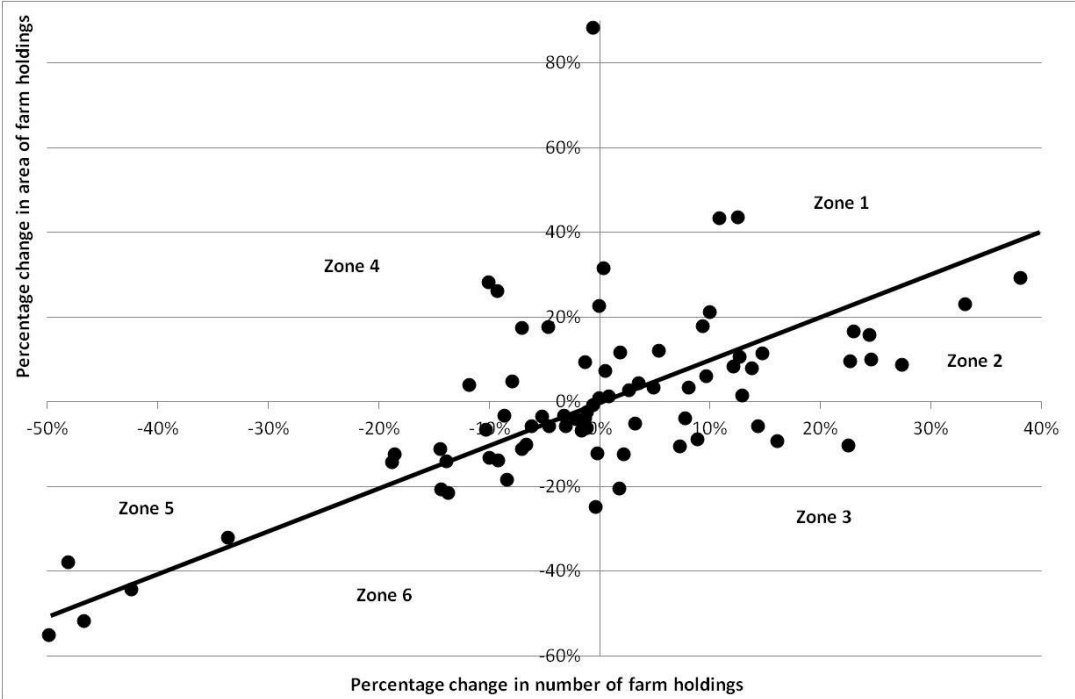
⁷ The black squares show the decline in agricultural employment as a percentage of total employment. The decline in the absolute level of employment will be less rapid when population growth is positive.

more remunerative employment in other sectors of the economy. In the Philippines, the provinces with a declining number of holdings also tend to be the most dynamic areas, located in the hinterlands of major urban centers such as Manila, Cebu, Iloilo; provinces such as Pangasinan; and the Ilocos region (Figure 17).

But along with the number of farm holdings, the total area of farm holdings is also a determinant of farm size. At the national level, at least in the developing countries of East and Southeast Asia where land is relatively scarce, it may be roughly correct to assume that total farm area will be roughly constant over the medium-term (as in Masters *et al.*, 2013). When this assumption is true, average farm size will be increasing if the number of holdings is declining. At the national level, an assumption of constant area seems to be roughly correct. In Thailand, according to the agricultural census, the total area of all holdings declined by less than 1 percent (cumulative, not per annum) between 1993 and 2013. In the Philippines, between 1980 and 2002, the total area of all holdings declined by 1.7 percent (again, this is cumulative, not per annum).

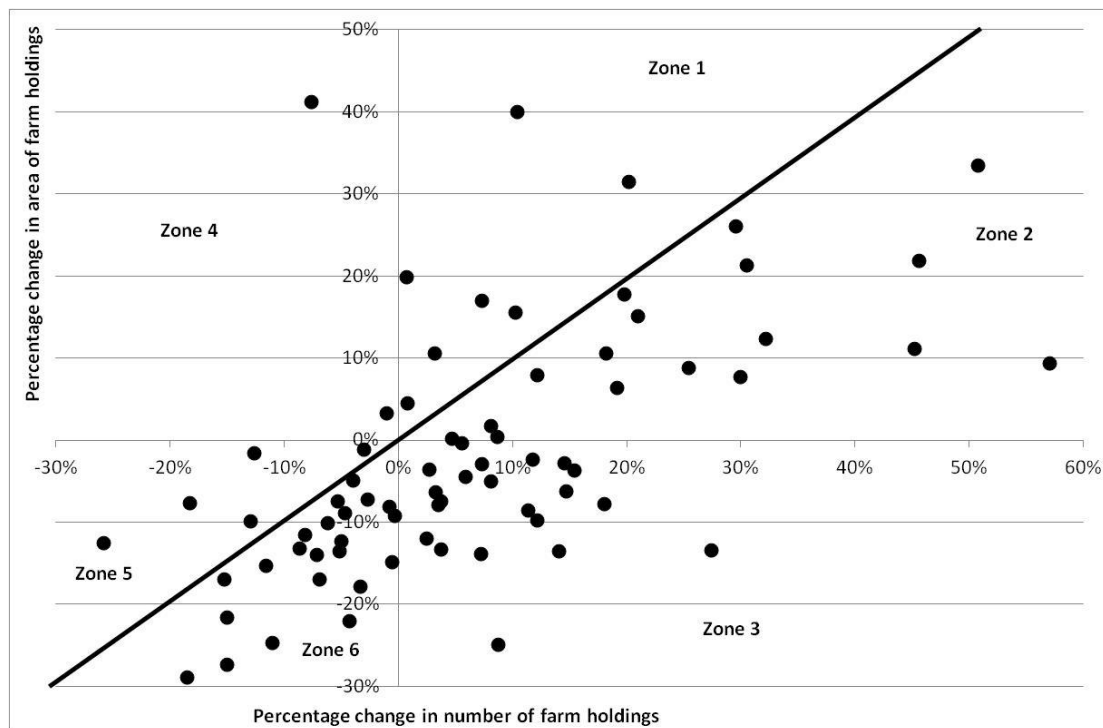
But these national level figures mask considerable variability at the provincial level, as can be seen in Figure 14 and Figure 15, which present scatter plots of the cumulative percentage change in the number of holdings on the x-axis and the cumulative percentage change in the total area of all holdings on the y-axis, the change being calculated over 2003-2013 for Thailand and 1991-2002 for the Philippines. From these scatter plots, it can be seen that the area of holdings has remained roughly the same in some provinces, increased substantially in some provinces, but declined substantially in others (for both countries). These scatter plots paint a very dynamic picture of sub-national land use underlying the relatively constant figures at the national level.

Figure 14. Scatter plot of percentage change in number and area of farm holdings for provinces between 2003 and 2013, Thailand



Note: Zones 1, 2, 5 and 6 are half quadrants divided by the 45 degree line shown in the diagram. Zones 3 and 4 are quadrants. Farm size is increasing above the 45 degree line (Zones 1, 4, 5) and decreasing below the 45 degree line (Zones 2, 3 6).

Figure 15. Scatter plot of percentage change in number and area of farm holdings for provinces between 1991 and 2002, Philippines



Note: Zones 1, 2, 5 and 6 are half quadrants divided by the 45 degree line shown in the diagram. Zones 3 and 4 are quadrants. Farm size is increasing above the 45 degree line (Zones 1, 4, 5) and decreasing below the 45 degree line (Zones 2, 3 6).

When the area of holdings is not constant or increasing, a decline in the number of holdings due to exit from the sector does not necessarily translate into larger farm sizes. If, for example, the percentage decline in the area of holdings is greater than the percentage decline in the number of holdings, then average farm size will decrease, not increase. Thus, Figure 14 and Figure 15 are divided into several different zones according to the magnitude of relative percentage changes in the total number of holdings and the total area of all holdings. Zones 1, 4 and 5 are circumstances where farm size is increasing, while Zones 2, 3 and 6 represent circumstances where farm size is decreasing.

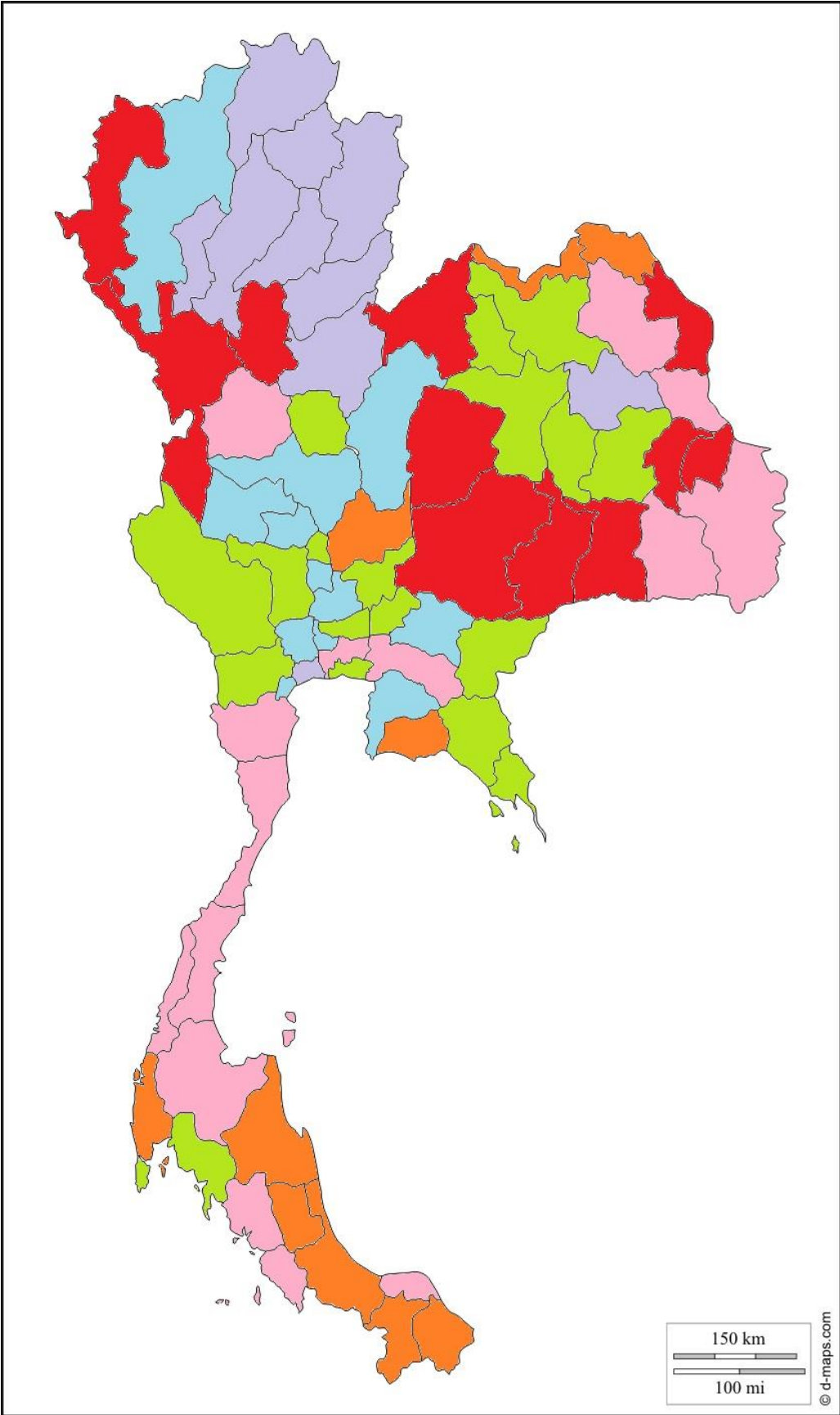
It seems reasonable to expect that farm sizes would increase in commercially dynamic areas, but this might not always be the case because total farm area might also be decreasing in such dynamic areas due to urbanization and its demands for more housing, growth of non-farm enterprises, and infrastructure development.⁸ This decline in agricultural area will offset to some extent the tendency towards larger farm sizes that is spurred by a decline in the number of holdings. Thus, in Figure 14 for Thailand, there are 31 provinces in Zones 5 and 6 combined (out of 76 total provinces), where both the total number of holdings and total area

⁸ Declining farm area is a key reason why farm sizes have not increased substantially in Japan and the Republic of Korea. In Japan, the total area of farm holdings declined from 7.1 million hectares in 1960 to 3.6 million hectares in 2010, a decline of nearly 50 percent. In Korea, the decline has been even more rapid, from 4.8 million hectares in 1960 to just 1.9 million hectares in 1990. To gain some perspective on the timing of these declines, note that Japan's per capita GDP in 1960 in constant US dollars was roughly similar to that of Malaysia in 2012. The decline in the total area of farm holdings in Korea started at a much lower income level, however: in 1960, Korea's per capita GDP was much lower than Japan's at that time, and it was similar to that of the Philippines today (data on GDP per capita used in these comparisons come from World Bank, 2014).

declined between 2003 and 2013. In a majority (19) of those 31 provinces, farm size declined, because the decline in area was larger than the decline in the number of holdings. In the Philippines (Figure 15), a similar proportion of provinces (27 out of 74) were in Zones 5 or 6 (where both number and area of farms declined). Even more so than in Thailand, farm size declined in most of these provinces (in 22 of the 27), as land is in much scarcer supply in the Philippines.

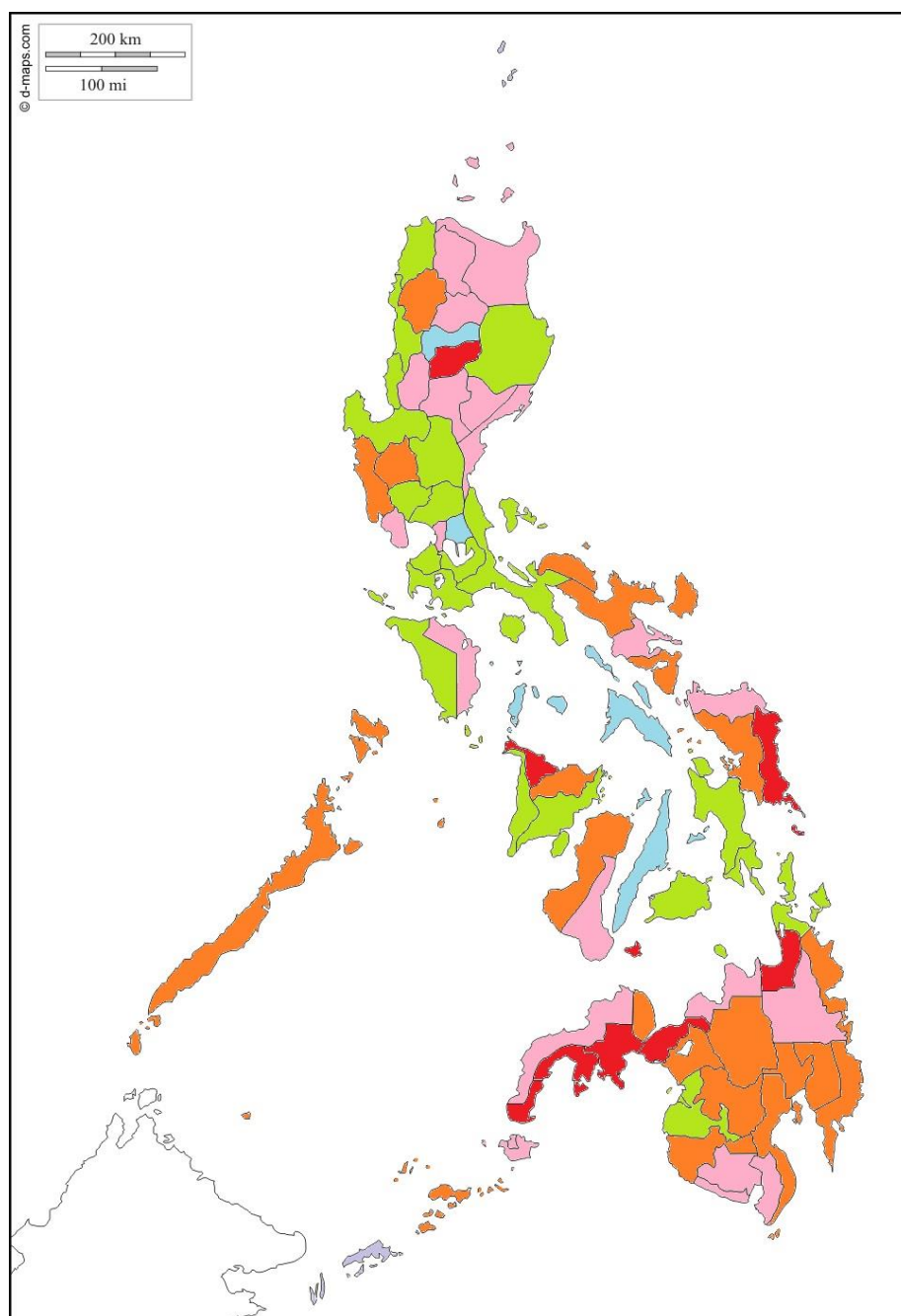
Comparing 2013 with 2003, farm size increased in 43 percent of provinces in Thailand, but in just 19 percent in the Philippines (between 1991 and 2002). This is due both to Thailand's more advanced non-farm economy (which leads to more provinces with a declining number of farms), as well as its greater supply of land (which leads to more provinces with an increased area of holdings). But the absolute size of the increase in farm size is relatively small. Among provinces where farm size increased between 2003 and 2013 in Thailand, average farm size increased by only about a third of a hectare. But even this figure perhaps overestimates likely medium-term increases in farm size in Asia, as it includes provinces where area has increased, and such areas are likely to be rare in Asia in the future. Among Thai provinces where both the number and area of holdings declined from 2003-2013 and farm sizes increased (zone 5), the average increase in farm size from 2003 to 2013 was from 3.44 hectares to just 3.66 hectares. This seems like a very slow rate of change over the period of a decade in a land-surplus dynamic economy.

Figure 16. Map of Thailand with provincial boundaries showing various combinations of changes in number of holdings, total area of all holdings, and farm size



Source: Blank map downloaded from: http://d-maps.com/carte.php?num_car=14637&lang=en.

Figure 17. Map of Philippines with provincial boundaries showing various combinations of changes in number of holdings, total area of all holdings, and farm size



Source: Blank map downloaded from: http://d-maps.com/carte.php?num_car=26013&lang=en.

Legend for figures 16 and 17

Zone	Change in number of holdings	Change in total area of all holdings	Change in farm size	Color
1	+	+	+	red
2	+	+	-	pink
3	+	-	-	orange
4	-	+	+	purple
5	-	-	+	blue
6	-	-	-	green

This is not to deny that some large farms are forming. Land rentals are contributing to these changes; in China in 1988, just 1 percent of land was rented in, but this had grown to 18 percent by 2008 (Jia, 2013). And it is also true that, at least for certain operations, some farms may be managed as a group. Such institutional innovations might mean that operational farm sizes are much larger in some cases, even above and beyond what would be calculated by taking into account farms that rent in land (which is done by most agricultural censuses).

But in order to truly understand how rapidly farms are getting larger, and the role that will be played by large farms in the overall agricultural economy, it is essential to use data that are systematically collected on large scales. The only such data that exist at present come from agricultural censuses, but they do not necessarily point to wide-scale land consolidation. For example, in 2013 in Thailand, there were nearly 1633 farms larger than 80 hectares, which allows for plenty of anecdotes about the importance of such farms. But these farms accounted for just 1.5 percent of the area of all farms, so it is not clear how important a role they are playing in the sector as a whole. Furthermore, the number of such farms (and their total area) decreased from 1993 to 2003 (by 9% in number and 28% in area), and again from 2003 to 2013 (by 34% in number and 43% in area). In addition to the decline in the number and area of large farms, it seems that there has been little progress in reducing land fragmentation in Thailand. In 1993, there were on average 1.70 parcels per farm, but by 2013 there were 1.78 parcels per farm.

Looking to the medium-term future, it seems likely that the pace of decline in the number of holdings will not accelerate too rapidly. In most of the Thai provinces where the number of holdings declined from 2003-2013, the annual percentage decline was 1 percent or less. Many farm households probably view farming as a safety net in case of crisis. Given that there have been two major crises in the past 20 years (the Asian financial crisis of 1997-1998 and the food and financial crisis of 2007-2008), many people will want to hold onto land as a safety net for some time to come. In the Philippines, there are additional political reasons why the number of holdings is not likely to decline. So many resources, both financial and political, have been invested in land reform over the past few decades that it seems unlikely there will be substantial land market liberalization that allows land reform beneficiaries to sell their land without any constraints.

The slow decline in the number of holdings, coupled with the land scarcity that exists in much of Asia, suggest that it is unlikely that farm sizes will typically become much larger for the foreseeable future. In China, farm size has been increasing since 2002, but it increased from 0.55 hectares in that year to 0.60 hectares in 2008, an increase of just 0.05 hectares (with nearly all of the increase being due to increased farm sizes in the Northeast; Nie and Fang 2013). Even in Thailand, which is relatively land surplus compared to other Asian countries, the magnitude of the increase in farm size has so far been small, as noted above. Increases of such magnitudes hardly seem like they will make a substantial difference to the nature of farm operations or to the income-generating potential of a typical farm.

The relatively slow decline in the number of holdings, and the overall scarcity of land, will have two key implications. First, as labour shortages increase, mechanization will occur, but it will need to work at much smaller field scales than in North America or Australia. In addition, given credit market constraints and the substantial fixed costs involved in owning farm machinery, most farmers will need to mechanize through rental markets: farm sizes will simply not be large enough to profitably work machinery full-time without renting out to other farmers. Fortunately, rental markets have arisen in many countries and contexts in Asia

(e.g. pump irrigation in Bangladesh; thresher rentals in the Philippines, and the rental of harvesting machines in Thailand mentioned above). Thus, the main role of government is to make sure that it does not hinder the formation of such markets.

Second, it seems impossible that farm sizes can increase enough to make a noticeable dent at increasing farm incomes. In addition to the trends noted above, a crude “back of the envelope” calculation that divides agricultural area in 2011 by the projected total population in 2050 also serves to illustrate the point. For Australia, New Zealand and the USA, this calculation gives values of 13, 2.0, and 1.0 hectares per person, respectively. For Viet Nam, Indonesia and the Philippines, this calculation gives just 0.10, 0.19 and 0.08 hectares per person, respectively. Thus, even when the structural transformation eventually leads to identical shares of the population employed in agriculture across all these countries (a time that is still many decades away), Asian farm sizes will never be as large as in North America, Australia and New Zealand. Relying on large farm sizes alone to solve the farm income problem in Asia will work for only a very tiny minority, because land resources are simply too limited.

Thus, for Asian farm households to keep up with their non-farm counterparts, it will be essential to grow more profitable crops (primarily non-staples) and diversify their incomes into non-farm sectors (or leave farming entirely). Fortunately, these processes seem to be happening. Isvilanonda *et al.* (2001) found for the Thai farmers that they surveyed in both 1987 and 1998 (located in Suphan Buri and Khon Kaen), income from rice cultivation declined, while income from non-rice agriculture more than doubled. In the Philippines, the share of non-farm income in total rural household income increased from 36 to 60 percent between 1985 and 1997, and in Bangladesh it increased from 37 to 46 percent (Hossain *et al.*, 2001a; Hossain *et al.*, 2001b).

It is not clear what impact the continued dominance of small farms will have on production and yield (or environmental management). The higher yields on small farms that are found in much of the literature seem to be due to the availability of relatively cheap family labour for which the shadow wage rate is less than the market rate, but this differential is not likely to persist with economic development. Large farms (in the operational sense) may have an advantage in that they can access more sophisticated technologies; in addition, they have more incentive to adopt them if such technologies have fixed costs of learning, because a large farm has more hectares over which it can apply these technologies, thus increasing the profits of doing so. A small farmer has little incentive to invest in time-consuming learning if she can only profit on one hectare of land, especially given the growing importance of rural non-farm income for farm households noted above.

But rental markets for machinery and services (that embody knowledge) have a long history in Asia, and are becoming increasingly common. Contract rice threshing arose relatively early in the Philippines during the Green Revolution, and rental markets for groundwater are common in Bangladesh. These markets arose spontaneously, without much in the way of government promotion. At present, there are enterprises in China that provide harvesting services to small farms over a large geographical area, moving from south to north as the harvest progresses. The growth of these enterprises seems to have benefited from some subsidies and other support, although it is still a private sector operation (Yang *et al.*, 2013). Pruning, spraying, bagging, pest management and harvesting services are provided by various firms for mango production in the Philippines and Indonesia. Similar examples exist for livestock and coffee, as well as other food products.

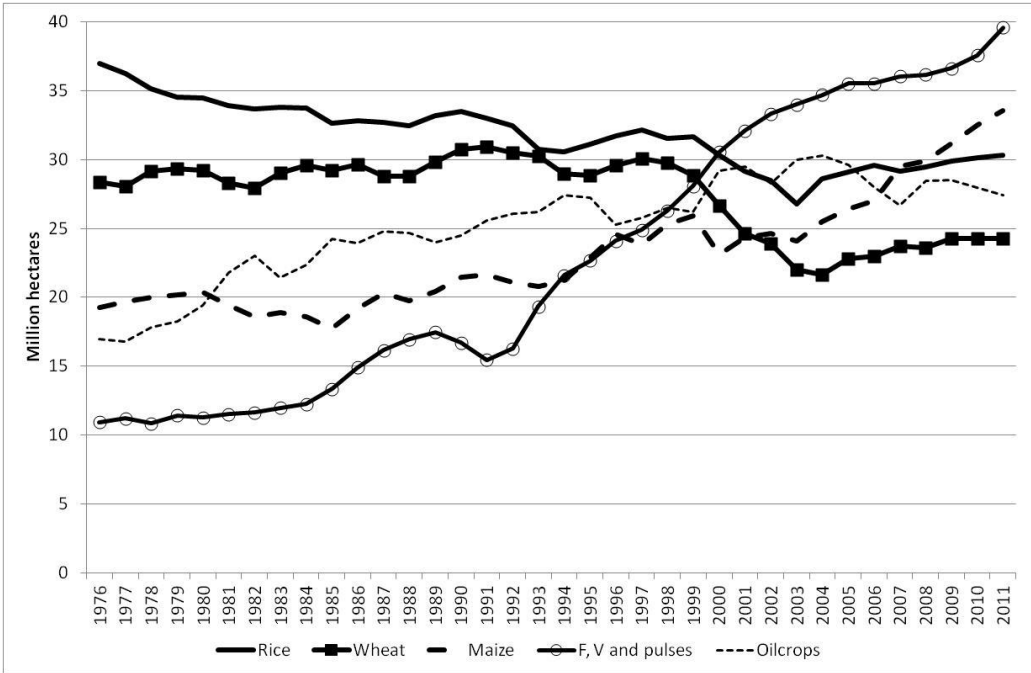
These rental markets may help greatly to overcome the “small farm problem” by overcoming some of the constraints faced by small farmers. More research is needed to determine under what conditions, if any, large farms will produce more than small farms, and how much more can be produced. But if there is a large difference, there should be incentives for small farms to lease their land to large farms, or to rent in machinery and services.

Crop and production diversification

As noted earlier, dietary diversification has been a key trend in East and Southeast Asia over the past decades, with increasing per capita incomes giving consumers access to meats, dairy products, fruits and vegetables, and vegetable oils. At a global level, this increased demand for certain products can only be met through diversification in production. But at national and lower levels, dietary diversification need not imply crop or production diversification, as the additional consumer demand can be met through international trade. This section will examine the extent to which crop diversification is taking place, as well as the extent to which international trade is being utilized to meet the demands of dietary diversification.

China is an example of a country where substantial crop diversification has taken place during the past 40 years, much of it in response to the changes in Chinese diets. The area⁹ devoted to fruits, vegetables and pulses (FVP) has more than doubled since 1990 (Figure 18), and these crops now account for more area than any single cereal (although much less than all cereals taken together). The area to maize (mostly used as animal feed) increased 56 percent from 1990 to 2011, and area devoted to oilseeds has also increased, especially compared with the mid-1970s (it has declined recently, however, with large increases in imports to satisfy rising domestic demand). During the same period (1990-2011), area to wheat declined by 21 percent and area to rice declined 10 percent.

Figure 18. Crop area harvested in China, 1976-2011



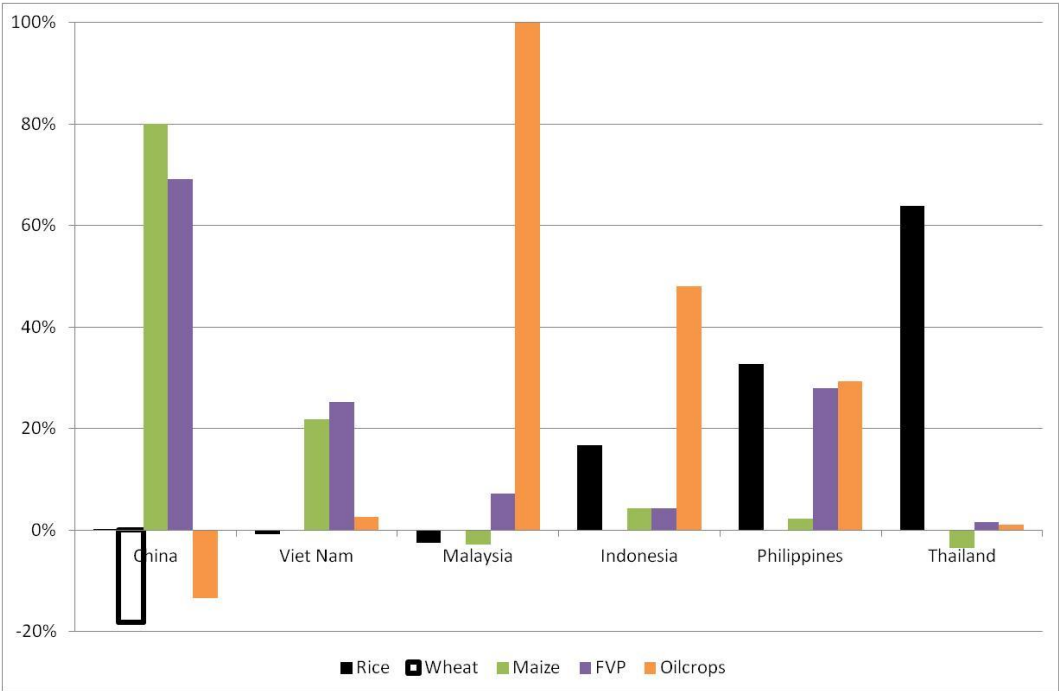
Source: Author using FAO (2014).

⁹ Throughout this section, “area” refers to area harvested, a measure that counts one hectare harvested twice per year as two hectares.

Over the past decade or so (2000-2011), of the increase in crop area harvested in China, 80 percent went to new maize area, and 69 percent went to new area for FVP (the sum of these two numbers is greater than 100 percent because of declines in area to oilcrops, wheat and other crops; see Figure 19). China is an example of a country where production trends are to a large extent mirroring standard trends in dietary diversification.

But this has not happened in all countries: Malaysia is an example that is more or less the polar opposite of China. Maize area harvested has declined, while rice area has been largely constant during the past 30 years. Area to FVP has increased, but is still at relatively low levels compared to other crops. Of course, the big story has been a massive increase in the area devoted to oilcrops, most of the resulting production bound for exports: oilcrop area increased from about half a million hectares in 1972 to more than 4 million hectares in 2011. Thus, maize and FVP have not assumed important roles in Malaysia’s cropping systems, in contrast to what has happened in China. Of the increase in crop area harvested between 2000 and 2011, 146 percent has gone to oilcrops, with most other crops declining in area. Increased area to FVP accounted for just 7 percent of the increase in area harvested to all crops (see Figure 19). The experiences of China and Malaysia are so different probably because the former is a large country with a wide range of agro-ecological zones suitable to a wide range of different crops, while Malaysia is concentrated within a narrow range of latitude, which encourages specialization.

Figure 19. Percentage of additions to total crop area harvested accounted for by different crops, 2000-2011

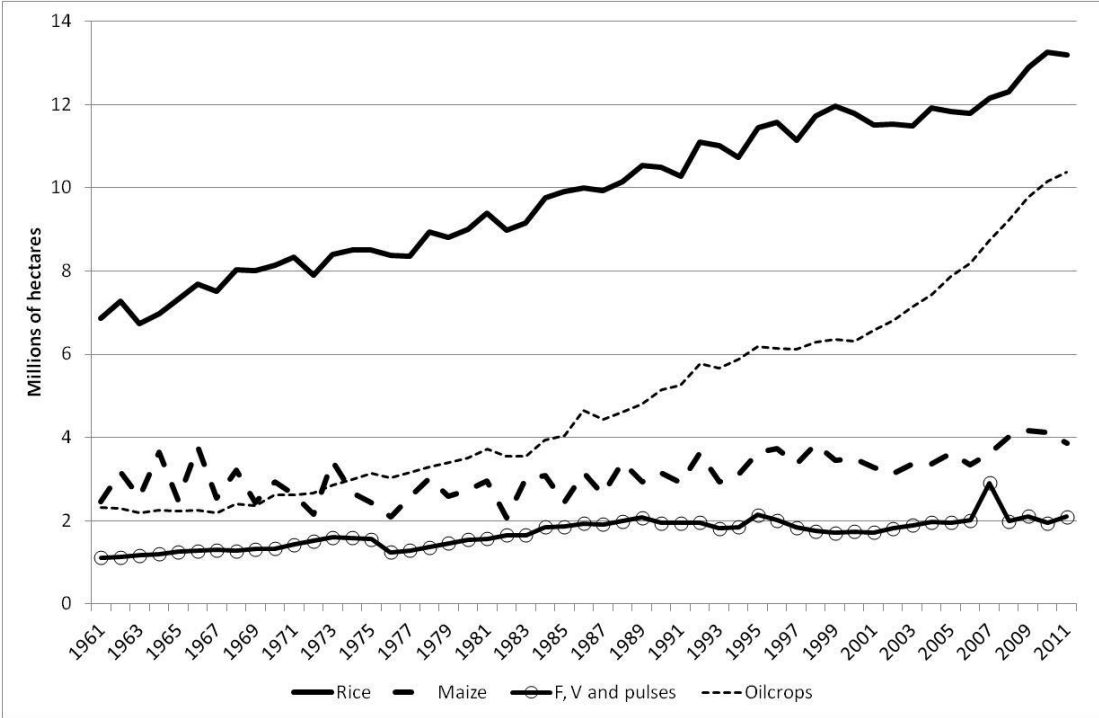


Source: Author using FAO (2014).

Among the VIP countries, Indonesia (Figure 20) and the Philippines (Figure 21) have had similar recent changes in cropping patterns. Of the increased area since 2000 in Indonesia, 48 percent has been oilcrops and 17 percent rice. Maize accounted for just 4 percent, as did FVP. In the Philippines, rice (33 percent) and oilcrops (29 percent) were again the two largest contributors to increased area, and maize contributed just 2 percent. But in the Philippines,

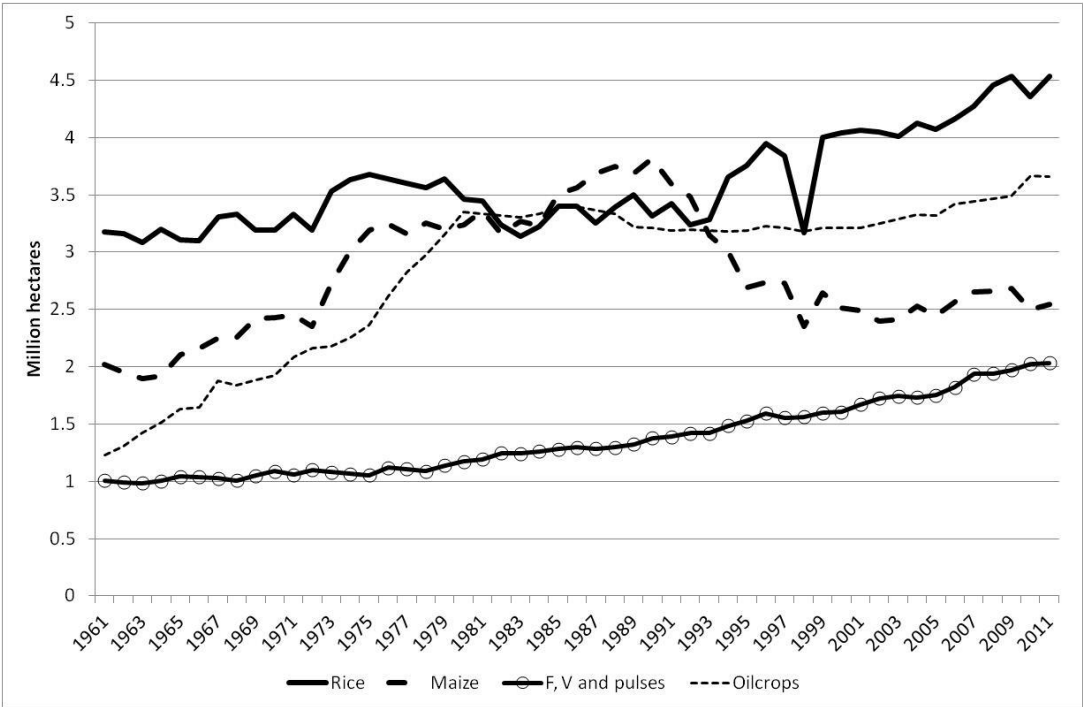
FVP also accounted for 28 percent of the increase. Viet Nam (Figure 22), by contrast, has looked more like China in terms of changes. Maize (25 percent) and FVP (22 percent) were the biggest contributors to changes in area harvested since 2000, while rice area declined slightly. Natural rubber, cashew nuts and root crops, primarily cassava, accounted for another 41 percent combined (not shown in Figure 19).

Figure 20. Crop area harvested in Indonesia, 1961-2011



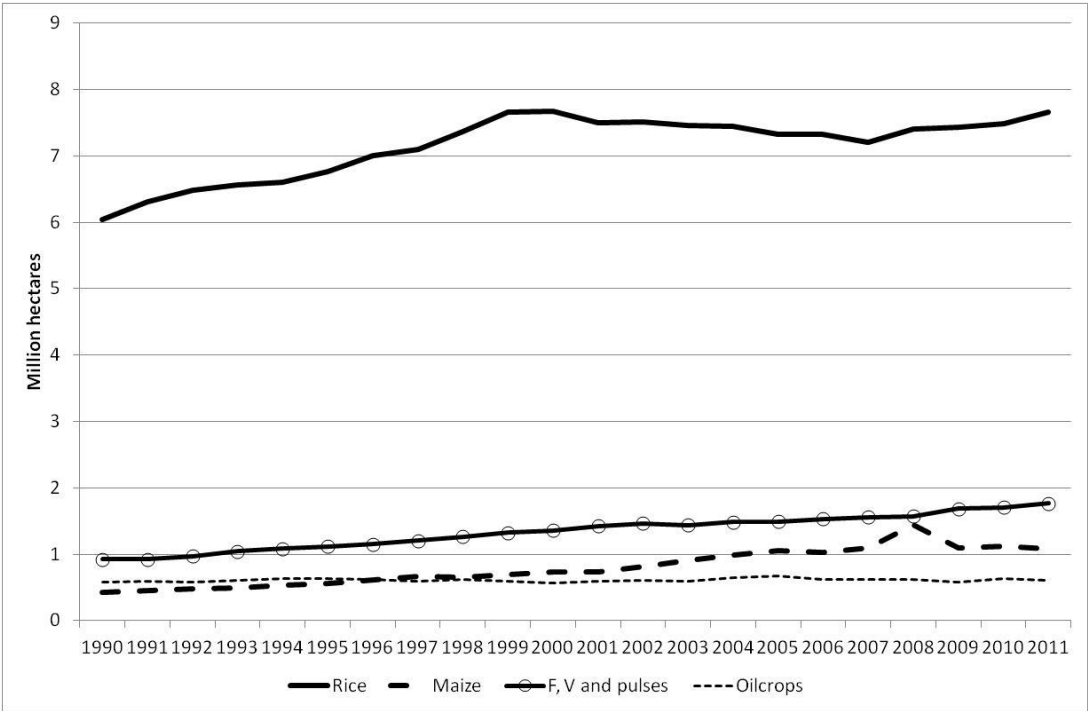
Source: Author using FAO (2014).

Figure 21. Crop area harvested in the Philippines, 1961-2011



Source: Author using FAO (2014).

Figure 22. Crop area harvested in Viet Nam, 1990-2011



Source: Author using FAO (2014).

It is interesting that Viet Nam’s agricultural area seems to have diversified more rapidly than the agricultural sectors in Indonesia and the Philippines, especially in light of some restrictions that Viet Nam places on converting some farms away from rice (Markussen *et al.*, 2010; Giesecke *et al.*, 2013). If the restrictions are removed in the future, then the pace of diversification could further accelerate, but this will also depend on the nature of irrigation systems, not just land use regulations. In all three countries, diversification is hindered by the fact that irrigation systems often flood large areas of land, especially in the wet season, making it difficult for farmers to diversify because most crops are not as tolerant of flooding as rice. Prices also play a role, and rice prices in Indonesia and the Philippines that are substantially above import parity have hindered crop diversification in those two countries. Viet Nam is a major exporter, and has not supported rice farmers with higher prices.

Some diversification is not well captured by changes in area. For example, raising livestock that are grain-fed requires little direct use of land (i.e., ignoring the land required for maize and soybean cultivation to produce the feed), and the area of livestock enterprises is not typically measured on an annual basis as is the case for crops. Thus, production growth seems a more appropriate measure for comparison in this instance. In most Asian countries, livestock production has grown more rapidly than crop production; thus, substantial diversification has taken place according to this metric. The relatively rapid pace of livestock growth was more pronounced from 1961-2000, however. In more recent years (2000-2011), the differential growth has been less noticeable. During this latter period, growth in livestock production outpaced growth in crop production in Malaysia, the Philippines, Thailand and Viet Nam, but in China and Indonesia, the reverse was true (see Table 3).

More notable has been the spectacular growth in aquaculture production. Many farmers have switched from growing crops to raising fish, but unfortunately area data for aquaculture are not available. In volume terms, growth in aquaculture since 2000 has substantially exceeded

that in both crops and livestock for all of the six countries. Across these countries, the species responsible for most of the growth are tilapia, carp, shrimp/prawns and catfish, with the relative importance of each of those species varying from country to country.

Table 3. Growth in net per capita crop, livestock and aquaculture production, percent per annum, 2000-2013

Country	Crops	Livestock	Aquaculture
China	3.1	2.7	5.6
Indonesia	3.1	2.9	13.2
Malaysia	1.4	2.6	9.7
Philippines	0.8	1.3	3.2
Thailand	2.0	2.3	4.1
Viet Nam	2.8	5.6	15.5

Note: Data on aquaculture pertain to inland freshwater and marine brackishwater bodies, but exclude marine aquaculture. Source of raw data: FAO (2015).

Recent changes in trade are something of a mirror image of the changes in cropping patterns – not surprisingly, countries tend to import what they are not producing. As noted earlier, little crop diversification has taken place in Malaysia; conversely, it is the country that has relied most on trade. It is now a net importer of eight of the first nine food groups considered in Table 4.¹⁰ In importing substantial amounts of a variety of different food groups, it has gone down a path similar to that followed by Japan, Korea and Taiwan, the only Asian economies with substantial agricultural sectors that have higher levels of per capita income. Thus, to some extent, Malaysia is just following the same path as those three economies, but it also has a strong comparative advantage in producing palm oil that is not likely to disappear in the foreseeable future. Japan, Korea and Taiwan do not have any comparable comparative advantage in agriculture.

Table 4. Net trade (2011 US\$ per capita) for various food groups, average 2009-11

	China	Indonesia	Malaysia	Philippines	Thailand	Viet Nam
Rice	(0)	(3)	(20)	(11)	+86	+36
Wheat	(1)	(8)	(15)	(8)	(7)	(7)
Maize	(1)	(2)	(27)	(1)	+2	(4)
Oilseed complex	(26)	+58	+412	+6	(28)	(23)
Fruit & Vegetables	+7	(2)	(30)	+9	+40	+19
Meat	(2)	(1)	(16)	(3)	+30	(12)
Milk	(2)	(3)	(15)	(6)	(5)	(5)
Fish	+5	+11	(1)	+5	+74	+53
Sugar	(1)	(5)	(23)	+1	+39	(2)
Food & Animals	(1)	(18)	(136)	(36)	+196	+35

Note: Numbers in parentheses indicate net import status. Numbers in bold italics with + signs indicate net export status. Food and animals does not equal the sum of the other nine food groups included in the table, as those nine

¹⁰ Note that both Malaysia and Indonesia are net importers of “food and animals” (Table 5), but are net agricultural exporters (Figure 6). The reason for this seeming inconsistency is that exports of rubber and palm oil are not included in “food and animals” but are included in “agricultural products.” The exclusion of palm oil from “food and animals” is due to the fact that some palm oil is used for industrial purposes, although Byerlee *et al.*, (2015) estimate that 80 percent of palm oil is used for food. If palm oil is included in the category “food and animals,” Malaysia and Indonesia become net food exporters.

groups are not an exhaustive list. Sources of raw data: FAO (2015) for trade and population data. IMF (2014) for US GDP deflator.

But it is not just Malaysia that has relied on trade – all of the six largest middle income nations in East and Southeast Asia have increased trade in agricultural products over the past ten years or so. This can be seen by comparing Tables 4 and 5, the latter of which is identical to Table 4 except that it applies to the years 1999-2001 instead of 2009-11. Comparing the two tables, it can be seen that nearly all exporters have increased their exports per capita in real terms over time, and nearly all importers have increased their imports per capita in real terms (the only exceptions are countries that are close to net zero in trade).¹¹

Table 5. Net trade (2011 US\$ per capita) for various food groups, average 1999-2001

	China	Indonesia	Malaysia	Philippines	Thailand	Viet Nam
Rice	+0	(4)	(9)	(3)	+36	+12
Wheat	(0)	(3)	(10)	(7)	(3)	(2)
Maize	+0	(1)	(13)	(1)	+0	(0)
Oilseed complex	(4)	+6	+165	+2	(11)	(4)
Fruit & Vegetables	+2	+1	(12)	+8	+24	+4
Meat	(0)	(0)	(9)	(2)	+17	+2
Milk	(1)	(1)	(14)	(6)	(4)	(3)
Fish	+2	+9	(6)	+5	+68	+22
Sugar	(0)	(2)	(11)	(0)	+13	+0
Food & Animals	(0)	(6)	(76)	(21)	+88	+22

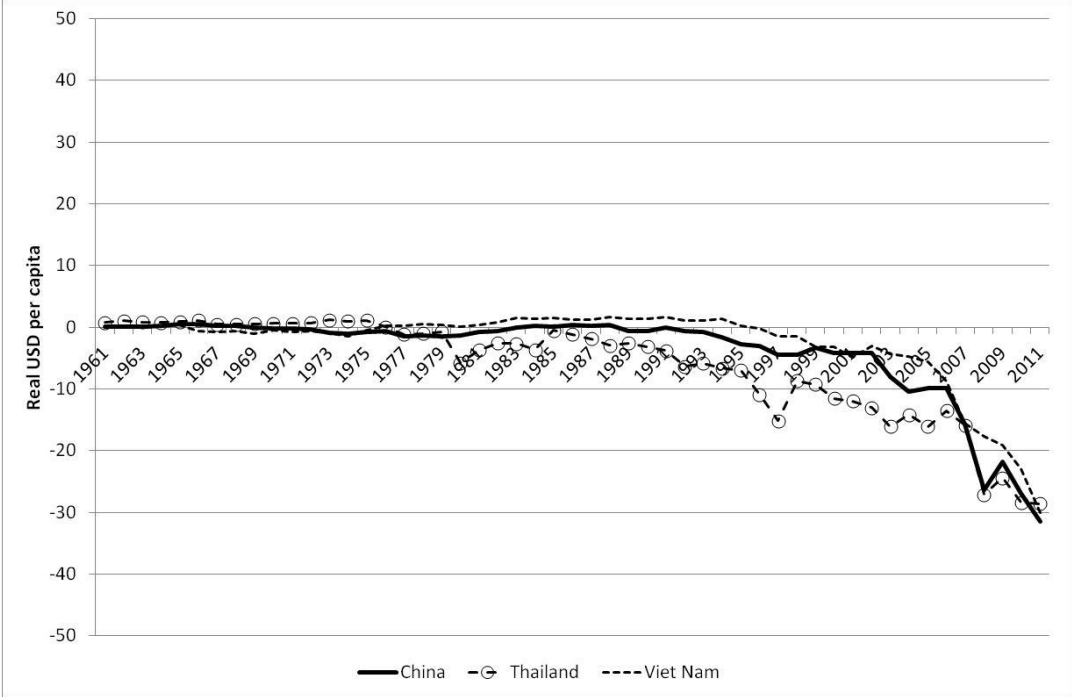
Note: See note and sources for Table 4.

The increasing use of international trade, especially for particular food groups, is also evident from Figure 23, Figure 24 and Figure 25, which show an exponential increase in real imports or exports per capita for many countries for these specific commodity groups (vegetable oils, FVP, meat and dairy). Note that these three food groups are the three for which consumption has increased the most due to dietary diversification: it appears that at least some of the dietary transition is taking place through international trade.

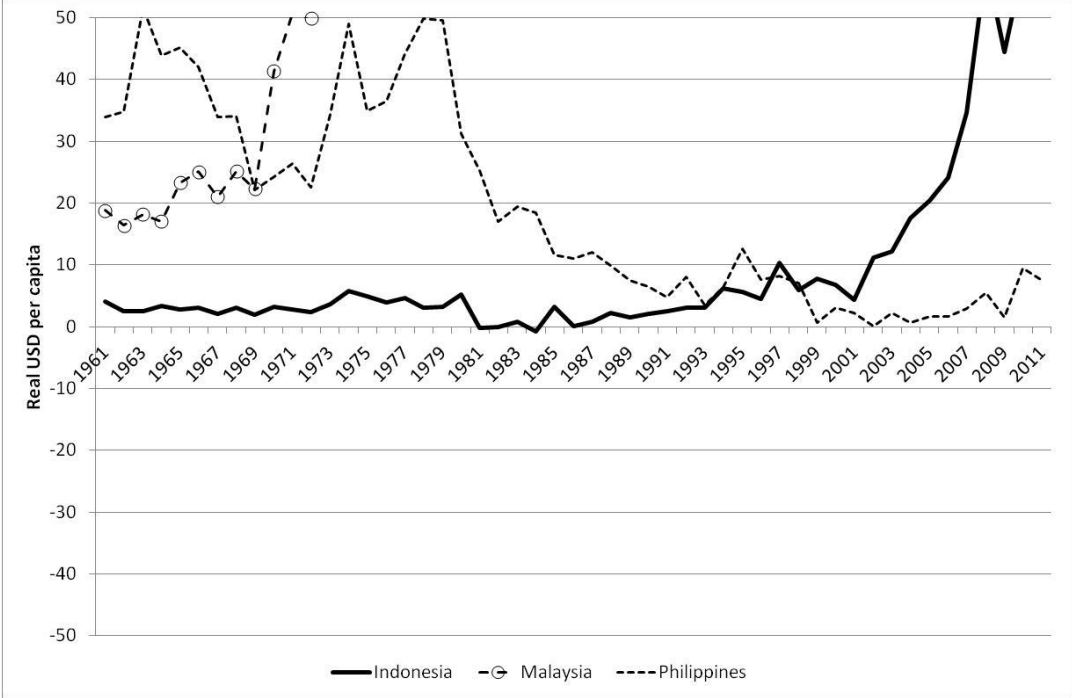
¹¹ Note that the phrases “exporter” and “importer” in this context do not refer to countries per se, but to country/commodity combinations – all countries are both importers and exporters. For example, Thailand is an exporter of rice (and other commodities), but an importer of oilseeds/vegetable oils. Malaysia is an importer of many commodities, but is an exporter of oilseeds/vegetable oils.

Figure 23. Inflation-adjusted net trade (value of exports minus value of imports) per capita, vegetable oils, 1961-2011

Panel A. China, Thailand and Viet Nam



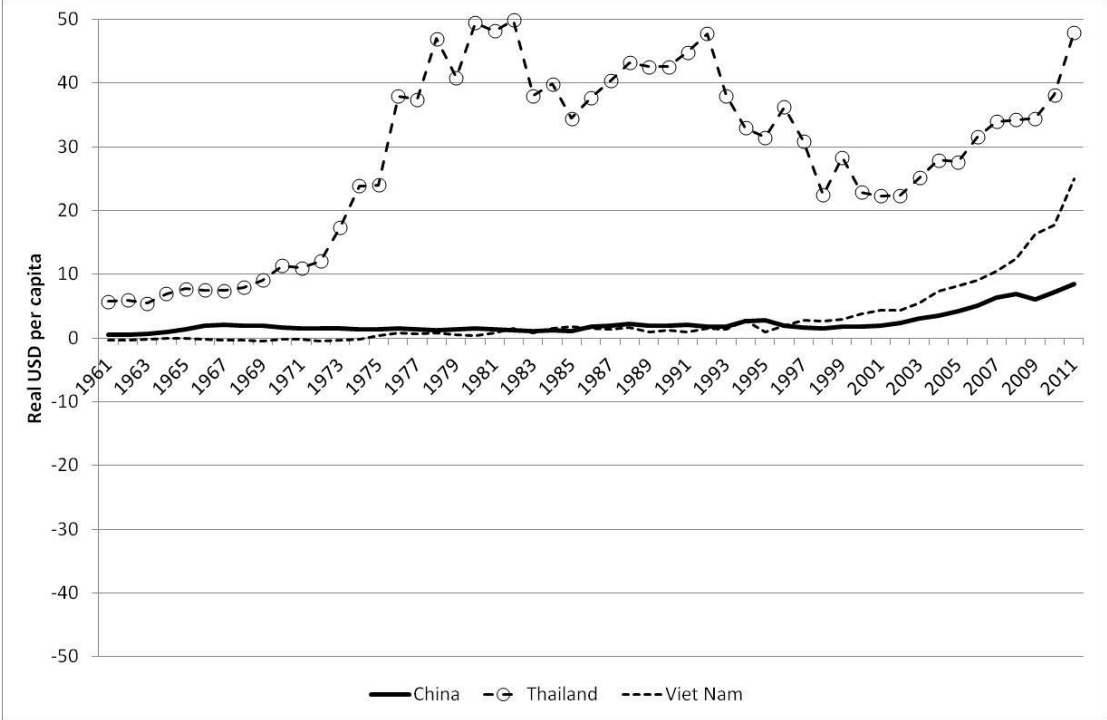
Panel B. Indonesia, Malaysia and the Philippines



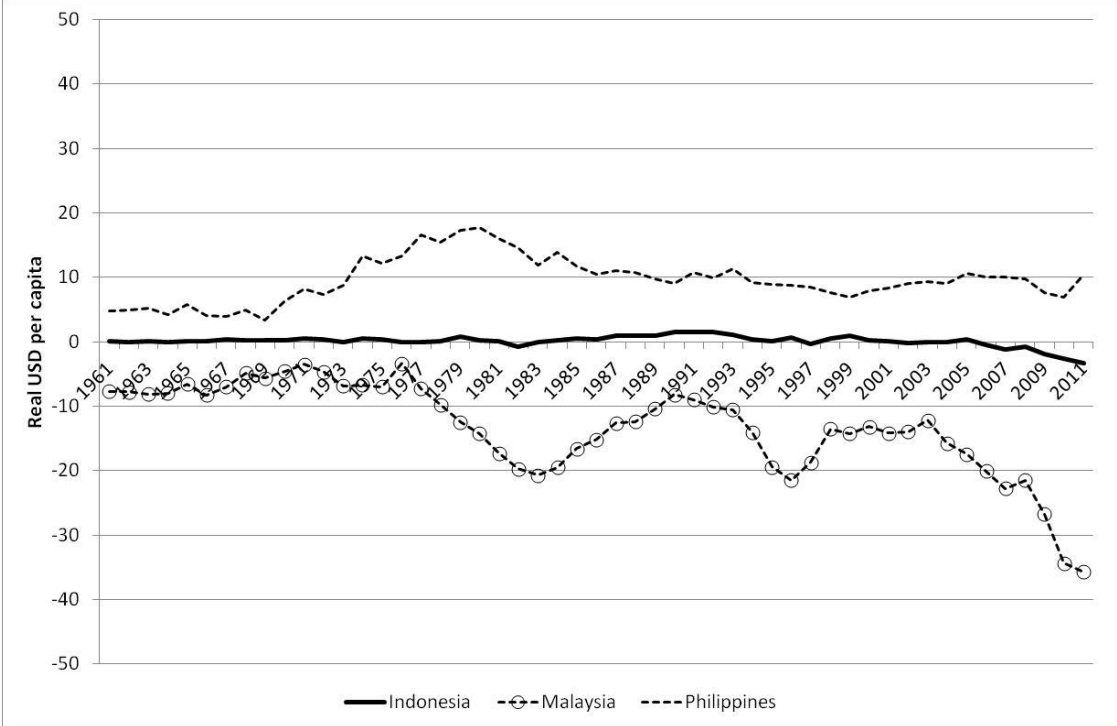
Note: The vertical axis is truncated at a value of \$50 per capita in order to show trends in net imports more clearly and to make it comparable with Figures 24 and 25. In 2011, Malaysia and Indonesia exported \$535 and \$74 per capita of oilcrops, respectively. Sources of raw data: FAO (2014) and World Bank (2013).

Figure 24. Inflation-adjusted net trade (value of exports minus value of imports) per capita, fruits, vegetables and pulses, 1961-2011

Panel A: China, Thailand and Viet Nam



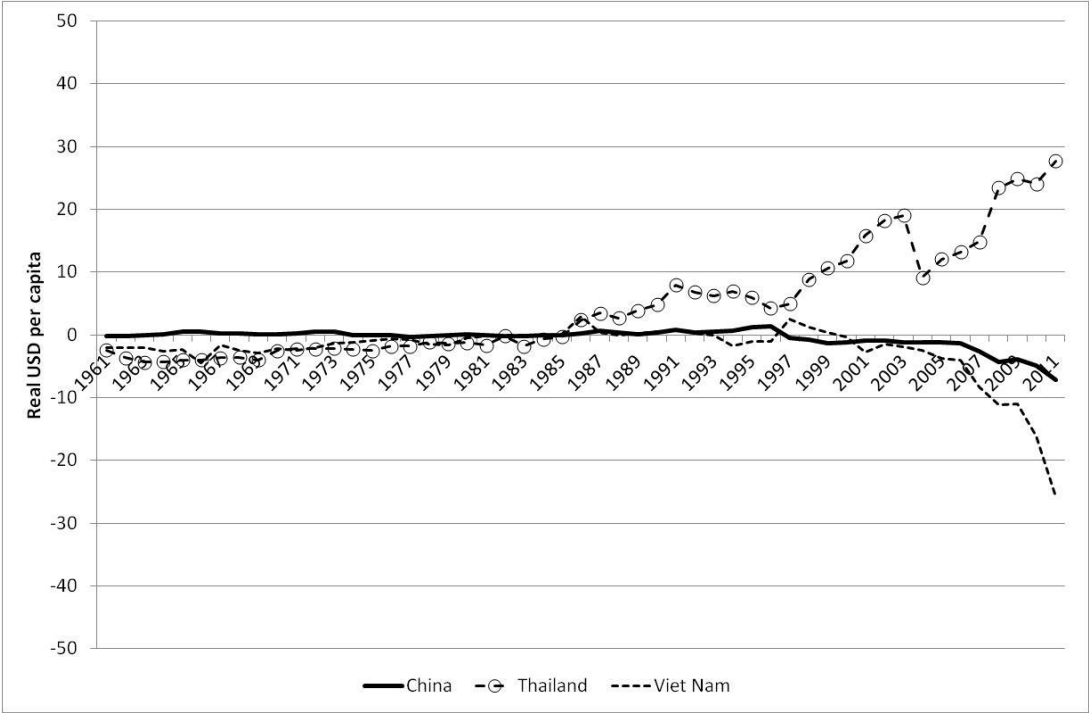
Panel B: Indonesia, Malaysia and the Philippines



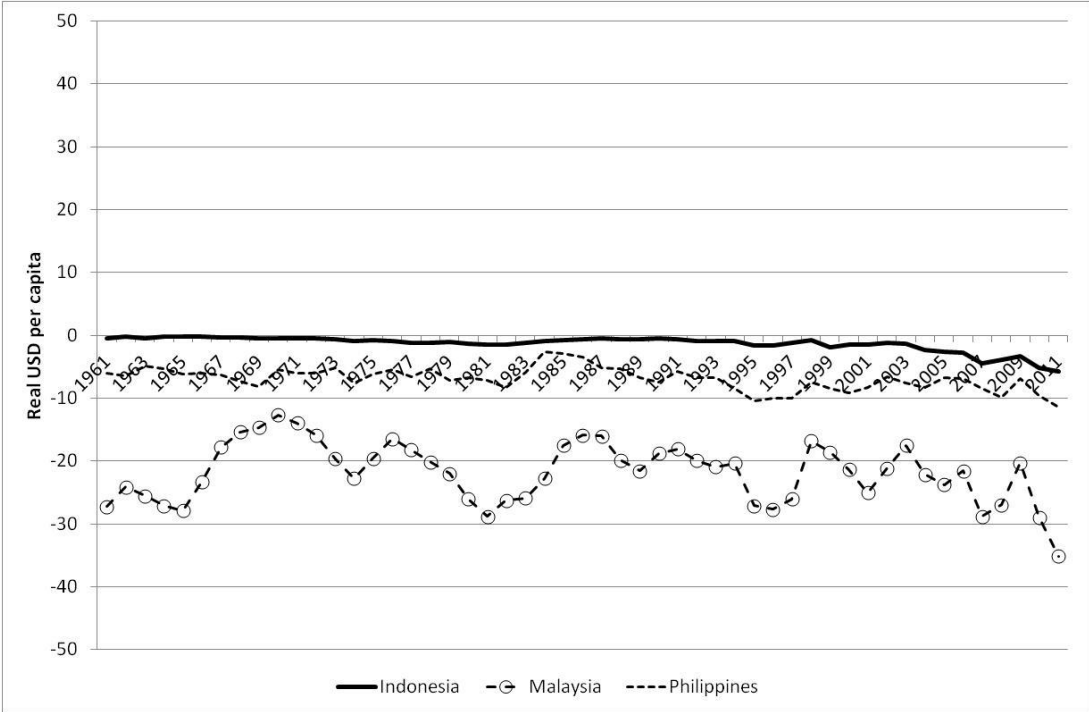
Source: Author using FAO (2014) and World Bank (2013).

Figure 25. Inflation-adjusted net trade (value of exports minus value of imports) per capita, meat and dairy products, 1961-2011

Panel A: China, Thailand and Viet Nam



Panel B. Indonesia, Malaysia and the Philippines



Source: Author using FAO (2014) and World Bank (2013).

Which commodities are exported and which are imported by which countries depends to a large extent on comparative advantage. Malaysia and Indonesia are similar in that they are major exporters of vegetable oils/oilseeds: the value of Malaysia’s “oilseed complex” exports

exceeded \$400 per capita in 2009-11, and Indonesia's exports of the same were nearly \$60 per capita in the same years (all dollar figures quoted in this section are in inflation-adjusted 2011 US dollars and represent net trade, i.e. exports minus imports). These dollar values per capita are two of the four highest values of net exports among the nine specific food groups¹² for the six countries. Furthermore, both Malaysia and Indonesia are importers of all the other eight specific food groups shown in Table 4, with the exception that Indonesia is an exporter of fish. These two countries also share important geographic characteristics: they are the two countries that are located most closely to the equator (giving them a comparative advantage in oil palm production), and they are archipelagic without the dominant river deltas that exist in mainland countries, predisposing them to be rice importers (Dawe 2013). The value of Malaysia's food imports is much greater on a per capita basis than Indonesia's, probably because (a) Malaysia is a wealthier country and more advanced in dietary transition; and (b) Malaysia is a smaller country and has a narrower range of agricultural growing conditions.

In agricultural trade, Thailand is the mirror image of Malaysia and Indonesia; it is an exporter of all food groups, except for oilseeds (Table 4). It is also a mirror image geographically, in that it is more northerly than Malaysia and Indonesia and has a dominant river delta that allows for large quantities of rice production. This is not true for all of Thailand, however. The southern peninsula is closer to the equator and lacks a dominant river delta; this part of the country is similar to Malaysia and Indonesia in that it grows oil palm and rubber, and cannot grow enough rice to meet its own consumption requirements.

China and Viet Nam form another group – they import oilseeds, meat, milk and sugar, but export fruits and vegetables and fish. But they are also slightly different from each other: Viet Nam exports large amounts of rice (similar to Thailand), while China is basically self-sufficient as measured by the dollar value of net imports per capita (China is now the world's largest rice importer in quantity and value, but those imports still account for a small share of domestic consumption).

Finally, the Philippines is somewhat of a cross between the other countries: it exports oilseeds/vegetable oils and imports rice, meat and milk (like Malaysia and Indonesia), but it also exports fruits and vegetables (like Thailand, Viet Nam and China) and fish (like all of these countries except for Malaysia).

The importance of trade relative to domestic production varies from product to product. For items like meat, most of domestic supply still comes from domestic production, not imports, although for specific types of meat there can be heavy reliance on imports. For other items, however, like milk and vegetable oils, the reliance on imports can be quite substantial. Thus, the importance of trade should not be exaggerated, but nevertheless it is an important means of satisfying the demand for dietary diversification, without necessarily requiring any agricultural transformation. And, looking at the commodity patterns of increased trade over time shown in Tables 4 and 5, it appears that comparative advantage is playing an increasingly important role in agricultural policies for these middle-income countries. This is most likely due to the general declines in barriers to international trade and transport costs in recent years.

¹² The phrase "specific food groups" refers to all food groups in Tables 4 and 5, with the exception of the "general" food group "Food and animals."

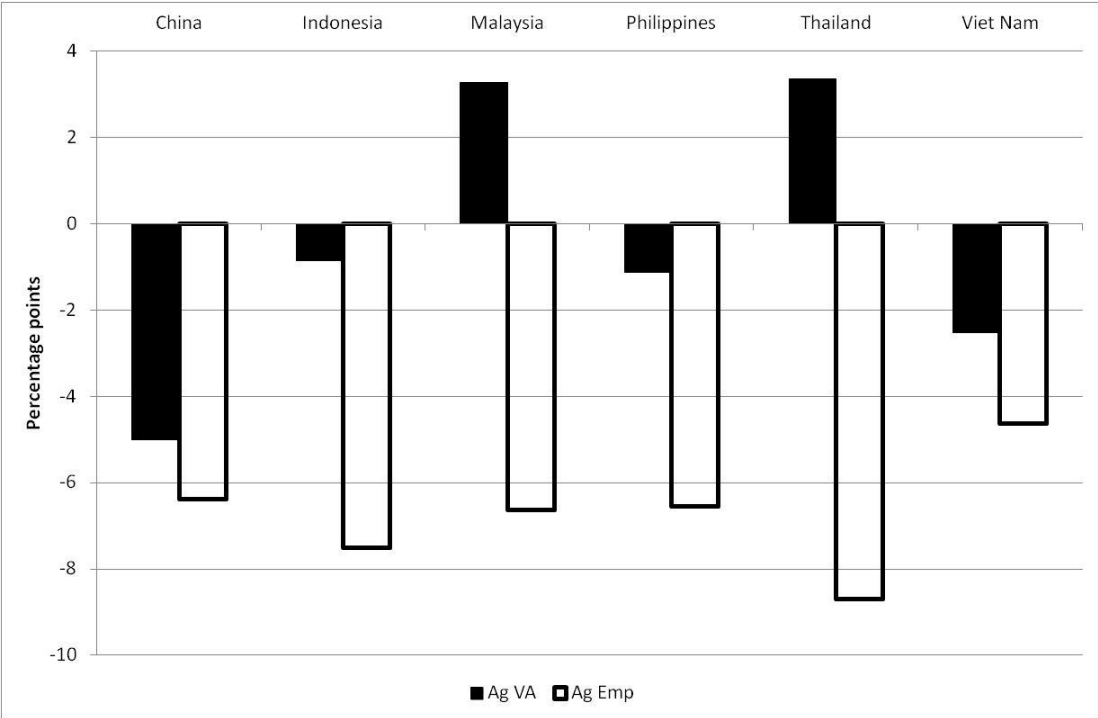
5. Future policy challenges

Asia in general has undergone amazing changes in the past fifty years, with rapid economic growth, a strong structural transformation and poverty reduction at a pace that has not been witnessed before in human history. In broad terms, Asian economic growth has been sustained over the past few decades by sound macroeconomic policy, investment in infrastructure and a generally supportive business environment. There are of course some exceptions, and in some cases the business environment surrounding agriculture in particular has been restrictive. But there does seem to be an appreciation among Asian leaders of the importance of economic growth, giving grounds for optimism that growth will continue for the next 15-20 years at least (although it is certainly not inevitable). Therefore, the discussion in this chapter assumes that continued per capita economic growth will continue. If the region were to go into prolonged recession, the discussion below will have little relevance (and poverty would likely increase, with much different implications for food demand and the agricultural and agribusiness sectors).

As the structural transformation continues, will all countries follow the same path of agricultural transformation? The answer is both yes and no. As noted above, all countries will see agriculture as a source of employment become continually less important (Figure 26). This decline is consistent with the increased mechanization noted earlier in the paper. But the pace of this change will be different in different contexts. While wages are of course a key driver of when mechanization occurs, it seems that social factors also make a difference – many entrepreneurs in the Philippines are worried about the labour displacement effects of mechanizing rice harvesting. Similar factors may be at work with rice threshing on Java. The importance of these social factors in different contexts are difficult to predict, especially in the absence of data on the pace of mechanization over time in different countries and provinces. Better data on this transition would presumably allow for better understanding and predictions of how rapidly this transition will occur in different contexts. It seems likely, however, that the speed of mechanization has been slower in the Philippines and Indonesia than in Thailand, China and Viet Nam – this is not good news for raising labour productivity.

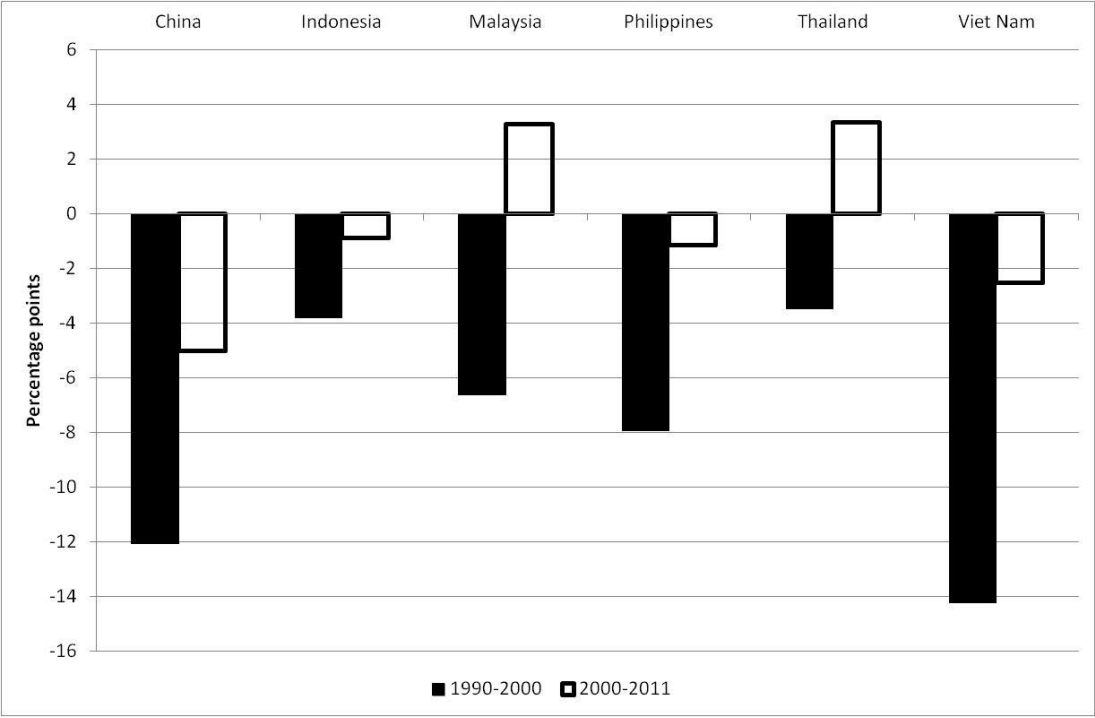
At the same time, the share of agriculture in GDP will decline more slowly than its share of employment (Figure 27), and for some countries will at times actually increase (as noted earlier). This is good news for the labour productivity of the workers who remain employed in agriculture – the income gap between non-farmers and farmers will get smaller, although it will still remain for many decades to come.

Figure 26. Change in agriculture’s shares in GDP and employment, selected countries, 2000-2011



Source: Author using World Bank (2014).

Figure 27. Change in agriculture’s share in GDP, selected countries, 1990-2000 and 2000-2011



Source: Author using World Bank (2014).

As the structural and agricultural transformations continue in the region, some crop and product diversification will occur, but this is likely to vary substantially across countries.

Large, geographically diverse countries such as China are likely to experience more crop diversification than small countries such as Malaysia, and this has been borne out by the experience of these two countries over the past few decades. All countries will import some commodities while exporting others, as trade barriers generally decline. Trade is likely to be especially important for vegetable oils, oilseeds and dairy products, which tend to be less politically sensitive than staple foods and therefore have more liberal trade policies. These commodities are also less perishable than fruits and vegetables, which facilitates trade over long distances.

Finally, in terms of farm size, while there will be differences across countries (with farms being larger where per capita endowments of agricultural land are higher), it seems almost certain that farms in all of these countries will remain small by international standards for decades to come. But small farm sizes will not necessarily mean that farm households remain poor or become inefficient. Farm households will increase their income by diversifying into the non-farm economy, and labour and knowledge shortages in agriculture can be dealt with through rental and service markets for machinery that can operate on relatively small fields. Private entrepreneurs and cooperatives will provide services and serve as intermediaries between small farms and the large processing operations that are likely to become (or already are) large by global standards. But land in Asia is simply too scarce for politics to allow large farms (in terms of ownership) to dominate the landscape. Political issues will be a particular constraint in the Philippines, which is highly unlikely to undo years of land reforms. It will be less of an issue in Thailand, where land is in relative surplus.

Furthermore, farm households are still poor enough that they continue to value land as a safety net to fall back upon in the face of economic crises such as the Asian financial crisis or the food price crisis. Thus, Asia will operate with small farms upstream but large trading and processing units downstream.

If farms do remain small in Asia, this does not necessarily imply a picture of stagnation. First, as noted above, farm household incomes are already diversifying beyond farming – see for example the work of Mahabub Hossain and colleagues in the Philippines (Hossain *et al.*, 2001a), Bangladesh (Hossain *et al.*, 2001b) and Thailand (Isvilanonda *et al.*, 2001). Thus, farm household incomes are increasing, even if it is done through the non-farm sector. Second, it is not yet clear whether small farms will become less efficient in the future than large farms – more evidence is needed.

The ability of small farms to be efficient will be strongly conditioned by various investments and policy choices that each country will need to make. Countries will have key choices to make about how far to go in many areas (e.g. food safety, environmental standards, irrigation management, investment regulations and incentives), two of which will be discussed here: international trade and price and production support for farmers; and provision of key public goods, both hard (roads, ports, etc.) and soft (education).

Not all countries will need to follow the same path in order to be successful, and policies in some of the above categories can substitute for those in another. Thus, the discussion below is not meant to show the best path or paths to follow, but rather to spark a discussion that is fully cognizant of the tradeoffs involved in using different policies and takes due consideration of the broad empirical trends that will occur if countries graduate to high income status, as all of them aspire to do.

International trade and price and production support for farmers

Historical experience of the structural transformation shows that farmers' income is below that of workers in the non-farm sector for a (lengthy) period of time, until countries become very rich. This income disparity (as evidenced by the fact that all of the scatter plot in Figure 5 is below the 45 degree line) leads farmers to push for higher domestic prices. There may also be deep behavioural reasons, related to the primal nature of food and food security, why political leaders and electorates seem so consistently to accede to this demand.

Government interventions to manipulate domestic prices are often based on international trade restrictions, but other policies are also used (e.g. domestic price support). It is important to note that policies to change domestic prices are much more common for rice than for other commodities, although rice is far from the only commodity to draw government intervention – other examples in the region include sugar, garlic and onions.

While a range of policies are used to raise domestic farm prices, restrictions on international trade are the most common. One reason protection from international trade is so attractive is that it requires so little in the way of government expenditures. Indeed, import barriers can generate government revenue through tariffs, or in some cases, especially with non-tariff barriers, it can generate rents. This is a win-win situation for the government (or its employees) and farmers, who are to some extent falling behind during the structural transformation and benefit from the higher food prices caused by trade restrictions. In the future, increasing use will probably be made of trade restrictions based on food safety considerations, especially for higher value-added products. To some extent such restrictions serve important public health purposes, but they can also be used to further protectionist interests. Their costs and benefits are similar to those of more traditional non-tariff barriers.

But along with the advantages, there are also disadvantages to trade restrictions. First, there are efficiency losses that come from countries not producing the agricultural products most suited to their natural geographic conditions, which are a major determinant of comparative advantage in agriculture. These “deadweight” efficiency losses get less important as the economy grows, because agriculture in general and rice in particular (where most of the self-sufficiency efforts are focused) becomes a smaller and smaller share of the economy. But they become more important as the gap between domestic and international parity prices becomes larger, in proportion to the square of that gap. And that gap is getting larger in some countries, especially China and Indonesia.

Second, high rice prices tend to increase poverty in most rice-importing Asian countries. While there are many poor farmers and many poor consumers, the balance of evidence from a number of studies (see the review in Dawe *et al.*, 2010) indicates that in Asian rice importers, the poorest 20 percent of the population consumes more rice than it produces, which means that higher prices reduce their effective purchasing power. Given the fact that many rice farmers are poor, this result may appear counterintuitive. But it is important to remember that there are many other groups of people in the countryside besides rice farmers: the rural landless, tenant farmers who may not benefit from high prices, and farmers of other crops (e.g. maize farmers in the Philippines are extremely poor). And of course there are also the urban poor, who grow very little if any rice. Conversely, those who benefit from high prices are the farmers with large amounts of surplus to sell on the market, who tend to be wealthier than other farmers – farmers with a quarter hectare of land or less do not produce enough rice to sell on the market, so don't benefit from higher prices.

Third, high prices leave less money available to spend on food with more nutritional value than rice (Block *et al.*, 2004; Torlesse *et al.*, 2003). Higher rice prices reduce effective purchasing power, leaving less money available to spend on foods with essential vitamins, minerals and amino acids that are lacking in rice. Given the high levels of “hidden hunger” due to micronutrient deficiencies around the region, and the increasing recognition of the importance of good nutrition for human development, high rice prices can impose a substantial cost.

Fourth, although the timing will vary from country to country, it is inevitable that per capita rice consumption will decline, as increasingly wealthy consumers demand a wider diversity of foods. Given this eventual decline (it is already taking place in many countries), it is important that farmers also diversify their production decisions. While many farmers, especially those with low-lying land, must continue to grow rice during the wet season, diversification is usually possible in the dry season. High rice prices impede this natural and essential diversification process, however, and can trap farmers in the production of a “dead-end” crop. Keeping rice prices well above import parity prices discourages farmers from diversifying into higher value-added commodities that can lead to greater incomes and a more dynamic agricultural sector. Indeed, getting stuck in a “rice rut” is more of a danger than the “small farm problem,” as farmers can rent in machinery and services to overcome the disadvantages of a small farm. But rice is simply a lower value commodity than fruits and vegetables, and continuing to plant rice will hinder progress at improving farm incomes.

Fifth, because rice is a major expenditure item for workers, high domestic rice prices lead to high wages and thereby erode competitiveness in an increasingly globalized economy.

Finally, high domestic prices of rice encourage consumers to shift some of their diet away from rice and towards wheat. To some extent this is helpful, as it reduces reliance on rice. Nevertheless, at least in Southeast Asia, no wheat is produced, so reliance on imported cereals is not reduced, but only shuffled from one crop to another. If world wheat prices were uncorrelated with world rice prices, this dietary diversification would reduce risk. But in fact the two prices are correlated, so the risk reduction achieved is somewhat minor. In addition, it is commonly stated that the world rice market is more unstable than that for wheat and maize, but this is not so true anymore. From the mid-1960s to the end of the 1970s, the world rice market was very unstable: the standard deviation of annual real price changes was 30.7 percent for rice, compared to just 22.2 percent for wheat and 17.2 percent for maize. But for the past 25 years (1987 to 2012), the figures for the world’s three main cereals are essentially identical: 19.1 percent for rice, 18.8 percent for maize, and 17.8 percent for wheat.

Thus, trade restrictions may well be a lose-lose situation from the vantage points of economic efficiency and equity, as many of the poor are net food buyers who are harmed by higher food prices. Further, from a strategic point of view, higher food prices slow down the structural transformation. This might be sensible if the slowdown were temporary, buying farmers (and city planners) time to adjust. But the apparently primal desire for self-sufficiency is not consistent with a gradual transition – for example, rice prices in the Philippines have been above international prices for a century and show no real signs of moving towards international parity, free trade agreements in ASEAN and the WTO notwithstanding.

It is also important to realize that along with declining (per capita) rice consumption, consumption of meat, fish, eggs, milk, fruits and vegetables are increasing. Much of this dietary diversification comes directly or indirectly from imports – for example, animal feed in

Viet Nam comes from imported maize and soybeans, and its dairy cows are imported, as are Indonesia's beef cattle. To some extent, this is sensible, as many of these products can be produced more efficiently elsewhere. But to the extent that the imports are due to trade barriers (or land use restrictions) that keep land in rice, this is not a welcome development, as it prevents local farmers from capitalizing on and benefiting from local changes in dietary patterns.

Looking ahead, different countries in the region are likely to have different policies towards international agricultural trade. In general, countries are more likely to promote free trade for the commodities they export because it is typically in their commercial interests to do so, while countries are more likely to impose trade restrictions for the commodities they import in the hopes of achieving a greater degree of self-sufficiency. Furthermore, import restrictions help support domestic farmer incomes without any drain on the government budget (the opportunity costs of import restrictions in the form of higher domestic prices are very real, but are not felt by policymakers as keenly as the higher budgetary expenditures necessary to support the prices of exports). Since all countries export and import different agricultural products, trade policies are likely to vary by commodity. Trade protection for rice is likely to continue in Malaysia, Indonesia and the Philippines, all of which are rice importers, and China has been moving down this path in recent years as higher labour and land costs are making domestic rice production less competitive at the margin (in earlier years, domestic rice prices in China were roughly equal to world prices adjusted for transport costs).

But direct price and/or income support not using trade restrictions is becoming more common, as can be seen in Malaysia, Thailand and China, the three middle-income countries with the highest levels of per capita income among the six focus countries. These are the countries who are most able to afford it, precisely because of their higher level of per capita income. Given continued economic growth in the region, and the lower level of labour productivity in agriculture, it seems probable that agricultural price and income support will continue to increase. It is possible to imagine scenarios where these countries make substantial moves towards agricultural free trade (as have Australia and New Zealand), but such scenarios seem highly unlikely. Australia and New Zealand have high amounts of land per capita, which makes it easier for farmers to have enough land to earn an income that is comparable to what can be earned outside agriculture. This is not the case in the middle-income countries of Asia.

Thus, the relevant scenarios for these six middle-income countries concern *how* to provide price and income support to agriculture in a manner that does not burden the government with high levels of expenditures that crowd out the provision of public goods that are crucial for creating a healthy, dynamic rural economy. It should always be kept in mind that free markets are a means to an end, not an end in and of themselves, but at the same time it must be realized that government policies that ignore the functioning of markets are likely to cost large amounts of money and encourage farmers to make adjustments that are not socially optimal (in this regard, witness Thailand's recent rice pledging policy – Poapongsakorn 2014).

How can farmers be supported in an efficient way that does not burden government finances or distort markets excessively? One way is to design social safety nets that provide support based not on agricultural production, but rather on poverty – after all, farmers are not the only ones who face hardships. If it is necessary to base some government support on agricultural production, that support should ideally be limited or capped for any given household. Trade restrictions do not cap support, but rather provide greater support for households with more

production, with the largest farms (typically not poor) receiving the most support. Because Indonesia and the Philippines rely the most on trade restrictions (especially for rice, but also for other commodities), this will be a particular challenge for these countries. But this was also a problem for Thailand during the time of the now deposed Yingluck government, which did not cap its rice price support and as a result received warnings from the International Monetary Fund (IMF) and various ratings agencies who were concerned about the impact of such large expenditures on the government's creditworthiness. China has done a better job to date, with many of its subsidies being delivered in lump-sum fashion to farmers. For example, its fertilizer subsidy does not affect the market price of fertilizer – it simply provides money to farmers that they can use to buy fertilizer if they so desire.

Designing efficient price and income support will be a challenge, as it is in developed countries (witness the difficulties involved in capping farm subsidies in those countries). But the ability of countries to come up with innovative and efficient ways to support farmers will be a key determinant of their success at eradicating poverty and food insecurity and making the transition to high-income status.

In the case of rice, it is perhaps inevitable that domestic prices will eventually end up at high levels, as has happened in Japan and Korea. But these two countries are quite wealthy, and their citizens can afford the higher prices without falling into poverty or sacrificing a nutritious diet. And given rice's small share in workers' budgets, high rice prices do not seriously harm industrial competitiveness in those countries. The question then becomes at what stage in the economic development process should countries allow domestic prices to increase substantially above world prices? Given the large numbers of people in the middle-income economies of East and Southeast Asia who are still suffering from poverty, chronic hunger and micronutrient deficiencies, the human costs of allowing rice prices to rise to high levels should be given careful consideration. Social protection might be a possible alternative to trade restrictions in terms of supporting farmers, but effective targeting will present challenges, as it has in Indonesia (Olken, 2003). Recent redesign of the Raskin program, however, holds some promise for improving targeting and minimizing government expenditures without sacrificing benefits to the poor.

The biggest impediments to diversifying away from rice (other than high rice prices) are the substantial price and production risk for crops such as fruits and vegetables. Tree crops also require substantial up-front investment, with returns on investment that come several years later. Therefore, encouraging crop diversification can be done by finding ways to reduce production risk (e.g. through investments in agricultural research) or by helping farmers to manage the inevitable price risk (e.g. through forward contracts). Warehouse receipt systems and futures markets may have some role to play in this process, but there are many constraints to their successful adoption in developing countries.

Provision of key public goods, both hard (roads, ports, etc.) and soft (education)

Future agricultural growth will be driven by investment. Most of that investment, both in primary agriculture and downstream sectors, will have to come from private sources (FAO, 2012). Farmers themselves must purchase implements and machinery, make investments to improve soil fertility and acquire knowledge to improve the management of their farms. The same is true at all stages in the value chain – upstream of the farm, in seed and fertilizer production and distribution; and downstream, in processing, marketing and distribution.

Farmers (and prospective farmers) will invest in agriculture only if their investments are profitable, however, and this requires an appropriate policy and regulatory environment as well as investment in a wide range of public goods. At least three types of public investment are critical:

- direct investment in agricultural research and development to increase productivity and to enhance the ability of agricultural systems, especially smallholder farms, to meet future food demand while coping with climate change and resource scarcity;
- investments to link the primary agriculture sector with consumers, including agricultural institutions, extension services, rural roads, ports, power, storage and irrigation systems; and
- non-agricultural investment to enhance the rural institutional environment and improve human wellbeing; such investments include education, particularly of women; sanitation and clean water supply; and health care.

All of these investments have been shown to have consistently high rates of return, both in financial terms and in terms of reducing poverty, across a wide range of countries both in Asia and in Africa (Fan, 2008). In Latin America, expenditures on public goods have been shown to be more effective than subsidies at raising the rate of agricultural growth, as well as improving the environment (López and Galinato, 2007).

Input subsidies can make sense, although only in certain limited situations (Zorya and Santos, 2014). If farmers need to learn about new inputs, then a subsidy can encourage adoption and accelerate the learning process. Subsidies can also compensate for poorly functioning credit markets. In these cases, subsidies can be a wise investment. This was likely the case in the early years of the Green Revolution. But, once farmers know about the new inputs, subsidies become much less beneficial. In fact, they can even be detrimental, as farmers over-apply fertilizer, leading in many cases to lower yield, less production and in nearly all cases to more environmental degradation. Pesticide subsidies have similar problems, especially in rice, for which brown planthopper populations are increased by pesticide use and have been a major threat to production in recent years. Because most farmers in Asian middle-income countries today are well aware of the costs and benefits of fertilizers and pesticides, subsidies for these inputs are not likely to be socially beneficial.

Input subsidies also often require large quantities of government funds, leaving less money for spending on items such as agricultural research that can have a real impact on production and productivity. Finally, general input subsidies also tend to disproportionately benefit larger and richer farmers, because they use more inputs. If it is desirable to increase farmer income, it is preferable to use targeted and limited cash transfers that have maximum upper limits for individual farmers and are not tied to input use (see the earlier discussion on price supports).

When input subsidies are employed, they should be used only for highly specific interventions, targeted to reduce budgetary expenditures; designed carefully and of limited duration. For example, the subsidies should be large enough to positively affect investment decisions, but not so large that the private sector has no “skin in the game.” The private sector must put up enough money for such investments that they have the incentives to manage those investments properly. Otherwise, the likely outcome is “white elephant” projects, as has happened with many projects where the government hands out free machines that turn out to be of little value or interest to the recipients (Schmidley, 2014).

Use of subsidies should also give consideration to the local context and should be used to speed up processes that would happen anyway. For example, temporary machinery subsidies may make sense in China due to rapid wage growth. Subsidies for certified seed could make sense for a limited period of time in certain poor regions of all countries where families' budget constraints tempt them to save seed instead of buying seed on the market.

Alternatively, investment in education could teach these farmers how to improve the quality of their own saved seed. As with fertilizer and pesticides, fuel subsidies are unlikely to be a good idea, as fuel has many different uses throughout the economy, making such subsidies a huge drain on the government budget (and exacerbating climate change in addition).

Key areas where subsidies are essential for increasing productivity and enhancing the food security and the well-being of farmers and consumers include education (both agricultural extension and education more broadly) and health care.

Education is particularly important in middle-income countries that aspire to achieve upper income status. As wages increase, these countries will lose (or have already lost) jobs in industries such as garments and footwear to low-income countries where wages are lower, such as Bangladesh and Cambodia. But if workers do not have the capacity to take jobs in more complex industries, there will be large pools of unemployed people that exert a drag on GDP growth and can be a source of political instability. The long lead times involved in improving an educational system, and the fact that students are in school for many years, suggest that it is important for middle-income countries to start these changes as soon as possible.

But it is not only the industrial and service sectors where workers need to be better educated. If agriculture is to become more productive, and farming more profitable, it will have to be done by smarter farmers taking full advantage of knowledge-intensive technologies. (And it is of paramount importance that the profitability of farming increase rapidly, so that farmers can keep pace with income growth in the non-farm sector). But in order to take full advantage of knowledge-intensive technologies, farmers must be well-educated, not only in a traditional academic sense but also in practical matters. Much of middle-income Asia would benefit from an expansion of agricultural high schools that integrate agriculture better into traditional curricula. Such education will lead not only to more knowledgeable and productive farmers, but also to adoption of complex and site-specific technologies that increase productivity and improve the environment.

Furthermore, as labour becomes more scarce in many rural areas, there will be no choice but to mechanize. But it is not just a simple matter of replacing human labour with machines – the machine operators must be trained and highly skilled. If they are not, the machines will not be operated efficiently, and post-harvest losses may increase. Again, education and training will be important. It won't be necessary for every farmer to have their own machine – indeed, it is better if most farmers rent such services. That way, they can take advantage of machine operators who have gained specialized knowledge, perhaps through a network of agricultural high schools.

And if farmers want to form small and medium enterprises that engage in downstream agricultural processing and add more value, that will also require more educated farmers. Some farmers will need to specialize in accounting, some will need to specialize in marketing, some will need to specialize in soil science, etc. All of these tasks will require additional

education. And for farmers that leave farming entirely, of which there will be many, education is also critical in order to secure higher-paying jobs.

As with education, there is a strong theoretical rationale for subsidizing health care, which is subject to many market failures and is a public good. A healthier workforce is able to work harder, and more importantly in today's economy, think smarter.

There are often political difficulties in making investments in public goods, however. Many (although not all – for example, construction jobs provide short-term employment) of the returns to such investment can take years to materialize and are spread over a wide range of stakeholders, both of which make it difficult for politicians to claim credit to their constituents (FAO, 2012).

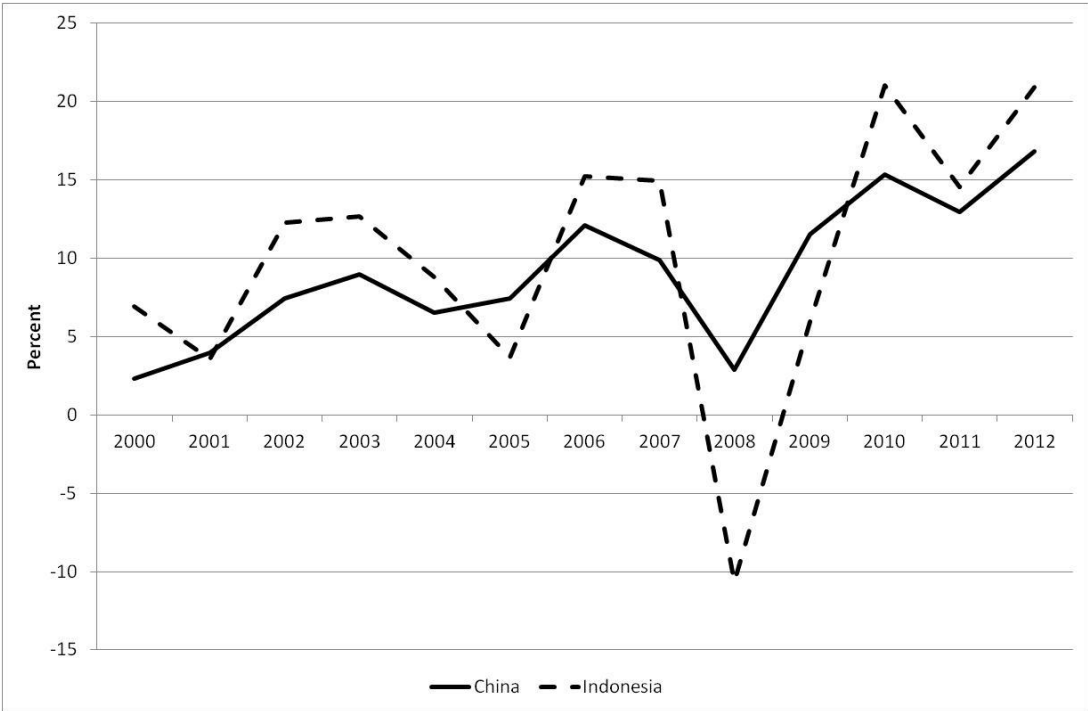
The health sector may be an exception to this general difficulty in subsidizing public goods, however. Health services are used by nearly everyone, and providing free (or subsidized) medicines, diagnostic tests and doctor visits is highly visible and can provide short-term benefits to constituents (Yates, 2014). These benefits might be able to deflect fallout from other politically unpopular decisions, such as removal of fuel or fertilizer subsidies.

Investment in education and health, infrastructure and science are very basic, but they are nevertheless essential to enable the poor to lift themselves out of poverty. There are numerous examples of the success of such spending. China has generally done quite well in the provision of many (some, but not all) public goods, and it has grown rapidly and seen a rapid reduction in poverty as a result (although widening inequality is a problem). Indonesia in years past invested heavily in rural services such as roads, health and education and grew quite rapidly, also with a tremendously rapid reduction in poverty (Timmer, 2004).

But in recent years there has been a proliferation of subsidies in several countries. Thailand, while building on a decades-old policy, dramatically increased the size of the subsidies to rice farmers in 2011 with their paddy pledging policy (although that policy is now in abeyance). Indonesia's fertilizer subsidy has existed for decades as well, but the fiscal burden has increased dramatically over the past ten years as oil and natural gas prices have risen.¹³ And the National Food Authority in the Philippines has built up huge debts by selling rice at low prices without much targeting of those subsidized sales. OECD estimates of Producer Subsidy Equivalents (PSE) have been more or less steadily increasing over the past decade for both China and Indonesia (Figure 28; OECD has not officially released estimates for Malaysia, the Philippines, Thailand or Viet Nam). Thus, several of the countries in the region need to tackle the subsidies issue in order to free up spending for public goods.

¹³ The recent fall in prices, at least at the time of writing, has not erased all of the gains in prices since the turn of the century.

Figure 28. Producer support estimate (PSE) as percentage of gross farm receipts



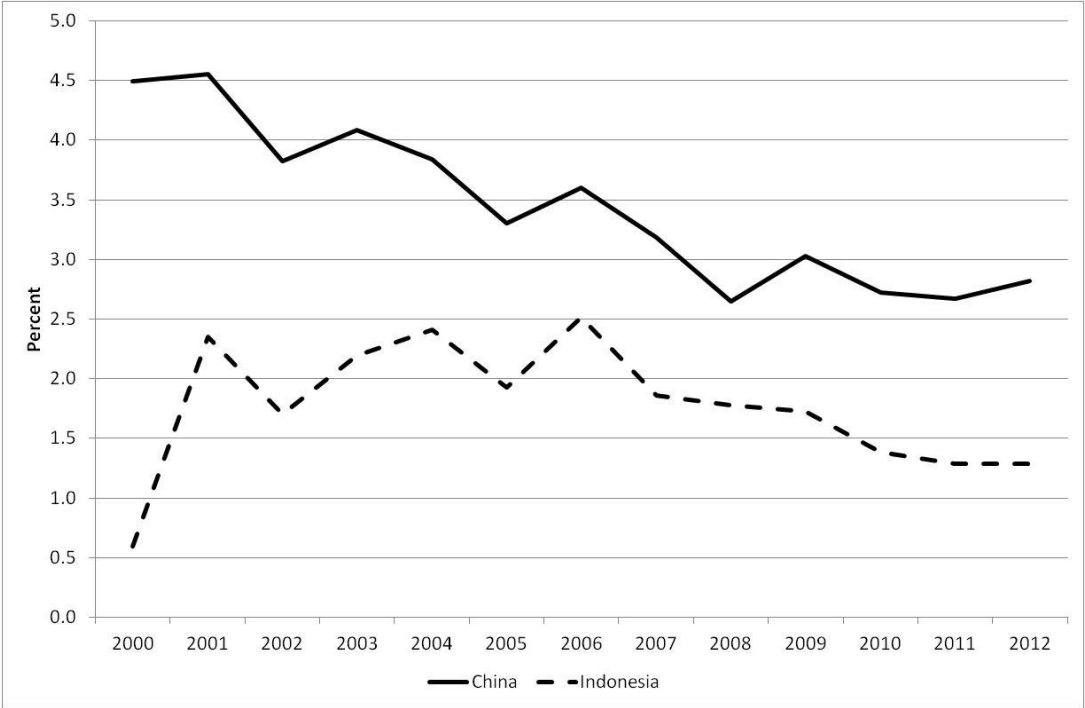
Source: Author using OECD (2015).

Consistent with the above-noted OECD PSE estimates, Gale (2013) has also noted that China has dramatically increased subsidies to its farmers. But these subsidies may be less distortive of markets and more equitably distributed than in other Asian middle-income countries. The largest farm subsidy in China is the general input subsidy, but it is seen as a general entitlement and is given in lump-sum fashion to farmers – it does not lower the market price of fertilizer. The seed subsidy functions in a similar fashion. In addition, agricultural land is distributed much more evenly in China than in other Asian countries – thus, distribution of subsidies by land ownership results in a more even distribution of benefits in China than it would in Thailand, the Philippines or Indonesia. China is using machinery subsidies, and these are implemented decidedly differently – they reach only a small number of people (given that it makes sense for only a few farmers to own machinery in order to ensure adequate capacity utilization). These machinery subsidies explicitly lower the price of machinery (in contrast to the fertilizer and seed subsidies). China also purchases grain at support prices that have been rising rapidly in recent years. Gale (2013) estimates that only 6 percent of all grain production in 2012 was purchased at state support prices, but it is important to note that domestic market grain prices have been rising rapidly in recent years, and now tend to be well above world market prices; this was much less true a decade earlier. The transition has been especially sharp for rice.

It is hard to imagine that middle-income countries will escape the middle-income “trap” and become upper-income countries if investments in public goods are not made on a sufficiently large scale. Unfortunately, in terms of general support to public goods in agriculture, those expenditures have been declining as a share of gross farm receipts over the past decade for both China and Indonesia, although China’s GSSE estimates are much higher than those for Indonesia (Figure 29). While the exact institutional modalities will differ within and across

countries, the broad importance of spending on public goods (and the dangers of broad costly subsidies) holds for all Asian middle-income countries. In this sense, one size does fit all.

Figure 29. General Support Services Estimate (GSSE) as percentage of gross farm receipts



Source: Author using OECD (2015).

6. Concluding thoughts

If overall economic growth does continue for the next decade or two, agriculture will not be the primary driver of that growth in the middle-income countries of Asia. The agricultural sector will nevertheless be important for two reasons. First, it still accounts for 10-15 percent of overall GDP (more in Viet Nam), which is far from trivial. Agriculture may not be the growth engine, but it is a large enough sector that its performance will have macroeconomic consequences. Second, because even larger shares of employment (30-40 percent in most of these countries; less in Malaysia but more in Viet Nam) are found in agriculture, the sector still plays an important role in livelihoods, especially of the poor. If agriculture does not perform well, it will not bode well for poverty reduction or political stability.

The scenarios that play out for agriculture in Asian middle-income countries in the next 15-20 years will depend crucially on many factors, especially those noted above: international trade and the provision of public goods.

Public provision of education and health services are crucial for farmers. Farm management in the future will become more complex as new, more knowledge-intensive technologies continue to be developed. If farmers do not understand and can't use these technologies, they will not be competitive. Each and every farmer will not need to understand them all – specialization will be key, as Adam Smith emphasized more than 200 years ago. This specialization can occur through farmer organizations and cooperatives, but also through rental service markets, which are much more widespread than cooperatives. And health

services are important so that farmers do not suffer major financial setbacks due to the inevitable illnesses that everyone faces at one time or another.

Nearly everyone agrees that rural roads, education and health are important – the crucial issues are how much to spend in these areas and how to convince politicians it is in their interests to do so. In order to increase spending in these areas as much as possible, it will be important to emphasize not only the benefits to the poor and the overall economy, but also the short-term benefits to politicians who will (or will not) authorize such spending. Construction and maintenance of roads can provide short-term employment, and subsidized education and health care can also make constituents happy.

International trade is a different story. Although most economists recognize the general benefits of open (at least to some extent) trade, there is no consensus among politicians, or non-economists in general, that more open international trade is a good thing. And making policy moves toward freer trade is made more difficult by the fact that trade restrictions often create economic rents for those who are well-connected.

It is not essential to have a completely unrestricted laissez-faire trade regime. But it is also important to understand the dangers of excessive impediments to open trade. One danger is that distorting the price of a particular commodity (often rice) affects resource allocation within agriculture – higher rice prices lead to more rice area planted (good) but less area planted of other crops (bad). Policies that encourage farmers to stay dedicated to rice farming – including land use restrictions, input subsidies, irrigation system design and international trade barriers – are increasingly anachronistic and risk exposing Asia to heavy import dependence for a range of higher value foods. Such policies also impede better nutrition, as healthy diets rely on people eating a wide variety of different foods.

It is tempting to think that this can be solved by raising the prices of all agricultural products, with a view to benefiting farmers even more (and, at the same time, perhaps reducing resource misallocation by avoiding distortions in *relative* agricultural prices). But this is a very dangerous approach, as it will create a “high-cost” economy that is unable to diversify into various industrial activities where labour productivity is higher than in agriculture, leading to stagnation in a “middle-income trap.” Lack of economic diversification is inevitable if food prices are raised too high, as food still accounts for a very large share of consumer expenditures in all of these countries. This is especially true for the poorest half of the population, which spends at least half of its income on food and is most in need of finding sustainable employment in industries that can compete internationally. High food prices will prevent these industries from growing, and pro-poor economic growth may grind to a halt.

Finally, it is important to note that many of the areas of policy and investment emphasis discussed above that will be important as middle-income countries try to make the transition to high-income status are outside the typical purview of Ministries of Agriculture. In most countries, there are separate ministries devoted to education, health and trade. Thus, policymakers in the Ministry of Agriculture will need to engage in policy issues that are outside their traditional domains of expertise and develop partnerships and collaboration with other public and private sector organizations (Otte and Pica-Ciamarra, 2014). This will require additional training, as well as a re-orientation of mindset.

References

- Eliste, P & Zorya, S.** 2015. *Cambodian agriculture in transition: opportunities and risks*, 248 pp. (available at: <http://documents.worldbank.org/curated/en/2015/08/24919384/cambodian-agriculture-transition-opportunities-risks>).
- Anderson, K. & Hayami, Y. with associates.** 1986. *The Political economy of agricultural protection: East Asia in international perspective*, London, Allen & Unwin.
- Anderson, K. & Nelgen, S.** 2012. Updated national and global estimates of distortions to agricultural incentives, 1955 to 2010. Washington, DC, World Bank.
- Beintema, N. & Elliott, H.** 2011. Setting meaningful investment targets in agricultural research and development: challenges, opportunities and fiscal realities. In Conforti, P., ed. *Looking ahead in world food and agriculture: perspectives to 2050*. Rome, FAO. pp 347-387.
- Block, S., Kiess, L., Webb, P., Kosen, S., Moench-Pfanner, R., Bloem, M.W. & Timmer, C.P.** 2004. Macro shocks and micro outcomes: child nutrition during Indonesia's crisis. *Econ. Human Biol*, 2(1): pp 21–44.
- Bordey, F., Moya, P., Beltran, J., Launio, C., Litonjua, A., Manalili, R., Mataia, A., Besenio, J., Macalintal, F., Malasa, R., Marciano, E., Milanese, M., Paran, S., Redondo, G., Relado, R., San Valentin, M., Tanzo, I., Tulay, E., Valencia, S., Viray, C. & Yusongco, C.** 2014. *Benchmarking the cost and profitability of paddy production in selected Asian rice bowls*. Presented at the 8th meeting of Asian Society of Agricultural Economics. Dhaka, Bangladesh.
- Byerlee, D., Falcon, W. & Naylor, R.** 2015. *The Tropical oil crops' revolution: managing tradeoffs among food, farmers, fuel and forests*. Oxford University Press.
- Christiaensen, L.** 2012. *The Role of agriculture in a modernizing society: food, farms and fields in China 2030.* Discussion Paper, Washington, DC, World Bank.
- Dawe, D.** 2005. *Economic growth and small farms in Suphan Buri, Thailand*. Presentation to the workshop on Agricultural Commercialization and the small farmer, 4-5 May, Rome, FAO.
- Dawe, D., Block, S., Gulati, A., Huang, J., & Ito, S.** 2010. Domestic rice price, trade and marketing policies, Chapter 3.2 in S. Pandey et al., eds. *Rice in the global economy: strategic research and policy issues for food security*. International Rice Research Institute.
- Dawe, D.** 2013. *Geographic determinants of rice self-sufficiency in Southeast Asia*. Agricultural and Development Economics Division (ESA) Working Paper 13-03. Rome, FAO.
- Dawe, D.** 2014. The two faces of rice prices. *Rice Today*, 13 (3): 40-41.
- Ehui, S.** (2013): *Input subsidies: The South Asian experience*. Power Point Presentation, Washington, DC, World Bank.
- Fan, S.** 2008. *Public expenditures, growth, and poverty: lessons from developing countries*. Baltimore, MD, USA, Johns Hopkins University Press.
- Fan, S., Gulati, A. & Thorat, S.** 2008a. Investment, subsidies, and pro-poor growth in rural India. *Agricultural Economics*, 39(2): 163–170.

- Fan, S., Hazell, P. & Thorat, S.** 2000. Government spending, agricultural growth and poverty in rural India. *American Journal of Agricultural Economics*, 82(4): 1038–1051.
- Fan, S., Yu, B. & Jitsuchon, S.** 2008b. Does allocation of public spending matter in poverty reduction? Evidence from Thailand. *Asian Economic Journal*, 22(4): 411–430.
- Fan, S., Zhang, L. & Zhang, X.** 2004. Reforms, investment and poverty in rural China. *Economic Development and Cultural Change*, 52(2): 395–421.
- FAO.** 2012. *State of Food and Agriculture 2012. Investing in agriculture for a better future.* Rome.
- FAO.** 2014. FAOSTAT. Online statistical database (available at: <http://faostat.fao.org/>).
- Flaherty, K., Stads, G. & Srinivasacharyulu, A.** 2013. *Benchmarking agricultural research indicators across Asia–Pacific. ASTI regional synthesis report.* (available at: <http://www.asti.cgiar.org/pdf/ASTI-Asia-Pacific-Regional-Synthesis.pdf>).
- Fuglie, K.** 2012. *Productivity growth and technology capital in the global agricultural economy.* In Keith O. Fuglie, Sun Ling Wang and V. Eldon Ball, eds., *Productivity growth in agriculture: an international perspective.* Oxfordshire, UK, CAB International.
- Gale, F.** 2013. Growth and evolution in China’s agricultural support policies. *Economic Research Report*, number 153. United States Department of Agriculture Economic Research Service (available at www.ers.usda.gov/publications/err-economic-research-report/err153.aspx).
- Giesecke, James A., Tran, Nhi Hoang., Corong, Erwin L. & Jaffee, S.** 2013. Rice land designation policy in Viet Nam and the implications of policy reform for food security and economic welfare. *Journal of Development Studies*, Vol. 49 (9), published online 23 April 2013.
- Hossain, M., Gascon, F. & Marciano, E.B.** 2001a. Income distribution and poverty in rural Philippines: insights from repeat village study. *Economic and Political Weekly*, 35(52/53): 4650-4656.
- Hossain, M., Sen, B. & Rahman, HZ.** 2001b. Growth and distribution of rural income in Bangladesh. *Economic and Political Weekly* 35 (52/53): 4630-4637.
- Isvilanonda, S., Alia, A. & Hossain, M.** (2001). Recent changes in Thailand’s rural economy: Evidence from six villages. *Economic and Political Weekly*, 35(52/53): 4644-4649.
- Jia, Xiangping.** 2013. *Transforming agricultural production in China: from smallholders to pluralistic large farms.* Rome. Presentation made at FAO headquarters on 16 December 2013.
- López, R. & Galinato, G.** 2007. Should governments stop subsidies to private goods? Evidence from rural Latin America. *Journal of Public Economics*, 91(5): 1071–1094.
- Markussen, T., Tarp, F. & van den Broeck K.** 2011. The forgotten property rights: evidence on land use rights in Viet Nam. *World Development*, 39(5): 839-850.
- Moya, PF., Dawe, D., Pabale, D., Tiongo, M., Chien, NV., Devarajan, S., Djatiharti, A., Lai, NX., Niyomvit, L., Ping, HX., Redondo, G. & Wardana, P.** 2004. *The economics of intensively irrigated rice in Asia.* In A. Dobermann, C. Witt, D. Dawe, eds., *Increasing the productivity of intensive rice systems through site-specific nutrient management.* Enfield, N.H., USA, Science Publishers, Inc. and Los Baños, Philippines, International Rice Research Institute (IRRI), pp. 29-58.

- Moya, P.F., Kajisa, K., Barker, R., Mohanty, S., Gascon, F. & San Valentin, M.** 2014. *Changes in rice farming in the Philippines: insights from five decades of a household level survey*. Los Baños, Philippines, International Rice Research Institute.
- Nie, Fengying. & Fang, Cheng.** 2013. *Family farming in China: Structural changes, government policies and market development for growth inclusive of smallholders*. Seminar presentation at FAO headquarters on 13 December. Rome, FAO.
- OECD (Organization for Economic Cooperation and Development).** 2015. *Data on producer support estimates* (available at: <http://www.oecd.org/agriculture/agricultural-policies/producerandconsumersupportestimatesdatabase.htm#country>) (retrieved 10 July 2015).
- Olken, B.** 2006. Corruption and the costs of redistribution: micro evidence from Indonesia. *Journal of Public Economics*. 90: 853-870.
- Otte, J. & Pica-Ciamarra, U.** 2014. *Livestock sector policy and food security* (mimeo)
- Pardey, P.G. & Beintema, N.** 2001. *Slow magic: agricultural R & D a century after Mendel*. Washington, D.C. International Food Policy Research Institute. 36 pp.
- Poapongsakorn, N.** 2014. The Benefits and Costs of a Paddy Pledging Policy: The Experience of Thailand. *In Rice in the shadow of skyscrapers: policy choices in a dynamic East and Southeast Asian setting*. Washington, DC, World Bank, Rome, FAO, and Los Baños, Philippines, International Rice Research Institute.
- Poapongsakorn, N. & Eliste, P.** 2013. *Sustaining competitiveness of Thai agriculture* (mimeo).
- Reardon, T., Timmer, C.P., Barrett, C.B. & Berdegue, J.A.** 2003. The rise of supermarkets in Africa, Asia, and Latin America. *Am. J. Agr. Econ.*, 85(5): 1140–1146.
- Reardon, T., Timmer, C.P. & Minten, B.** 2012. The supermarket revolution in Asia and emerging development strategies to include small farmers. *Proc. Nat. Acad. Sci., USA*. 109(31): 12332–12337 (July 31).
- Reardon, T. & Timmer, CP.** 2014. Five inter-linked transformations in the Asian agrifood economy: Food security implications. *Global Food Security*, 3(2): 108-117.
- Schmidley, A.** 2014. Measures for reducing post-production losses in rice. *In Rice in the shadow of skyscrapers: policy choices in a dynamic East and Southeast Asian setting*. Washington, DC, World Bank, Rome, FAO, and Los Baños, Philippines, International Rice Research Institute.
- Timmer, CP.** 2002. Agriculture and economic development. *In Bruce Gardner and Gordon Rauser, eds., The Handbook of Agricultural Economics*, Vol. 2A. pp. 1487-1546. Amsterdam, Netherlands.
- Timmer, CP.** 2004. The road to pro-poor growth: Indonesia's experience in regional perspective. *Bulletin of Indonesian Economic Studies*, 40(2): 177-207.
- Timmer, CP.** 2014. *Food security and scarcity: why ending hunger is so hard*. Philadelphia, USA, University of Pennsylvania Press. 240 pp.
- Torlesse, H., Kiess, L. & Bloem, M.W.** 2003. Association of household rice expenditure with child nutritional status indicates a role for macroeconomic food policy in combating malnutrition. *J. Nutr.*, 133(5): 1320–1325.

- USDA – ERS (United States Department of Agriculture – Economic Research Service).** 2014. *Data products – International Agricultural Productivity*. (retrieved 10 July 2015) (available at: <http://www.ers.usda.gov/data-products/international-agricultural-productivity.aspx#.UzJQRKiSw40>).
- Wiggins, S. & Keats, S.** 2014. *Rural wages in Asia. ODI Report*. (available at: www.odi.org/rural-wages) (retrieved 7 October 2014).
- World Bank.** 2008. *World Development Report: Agriculture for Development*. Washington DC.
- World Bank.** 2014. *World Development Indicators online*. (available at: <http://data.worldbank.org/products/wdi>) (retrieved on multiple dates in 2014)
- Yang, J., Huang, Z., Zhang, T. & Reardon, T.** 2013. The rapid rise of cross-regional agricultural mechanization services in China. *American Journal of Agricultural Economics.*, 95(5): 1245-1251. doi: 10.1093/ajae/aat027.
- Yates, R.** 2014. Recycling fuel subsidies as health subsidies. *WHO Bulletin* (available at: <http://www.who.int/bulletin/volumes/92/8/14-143495>) (retrieved 10 July)
- Zorya, S. & Santos, N.** 2014. Improving the quality of agricultural public expenditures in Asia. *In Rice in the shadow of skyscrapers: policy choices in a dynamic East and Southeast Asian setting*. World Bank, FAO, IRRI.

ESA Working Papers

WORKING PAPERS

The ESA Working Papers are produced by the Agricultural Development Economics Division (ESA) of the Economic and Social Development Department of the Food and Agriculture Organization of the United Nations (FAO). The series presents ESA's ongoing research. Working papers are circulated to stimulate discussion and comments. They are made available to the public through the Division's website. The analysis and conclusions are those of the authors and do not indicate concurrence by FAO.

AGRICULTURAL DEVELOPMENT ECONOMICS

Agricultural Development Economics (ESA) is FAO's focal point for economic research and policy analysis on issues relating to world food security and sustainable development. ESA contributes to the generation of knowledge and evolution of scientific thought on hunger and poverty alleviation through its economic studies publications which include this working paper series as well as periodic and occasional publications.

Agricultural Development Economics (ESA)

The Food and Agriculture Organization of the United Nations
Viale delle Terme di Caracalla
00153 Rome, Italy

Contact:

Office of the Director
Telephone: +39 06 57054368
Facsimile: + 39 06 57055522
Website: <http://www.fao.org/economic/esa/esa-home/en/>
e-mail: ESA@fao.org