CHAPTER 3

Agricultural land transformations in Asia

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Key messages

- Food production and productivity improvements have contributed to lifting millions of people out of poverty and reduced hunger and malnutrition, but are associated with patterns of land intensification that have degraded agricultural land and caused great environmental harm.
- Underlying drivers affecting land conversion to and from agriculture include population growth, economic growth and transformation, urbanisation, and developments within agriculture such as increasing private sector investments and technological progress.
- Drivers for agricultural intensification in Asia include access to inputs such as fertilisers, pesticides and improved varieties, and food security priorities reflecting the need to produce more from the limited available land.
- For the short term, the strategy to achieve SDG goals such as zero hunger could mean sustaining the current food production levels while addressing the food loss and distributional issues so that a significant part of the current disparities in food security are addressed without further stressing the agricultural systems.
- Over the long term, more transformational changes in agricultural production systems and consumption patterns will be required.

3.1 Introduction

Agricultural land contributes to the human security goals of countries in the region. Any unsustainable trends in land use will undermine their ability to achieve these goals.

Despite the rapid and landscape-wide transformations in land use that can be observed in many parts of the region, agriculture is still the single largest user of land in Asia (FAO 2018). How Asian countries use their agricultural land today and in the near future will have long-term consequences, considering that a large number of people continue to live in rural areas and depend heavily on natural resources and ecosystem services. How they use the land and its resources will also be important to their national wellbeing.

As pointed out in Chapter 2, agricultural land in Asia has been undergoing significant transformations over recent decades as a result of several interconnected drivers. These include population growth, urbanisation, and growing affluence and its impacts on food habits (Vadrevu, Ohara and Justice 2017). These land transformations fall into two categories: changes in agricultural land area and changes in agricultural land use. The first category is to do with the
shifting of land use into and away from agriculture. The second category is to do with the way agricultural land is managed.

Overall, the amount of land employed for agriculture in Asia has been steadily growing over the past several decades, though the rate of change lessened after the 2000s and is not uniform across the region (FAO 2018). At the same time, agriculture has also been steadily losing land to other uses associated with urbanisation, infrastructure development and industrialisation. These changes have profound impacts on the agricultural livelihoods of rural populations, food security and the overall wellbeing of countries in the region.

In addition to changes in land area, intensification involving the movement away from extensive and subsistence farming to more intensive farming that increases land productivity has been an especially profound transformation within the agriculture sector in the region (Nin-Pratt 2016; Hazell 2009). Agricultural intensification can be observed in all Asian countries irrespective of the degree of their development, resulting in widely varied impacts from country to country on the demand for agricultural land. Understanding of intensification patterns and their impacts will contribute to better land management policies.

Keeping the above regional context in view, this chapter reviews a) the state of past and ongoing major agricultural land transformations in Asia in terms of changes in agricultural land use and intensification, b) drivers responsible for the changes, c) associated trade-offs, and d) policies and practices that could ease pressure on agricultural land.

### 3.2 State: Major agricultural land transformations in Asia

Two kinds of agricultural land transformations can be observed in Asia: a) agricultural land-use change and b) agricultural land-use intensification. The former refers to the change in land either by conversion of land into agricultural use or conversion of agricultural land away from agricultural use. The latter refers to how agricultural land is used and how it is managed. These two kinds of transformations are not independent of each other; one form of transformation can significantly impact the other and vice versa. For example, poor management of land may create more demand for land to be converted into agriculture to meet growing food demand.

#### 3.2.1 Agricultural land-use change

Most Asian countries have witnessed significant land-use transformations over past decades. Between 1961 and 2015, the area of agricultural land remained constant in eight countries, declined in 10 and increased in 29 (Figure 3.1). From Figure 3.1 it is evident that a large portion of agricultural land in Asia did not record significant changes (striped areas). The countries that have lost a significant amount of agricultural land in terms of percentage change include Brunei Darussalam (66.7% decline compared to 1961), Japan (48%), Republic of Korea (35.3%), and Mongolia (24.6%). The five countries that experienced the highest rate of growth in agricultural land during the same period are Malaysia (49.5%), Viet Nam (47.8%), United Arab Emirates (44.5%) and Bhutan (40.7%). A different picture emerges when the absolute extent of land (in millions of hectares) either gained or lost from agriculture is considered during the same period. For example, China, Indonesia and Saudi Arabia gained 153, 18.6 and 87.2 million hectares (Mha) of agricultural land, respectively, whereas Mongolia and Iran lost 27.8 and 13.7 Mha, respectively. The trends indicate that there is now a very small proportion of arable land that can be converted to agriculture.
New agricultural land is often sourced from forests and grasslands, and any expansion of agriculture in the future would have to come at the cost of these land uses (FAO 2016).

Figure 3.1. Change in agricultural land in Asia

Note: Striped area, no change; Black fill area, declining; dotted area, increasing. Source: Author, based on data from FAO (2018)

The source of new agricultural land differed for countries that gained agricultural land in the past three decades. For example, a significant amount of agricultural land came from “other land” categories, i.e. land not used for agriculture and forestry, in China (30% of the agricultural land gained in the past two decades) and Saudi Arabia (almost all the agricultural land gained in the past two decades), while most of the gain in agricultural land in Indonesia came from forests, as indicated by the concurrent decline in forest land. Agricultural land lost in Iran and Mongolia has either gone to afforestation or to other land use categories (FAO 2018).

4 The “other land” category in the FAOSTAT database refers to all other land categories not related to agriculture and forestry. This category includes land that was not put to any economic uses such as barren lands, and land used for dwellings and infrastructure such as roads.
3.2.2 Agricultural land intensification

In addition to the changes in area, major transformation is associated with changes in land management practices. These can broadly be classified as extensive and intensive land uses. Extensive agricultural land use consists mostly of peasant farming and other forms of ancient and traditional agricultural practices associated with subsistence farming, largely to produce food for own consumption. Extensive agriculture also includes certified organic agriculture, which targets health-aware consumers willing to pay premium prices. On the other hand, intensive agriculture involves the use of market-based production inputs such as chemical fertilisers and pesticides, as well as technological and labour inputs. Intensive farming can be characterised in terms of number of crops grown in a year (either simultaneously or sequentially), types of crops grown (e.g. cash crops versus cereals; high yielding varieties), amount of labour employed, investments made in farm mechanisation, and the amount of market-based inputs used. Hao et al. (2015) classified agricultural intensification as labour intensification, capital intensification, intensity of labour-saving inputs and intensity of yield increasing inputs.

Agricultural land-use intensification has also been defined as the degree of yield increase caused by production choices made (Dietrich, et al. 2012). However, even though crop yields can provide a picture of intensification, this interpretation needs to be treated with caution since factors other than human interventions, such as better rainfall and temperature, could contribute to better crop yields. With this in mind, the discussion in this chapter views trends in agricultural land-use intensification in terms of production factors.

Agricultural intensification can be measured by the amount of land employed to generate a certain amount of produce and the amount of inputs such as water, energy and chemical fertilisers and pesticides used in agricultural production. The availability of irrigation facilities often drives agricultural intensification by enabling farmers to grow multiple crops in a year using short duration high yielding varieties, and supports other inputs that increase intensification, such as fertilisers, pesticides and machinery, and reduces labour dependency. Hence, irrigation can be a good indicator of intensification.

Figure 3.2 provides percentage changes in chemical input use and irrigation along with changes in crop productivity in selected Asian countries. On the one hand, there have been remarkable increases in the use of chemical inputs in developing countries such as Bangladesh, China, India, Indonesia, and Viet Nam, whereas their use declined in developed countries such as Japan and Republic of Korea. Indonesia recorded the largest increase in chemical inputs use followed by India and Bangladesh. The decline in Japan and Republic of Korea is largely due to a decrease in their farming populations. The decline in their agricultural populations has received a lot of attention in the policy discourse in these countries, as this trend has significant implications for their food self-sufficiency and conversely their dependency on food imports.
Drivers of change

Multiple drivers are behind agricultural land-use change and management in Asia. As listed in Table 3.1, some of the major drivers of land-use change include population growth, economic development, developments within the agriculture sector such as access to fertilisers, irrigation and other technologies, urbanisation and resource degradation. Characterising these drivers is a major challenge. The reasons for this include: a) feedback connections between drivers (e.g. rapid urbanisation providing better quality of life in urban areas could pull more agricultural labour out of the agriculture sector); b) that because some drivers are not particular to the agriculture sector they lie outside the influence of the decisions made within the sector (e.g. infrastructure- and energy-related decisions putting pressure on land); c) spatial variation in drivers within and between countries, which is not easy to capture in a macro analysis such as the one presented in this chapter; d) variation in drivers between farmer groups within a country reflecting their socio-economic and cultural circumstances, which may not be captured in a country- or regional-level analysis of drivers (disaggregated data based on farmer socio-economic and landholding size conditions is not widely available); e) drivers that are operating at the local level, which may not be captured at the national and regional level due to the masking effect of other drivers (e.g. upstream and downstream interactions along a river course or at a watershed level can have significant impact on land-use changes); f) limited time series and high quality data on agricultural land-use changes; g) the lack of systematic collection and reporting of drivers at the national and international levels making it difficult to assess them at specific spatial and temporal scales; and h) as a result of lack of data, few empirical evidence-based studies on drivers and their relationship with the observed land-use changes.

The literature reports on various drivers that create pressure on the land leading to land-use changes and land-use intensification. These drivers are complex and can be cascading in nature, i.e. some acting as precursor drivers for the next set of drivers. Table 3.1 lists drivers that have been
identified in a number of studies. It shows that some drivers are common to both land-use change and land-use intensification. An example is economic growth, which can encourage people to move out of agriculture (as is happening in many of the developed economies in the region) and can drive agricultural intensification (as is happening throughout the region).

Table 3.1 Drivers for land conversion related to agriculture and agricultural intensification reported in selected literature

<table>
<thead>
<tr>
<th>Land conversion drivers</th>
<th>Reference</th>
<th>Agricultural intensification drivers</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic growth</td>
<td></td>
<td>Crop diversification Improved varieties Controlled environments Type of crops grown</td>
<td>(Gunasena 2001; Hao, et al. 2015)</td>
</tr>
<tr>
<td>Economic growth Economic transition Rural private enterprise development Infrastructure including rural infrastructure and highways</td>
<td>(Azadi, Ho and Hasfiati 2011; Vadrevu, Ohara and Justice, 2017; Guo, Wang and Du 2014)</td>
<td>Irrigation Groundwater access</td>
<td>(Alauddin and Quiggin 2008; Gunasena 2001)</td>
</tr>
<tr>
<td>Agricultural development including commercial agriculture Private sector investments in agriculture Foreign direct investment in agriculture Increase in agricultural trade Food security priorities</td>
<td>(FAO 2016, Hosonuma, et al. 2012; Ravanera and Gorra 2011)</td>
<td>Fertilisers</td>
<td>(Nani, Sitaula and Bajracharya 2011; Gunasena 2001)</td>
</tr>
<tr>
<td>Urbanisation Urban population</td>
<td>(Guo, Wang and Du 2014; Azadi, Ho and Hasfiati 2011)</td>
<td>Farm mechanisation Controlled environments</td>
<td>(Nani, Sitaula and Bajracharya 2011; Gunasena 2001)</td>
</tr>
<tr>
<td>Climate change (especially water and temperature as limiting factors)</td>
<td>(Oliver and Morecraft 2014; Niles, Lubell and Brown 2015; FAO 2016)</td>
<td>Farm mechanisation Controlled environments</td>
<td>(Nani, Sitaula and Bajracharya 2011; Gunasena 2001)</td>
</tr>
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</table>

Source: Author, from references cited

One distinctive feature of drivers for agricultural intensification is that most of the drivers are intrinsic to the agriculture sector. Other than the wider economic development happening in the region, agricultural intensification is reported to be driven by growth in irrigated area, growth in the use of fertilisers and pesticides, access to improved varieties and increasing investments in farm mechanisation and in controlled environments. Behind these drivers lie sets of agricultural policies for intensification and private sector investment in the agriculture sector. These drivers are enabling farmers to grow high yielding varieties and diversify crops. They also help them grow several crops.
in a year, whereas farming under rainfed conditions typically only allows single-year cropping. Agricultural intensification has also helped farmers produce for the market, and their access to markets has a feedback effect of further driving intensification. The drivers and their interactions vary from one location to another.

3.3.1 Drivers of land conversion to and from agriculture

Most of the land conversion to agriculture is associated with deforestation. Three models have been developed to explain this conversion: a) environmental Kuznets curve (EKC), b) forest transition model, and c) Borlaug hypothesis (FAO 2016). The environmental Kuznets curve explains that land conversion to agriculture happens under conditions of poverty and has high environmental impacts, whereas the reverse happens beyond a certain threshold of economic conditions through the abandoning of low fertile land and natural regeneration. The forest transition model suggests that not all the forest that was cleared for agriculture remains in agriculture and that low fertile land will eventually be returned to forests through natural regeneration or forestation programmes. On the other hand, the Borlaug hypothesis suggests that the pressure on land declines as the productivity of land is improved through commercialisation. This has the net positive effect of reducing the demand for agricultural land, making it available for diverse uses including for environmental services.

The drivers for land conversion to agriculture are many and varied. Large-scale commercial investment has been reported as one of the most important drivers of land conversion to agriculture (FAO 2016). Mechanisation is another important driver as it encourages land conversion to agriculture by reducing dependence on labour. The resulting efficiency gains encourage more investment in the sector. Greater policy focus on agriculture and mining can also drive land away from forests. For example, price policies that are supportive of agricultural commodities can create demand for new agricultural land.

Regional economic integration and private sector and foreign direct investment are becoming increasingly influential drivers (Ravanera and Gorra 2011). These economic drivers complement government priorities in the region to boost food self-sufficiency and agricultural exports. Regional economic integration through regional frameworks, such as the Association for Southeast Asian Nations (ASEAN), has greatly facilitated the regional trade in agricultural goods. The ASEAN Trade in Goods Agreement (ATIGA), as a strategy to promote regional agricultural trade, aimed to reduce import duties on unprocessed agricultural products to 0-5% by 2017. This has helped boost regional trade and the agricultural economies of several ASEAN member countries (ASEAN 2007; Lim 2013).

Drivers that take land away from agriculture include urbanisation, industrialisation and infrastructure development. Urbanisation can result in greater land prices around expanding urban areas due to the increased demand for housing. This can drive land in the urban periphery away from agricultural use. The decrease in rural populations that is happening in developed Asian countries such as Japan is also driving land out of agriculture. Declining farm profits, market imperfections, poor farm price policies, natural hazards and growing education levels can all lead people to move out of farming, predisposing land to be converted away from agriculture.

To better understand the drivers behind agricultural land transformation in Asia, principal component analysis (PCA) was carried out using time series data between 2002 and 2015, the time period for which most data were available for reliable analysis. The analysis was carried out for two
classifications of countries: a) based on the trend in agricultural land (i.e. increased, no change and decreased), and b) based on their developmental status using UN classification (i.e. highly developed economies, medium developed economies and least developed economies). The variables included in the analysis are a) agricultural land area in a country (ha), b) GDP PPP (gross domestic product, purchasing power parity; constant 2011, international $), c) chemical inputs used in agricultural production (fertilisers and pesticides), d) percentage of irrigated area, e) total population and f) percentage of rural population. The number of principal components were based on the slope of the Scree Plot, indicating that a two-component analysis was adequate to explain the variance. Log transformation was done to accommodate the wide variation among countries to avoid the scale differences. The PCA was based on a correlation matrix and hence the variables were considered standardised.

In Figure 3.3 the upper row of the component plot is related to the three trends of agricultural land change, i.e. increasing, no change and decreasing from left to right, and the lower row is related to the three developmental categories of countries, i.e. highly developed countries, medium developed countries and least developed countries. The analysis showed a positive correlation between principal components (PCs) 1 and 2 in most of the variables for which associations are presented.

When countries were grouped according to their agricultural land change trends, both the PCs correlated positively for percent of irrigated area, chemical inputs, gross production, GDP and total population, and correlated negatively for percent of rural population in countries where the agriculture land was either increasing or didn’t change.

Further, the percent of irrigated area and chemical inputs maintained a positive relationship between the two PCs across the three developmental categories of countries, indicating that irrespective of developmental level these factors have a positive influence on agricultural land. Total population and gross production showed negative correlation between both the PCs across the three development categories.

Figure 3.4 shows the multiple linear regressions between the dependent variable (agricultural land) and independent variables (GDP, agricultural production, total population, rural population, irrigated area and chemical inputs). Results show that the factors explained a high proportion of variance in agricultural land in all country groupings except in countries where the agricultural land didn’t change. In this case, only 53% of the variance was explained by the model. For example, the agricultural land in countries where it is increasing could be given as \( F(6, 6) = 26.496, p < 0.000 \) with an \( R^2 \) of 0.964. In this case, the linear model for predicting agricultural land is 
\[
7.593 + 0.0382(GDP) + 0.017(Chemical inputs) + 0.018(Total Population) - 0.107(% \text{ of irrigated area}) - 0.033(Gross Agricultural Production) - 0.135(% \text{ of rural population})
\]
It can be deduced that the agricultural area in these countries increased in direct proportion to the increases in GDP, chemical inputs and total population, and decreased with investments in irrigated agriculture.
Countries Grouped According to Land Change Trend

Countries Grouped According to Development Status

Figure 3.3 Relationship between two principal components determining the agricultural land conversion

Note: TrGDP: GDP PPP (constant 2011); TrFP: fertilisers and pesticides; TrPIA: % of irrigated agricultural area; TrGPIN: Agricultural gross production index number (2004-2006=100); TrTP: Total population; and TrPRP: % of rural population. Source: Analysis by the author, based on data from FAO (2018)
Countries Grouped According to Land Change Trend

Increasing ($R^2=0.96$)

No change ($R^2=0.53$)

Decreasing ($R^2=0.93$)

Countries Grouped According to Development Status

Developed ($R^2=0.93$)

Developing ($R^2=0.93$)

Least Developed ($R^2=0.74$)

Figure 3.4 Multiple regression results for agricultural land and selected independent variables

Source: Analysis by author, based on data from FAO (2018)
Urbanisation has played an important role in driving land out of agriculture. Nearly 65% of Asian countries have experienced rapid urbanisation (FAO 2018) contributing to the loss of agricultural land. Lao PDR followed by Thailand, China and Bhutan have the highest urban population growth rates, whereas countries in West Asia are slowly deurbanising. The urban population in Lebanon declined by 12% over the past 15 years and declines in the urban population can also be observed in Jordan (6%), Kazakhstan (6%) and the Philippines (6%) (FAO 2018).

The relationship between percentage of urban population and the percentage of agricultural land is shown in Figure 3.5. In the figure, countries marked with asterisks show a statistically significant correlation between the percentage of urban population and the percentage of agricultural land. For Southeast Asian countries such as Cambodia, Lao PDR, Malaysia, Myanmar, Thailand and Vietnam the correlation was highly significant. Countries where the correlation between agricultural land and urban population was negative mostly recorded a significant decline in agricultural land and for countries where the correlation was positive there was a significant increase in agricultural land. The growing domestic and international demand for biofuels is another significant driver for land conversion away from agriculture particularly in India (Schaldach, Priess and Alcamo 2011), China, Indonesia and Malaysia (Valin, et al. 2015).

Figure 3.5. Relationship between urbanisation and loss of agricultural land

Note: Countries marked with asterisks show statistically significant correlation at a probability level of 0.05 and less. Source: Analysis by author, based on data from FAO (2018)

Globally, new forms of energy sources are becoming popular. Asia quickly responded to the growing international and domestic demand for biofuels by introducing biofuel promotion policies. Asian countries have started producing biofuels from feedstock such as cassava (Thailand, China),
oil palm (Malaysia, Indonesia, PNG), jatropha (India, Thailand) and coconut (Philippines). Many of the feedstocks were already being produced by farmers for feed and food purposes and hence they already possessed the knowhow for their production. Introduction of feedstock processing acted as a driver for farmers to produce feedstock for biofuel purposes. At the peak of the biofuels boom, Asian countries were looking at a production potential of as much as 80 million litres of bioethanol and 51,000 million litres of biodiesel per annum (Elder, et al. 2008). India had a major share of biofuels in South Asia with biofuels constituting 3.01% of its total transportation fuels in 2007 (ibid.).

Rapid economic development, a growing middle class, changing lifestyles and increasing trade are also changing the way Asia is employing its agricultural land. A grower of cereals in the 1970s, by 2010 Asia’s livestock products had nearly doubled and it was producing more fruits and vegetables than cereals (ADB 2013). The region has also become a major meat consumer over the past three decades. The rate of growth of share of animal calories in total calorie intake is declining in Asian developed countries while it has increased at an increasing rate in developing Asia (FAO 2018). Meat production has increased at a compound growth rate of 12.6% over the past 38 years. Total per capita calorie intake, the per capita consumption of proteins and fats and meat imports have all substantially increased in the past three decades.

Increasing meat consumption is driving the demand for land for animal feed. Some of this land is employed for cultivating food for direct human consumption. There is a large trade-off associated with this change in land use, as employing land for producing animal feed is 100 times less efficient than cultivation of proteins for direct human consumption (Clark and Tilman 2017). Much of this land could be employed more efficiently for food for direct human consumption (ibid).

There has been rapid growth in the fast food markets in Asia with possible implications for the way agricultural land has been allocated among different crops. The Asia-Pacific fast food market expanded 11.7% between 1999 and 2003. With a market value of 77.9 billion USD in 2003, it is expected to grow even more rapidly in the near future with more expansion to come from China and India (Brown, et al. 2008). In terms of value, the Asia-Pacific region accounted for 28.3% of the global revenues from fast food markets in 2003 (ibid).

In a market survey conducted by Nielsen, most of the top fast food markets, in terms of frequency of consumer visits to fast food restaurants, are in Asia. Many are found in Hong Kong, Malaysia, Philippines, Singapore, Thailand, China, and India (Nielsen 2009). The number of fast food outlets has gone up at a fast pace in China. China’s fast food market was estimated to be worth 29 billion USD (The Economist 2008). One study suggests that about 97% of Chinese eat at fast food outlets on a regular basis (Brown, et al. 2008). The Yum! Brands, the world’s largest fast food chain restaurants’ company, which is based in the US, aimed to expand their fast food chain to 20,000 restaurants in China (Yum! Brands 2008). Fast food sales grew at an annual rate of 15-20% and 30% in India and Korea respectively (Brown, et al. 2008) and fast food outlets served 44% of total meals served in the commercial food service sector in Australia in 2007 (BIS Shrapnel 2009). The recession of 2008 didn’t stop the fast growth of the fast food industry (The Times 2008; The Guardian 2009). Some fast food chains such as McDonald have even put up a better revenue performance during this period than during better economic times (Chicago Tribune 2009).

The region also has seen a significant growth in breakfast cereals, new and emerging commodities such as quinoa and flax seeds etc. due to busy urban lifestyles that deprive consumers of their time to prepare their traditional cooked meals. Consequently, the retail sales of packaged food products in China, Indonesia, Philippines, India, Viet Nam, Japan, Singapore and South Korea increased at
an average annual growth rate of 11.7% during 2001-2007 (United States Department of Agriculture 2008). The highest growth rate was recorded in China (20.5%) followed by India (20.1%) (ibid.). In these countries, the packaged food sales were estimated to be USD 26.4 billion in 2007 (ibid.).

The growing fast food, packaged food and other trends described above could have important indirect implications for agricultural land use. They demand heavy food processing, encourage meat consumption and often promote unhealthy food choices. They also produce more food waste than the traditional practice of preparing food at home, which is a lost food security opportunity. They also have other environmental implications associated with the use of land, fertilisers and water for producing food. In addition, they work by sustaining and promoting urbanisation, which leads to further land-use change.

### 3.3.2 Drivers of agricultural intensification

Several of the main drivers behind agricultural intensification are listed in Table 3.1. The expansion of irrigation facilities, greater access to chemical inputs (chemical fertilisers and pesticides) and high yielding varieties are the traditionally and predominantly reported drivers of agricultural intensification in Asia. The “Green Revolution”, i.e. the technological breakthroughs that spurred significant food production gains during the 1900s, significantly expanded these drivers.

Trends in agricultural land intensification were examined using the three categories of countries described earlier, i.e. countries that gained agricultural land, countries that lost agricultural land and countries where the total area of agricultural land has been stable. Agricultural land intensification was expressed as a function of the combined market inputs of water, fertilisers and pesticides used in agricultural production and gains in agricultural productivity. Agricultural land-use intensification trends were examined with these parameters in 2002 and 2015 and expressed as percentage change from 2002 values.

The trends in agricultural intensification are presented in Figure 3.6 and Figure 3.7 for the three major land-use change categories and three income categories of countries, respectively. The analysis shows that an increase in the use of pesticides and fertilisers played a major role in agricultural intensification in the countries where agricultural land expanded. However, countries have not differed much in terms of drivers such as irrigated area. Countries where agricultural land declined had marginally higher productivity gains than those where agricultural land expanded. Similarly, the area under irrigation was marginally higher in countries where the agricultural land declined compared to the countries where agricultural land remained stable. This suggests that marginal gains in irrigated area and agricultural productivity may have contributed to a decline in agricultural land in some countries, while the countries that gained agricultural land were using more pesticides and fertilisers. The intensification trends observed in land-use trend groups (Figure 3.6) followed largely similar trends as those of the income groups with few deviations (Figure 3.7). For example, gains in agricultural productivity played a positive role in expanding agricultural land in low income countries compared to advanced economies and middle-income countries. Similarly, pesticides and chemical fertilisers appeared to have positive effects on the area of agricultural land in the advanced economies.

The food-fuel nexus deserves special attention due to the significant impact of this nexus on socio-economic and environmental aspects of agriculture. Here, the food-fuel nexus refers to energy use for farming operations (i.e. tillage, planting, harvesting and post-harvest operations
including processing and storage). This nexus is an important component of agricultural intensification.

Regional disparities exist in the strength and nature of the nexus between food and water and food and energy, reflecting the level of development of agriculture systems. In general, agriculture in fertile deltas and river basins is facing more serious nexus issues than regions dominated by rainfed and subsistence farming, as their agriculture relies heavily on off-farm inputs. Increasing freshwater and energy use in agriculture and food production in these areas is associated with the intensive use of chemical inputs and irrigation systems for the cultivation of high-yielding crops, a set of interventions that has its origins in the Green Revolution. No significant deviation in this pattern of intensification can be seen in the region. While low input-based agriculture has garnered increasing attention, it has not supplanted the dominant high input-based intensive agriculture.

Policies promoting intensification, either in the form of support prices or subsidies on agricultural inputs, have been adopted by most developing countries in Asia, while developed countries are slowly moving away from input subsidies to direct cash payments (Hudson, et al. 2011). Many of the price support policies are justified by governments as necessary to support economic and agricultural growth (Lopez, He and Falcis 2017), reduce poverty and secure farm profitability (Phakdeewanich 2017) and for meeting food security goals (Government of India 2014). These policies help keep farmers in farming, support priority agricultural crops and help farmers to sustain agricultural input rates (Dorward 2009; Lopez, He and Falcis 2017).

![Figure 3.6. Percentage change in three drivers of agricultural intensification in three categories of countries during 2002 and 2015](image)

Source: Author, based on data from FAO (2018)

The production of agricultural produce for export has contributed to agricultural intensification in some areas. Agricultural exports constitute a significant proportion of the GDP of countries in Asia. Developing countries such as China, India, Thailand, Viet Nam, Indonesia and Malaysia are major exporters of agricultural produce, with their exports accounting for 3.2, 13.2, 17.0, 15.2, and 26.5
per cent of their GDP, respectively in 2016 (World Trade Organization 2016). Developed countries and economies in transition also export agricultural produce, though not at the level of developing countries. In 2016, agricultural exports accounted for 1.6% of Japan’s GDP and 2.1% for South Korea. The underlying drivers for export-oriented agricultural production include the higher prices offered by international markets, growing demand for agricultural imports from developed countries, investments in agribusiness and finance and technology for export-oriented crops (Barker, et al. 2004; Mundlak, D.F.Larson and Butzer 2002; ADB 2013).

![Figure 3.7. Agricultural intensification in advanced, middle- and low-income economies during 2002-2015](image)

**Source:** Author, based on data from FAO (2018)

### 3.4 Trade-offs of current agricultural land-use changes and land-use intensification for sustainable development

Many of the major agricultural land changes that are taking place in Asia are contributing in important ways to some of the SDGs, at least in the short-term. However, the focus on increasing yields, targeting export markets and accommodating the desires of the region’s growing middleclass is driving patterns of land transformation that have serious social, environmental and economic trade-offs. Agricultural land changes are contributing to some SDGs, while harming others. Land degradation and desertification are particularly important trade-offs of unsustainable agricultural practices as they affect the performance of agricultural land over vast areas.

Figure 3.8 shows that agricultural land-use changes can have negative outcomes for crop productivity, soil quality, climate change (both in terms of greenhouse gas emissions and community vulnerability to climate change impacts) and ecosystem services. Changes in agricultural land can have significant implications for SDGs 1 – No Poverty, 2 – Zero Hunger, 3 – Good Health and Wellbeing, 6 – Clean Water and Sanitation, 12 – Responsible Consumption and Production, 13 – Climate Action and 15 – Life on Land (Vlek, Khamzina and Tamene 2017). Figure
3.8 depicts the anticipated relative impact of land-use changes on each SDG by using different sized boxes. The extent of impact of land-use changes on each SDG depends on how the impacts compound in a hierarchical manner and how other policies and actions compensate for these impacts. For example, while some agricultural land changes could negatively impact poverty, rural development programmes supporting livelihood diversification could alleviate the effects of this impact. However, some SDGs such as 15 – Life on Land and 6 – Clean Water and Sanitation may not benefit from such a compensatory advantage due to poor development of compensation mechanisms. It is important to note that the feedback connections between land changes and SDGs are bi-directional in nature, i.e. any changes in the status of SDGs could have either detrimental or beneficial impacts on agricultural land and vice versa.

The increased consumption of meat products has significant implications for agricultural land. It has led to greater allocation of land for production of livestock feed and thus competition with other agricultural land uses, greater competition for water and greater potential for land and water pollution (Ahuja 2012). The rapid changes in consumer preferences are forcing food producers to change their crop production choices. Only those farmers with the wherewithal to acquire skills and material inputs are able to reap the opportunities this offers, while many farmers are unable to tap the emerging market opportunities, either forcing them to quit farming or cope with the loss of income. The national agricultural research and development systems are too slow to react to these developing market conditions and have not been able to help farmers take advantage of these opportunities and steer these trends in the right direction. Several of these changes also have implications for food waste (discussed below), with significant environmental, social and health consequences.

Social trade-offs
The conversion of forests for agriculture has a range of social implications. Deforestation has incited local conflict and negatively impacted food security by harming the environmental services that forests provide (e.g. pollination, soil development and conservation, watershed protection, etc.) that are important for agriculture and direct provision of food for those living around forest areas (FAO 2016). Evidence from countries where forest areas remained stable or have increased showed a clear positive benefit of forests on food security in these countries (e.g. Viet Nam and Georgia in Asia) (ibid.).

Unsustainable agricultural practices are associated with widespread land degradation in Asia and this results in serious social trade-offs (environmental aspects of land degradation are discussed in the next section). SDG 15 – Life on Land emphasises the importance of reducing desertification, which requires effective strategies to arrest land degradation. Globally, the number of people living on degraded agricultural lands has increased in the past two decades with consequent implications for their wellbeing (Barber and Hochard 2016). People who are living on increasingly degraded lands may no longer be able to sustain themselves through gainful crop production. In some cases they have been forced into the distress sale of their lands to the wealthy, who have converted them to other more profitable uses such as commercial aquaculture, which contaminates waters and degrades the land even further (Scott 2008). Once the land that poor farmers depend upon is degraded it is unlikely to recover. Local agricultural extension systems and other government departments engaged in rural development often lack knowledge and the resources to assist poor farming households recover their land fertility.
Environmental trade-offs
There is a large literature on the impact of land-use changes within agriculture on the environment. This literature highlights impacts on soil and water and their relation to the maintenance of ecosystem processes (Hamidov, Helming and Balla 2016; Vlek, Khamzina and Azadi, et al. 2017).

Land degradation has been an important environmental trade-off of agricultural land-use transformations. Poor controls on land-use intensification processes have resulted in excessive tillage, excessive cropping without replenishment of soil nutrients, cultivation under unfavourable conditions, e.g. where water quality is poor or on slopes with fragile soils, and limited soil protection from surface runoff leading to erosion. This has resulted in degradation and abandonment of nearly 12 Mha of agricultural land in tropical Asia alone (Gibbs and Salmon 2015). Agricultural lands in India, China, Indonesia and Malaysia are reported to be significantly degraded due to water and wind erosion, nutrient depletion, salinity, contamination and loss of physical characteristics of soils (Bai, et al. 2008). Agricultural land degradation is especially evident from the intensively cropped Ganges and Mekong River basins due to intensive use of pesticides, chemical fertilisers, and monocropping.

Another important environmental trade-off from land-use intensification is associated with the water-food-energy nexus. This nexus can take the form of both a synergistic nexus and an antagonistic nexus. In a synergistic nexus, the policies and actions in one sector (e.g. food) will have beneficial impacts on the other components of the nexus (e.g. water). In an antagonistic nexus, any changes in one component will lead to negative impacts on other components. Due to a strong nexus between food, water and energy associated with land use and absence of efforts to decouple antagonistic linkages, sectoral efforts to meet food, water and energy needs in the region are increasingly leading to negative outcomes on the other components of the triad. As the food, water and energy nexus can have a series of cascading impacts, efforts to initiate and strengthen synergistic nexus are of paramount importance. Increased water and energy consumption are two...
obvious environmental trade-offs associated with agricultural land-use intensification and some changes in crop types. Traditionally, the water-energy nexus debate has focused on energy used for groundwater pumping, while ignoring the impact of price supports and other agricultural policies on water and energy use (Sinha, Sharma and Scott 2005). These policies have led to a disproportionate expansion of rice and wheat crops, with much greater consumption of water compared to other cereal crops (Sharma 2015). The biofuel boom of early 2000s spurred debate on food-fuel-water conflicts, as the production and processing of biofuels can consume a significant amount of water, and as biofuel production has the potential to displace traditional food crops. For example, soy feedstock can require 52,239-227,000 litres of water per MMBtu (million British Thermal Units) energy produced (O’Connor 2012; Edenhoffer, et al. 2012).

Agricultural land changes and intensification can have significant impacts on biodiversity (Kehoe, et al. 2015) and these impacts can manifest at the farm and landscape levels. Biodiversity loss is an especially serious concern in South and Southeast Asia, where the loss of native habitats has been accelerating. In these sub-regions, agriculture contributes significantly to habitat loss (Squires 2013). It is projected that 13-85% of the biodiversity in Southeast Asia could be lost by 2100 (ibid). Another major component of agricultural change affecting biodiversity is the rampant use of pesticides in agricultural fields and plantations (Gupta 2012). The problems include continued use of hazardous pesticides, improper use of pesticides including improper doses and application methods, and non-adherence to the safety norms for pesticide applications.

South Asian agriculture can be considered “environmentally-intensive” because of its extensive use of and impacts on groundwater (Alauddin and Quiggin 2008; Acharya 2014). Agricultural land-use intensification involving the increased use of chemical inputs has led to pollution of sub-surface and surface water sources, increased runoff and the resultant silting of reservoirs, and eutrophication (Wasantha, Hoang and Wilson 2015). The use of groundwater for irrigation has been widely promoted in the region and can have positive impacts for livelihoods, especially of smallholders, and food security (Molden 2007). However, without proper management irrigation can result in significant harm to the physical environment and threaten agricultural production in the long run. The price paid for groundwater use has often been lower than the social opportunity cost resulting in its overuse in South Asia (Alauddin and Quiggin 2008).

Land-use conversion to agriculture and agricultural intensification are also contributing to climate change (Nani, Sitaula and Bajracharya 2011). The conversion of forests to agriculture is associated with the release of huge volumes of carbon dioxide into the atmosphere. Intensification is contributing to climate change through the use of fertilisers that originate from fossil fuels, the use of fuels associated with farm mechanisation for tillage and groundwater pumping, and through the burning of crop residues. Expansion of agriculture in the tropics has been reported to have a warming effect on the atmosphere because of surface brightening and consequent reduction of net radiation not balancing the increase in temperature associated with reduced transpiration (Duveiller, Hooker and Cescatti 2017).

**Economic trade-offs**

Agricultural land changes can have significant potential for economic trade-offs. The expansion of agricultural land could be expected to lead to a decrease in import dependency for cereals. However, on the contrary, the import dependency for cereals of some of the countries where agricultural land increased continued to increase and at a higher rate than the countries where agricultural land either declined or stayed the same (Figure 3.9). This is especially so in Indonesia, where food grain imports continue to increase despite expansion in agricultural land, due to
relatively higher per capita consumption of rice and inefficient production practices (Indonesia Investments 2017). Plausible reasons for this trend could include rapid population increase at a rate higher than the rate of increase in agricultural production, increasing demand for food associated with a rapid increase in purchasing power, and any increase in agricultural productivity not being able to meet the demands of the growing population.

There has been a steady growth in agricultural areas reporting a stagnant or even decline in factor productivity, as in the case of the Gangetic Basin (Prabhakar and Elder 2009). The declining factor productivity is characterised by declining agricultural output despite increase in inputs such as fertilisers, pesticides, water and labour. Much of the declining factor productivity, especially in South Asia, has partly been attributed to a) the loss of soil fertility due to unbalanced application of fertilisers, b) soil degradation due to intensive cultivation practices with declining organic inputs (Kumar, Mittal and Hossain 2008) and c) inefficient irrigation systems supported by input subsidies to water and electricity (Government of India 2006; Hasanain, Ahmad, et al. 2013).

Declining factor productivity has a significant impact on farm profits and the net income of farmers, and can force them out of farming. If unnoticed and unmanaged, declining factor productivity can also have a significant impact on the environment as farmers may simply resort to increasing inputs with little or no increments in production in return. Agricultural research and extension systems are yet to tackle declining factor productivity effectively.

Figure 3.9. Food import dependency in three categories of countries compared for the periods 1970-75 and 2009-13

Source: Author, based on data from FAO (2018)

Another aspect of the economic trade-offs associated with agricultural intensification is the financial burden that government support to agriculture, such as price support and fertiliser subsidies, places on the public purse. Countries in Asia spend more than the rest of the world combined on agricultural subsidies (World Watch Institute 2014).
3.5 Measures for easing pressure on land

Any recommendations for addressing agricultural land conversion and intensification-related issues in Asia would have to comply with the national food security goals of the countries in the region and their current developmental needs. This is because agriculture still employs a significant proportion of their populations. These efforts would also have to take into account the impacts of climate change and other global pressures that the region is increasingly been exposed to.

Not all countries are experiencing the same level of agricultural land conversion and intensification and trends differ between countries. Hence, recommendations would have to be specific to each country or country groupings. Some drivers and related pressures originate outside the agricultural domain and hence agricultural policies or actions of agricultural ministries alone cannot fully address the issues arising from agricultural land-use and management changes. A coordinated policy environment within countries that takes a holistic view of the problem and addresses it from multiple angles is needed.

The discussion in this section is mainly focused on two kinds of desirable outcomes of policies and approaches, i.e. a) reduction in the demand for agricultural land and b) mitigating the negative impacts of intensive agriculture such as land degradation (i.e. the perils of intensification). The blue bars in the figures 3.10 and 3.11 indicate the potential of various solutions to reduce demand for agricultural land and to ease pressure of agricultural intensification. From Figure 3.10 and Figure 3.11 it is evident that approaches that can reduce the demand for agricultural land can also help avoid the perils of agricultural intensification to varying degrees. Many of the solutions introduced in this section have been widely discussed among the policy community and some are being implemented to varying degrees. The crux issue is scaling up the application of these solutions to effectively address pressure on the land and the associated natural resource degradation.

**Increasing agricultural productivity without harming the environment:** Improving agricultural productivity is a low-hanging fruit that can lessen the demand for new agricultural land (Prabhakar 2012). Agricultural productivity has been on the rise in the past three decades across the region, albeit with variations among countries in terms of the rate of productivity gains. Also, productivity gains are becoming harder as the rate of increase in productivity is far outweighed by the rate of increase in farm inputs used per unit of output. This situation is disturbing, especially considering that the food demands of growing populations are outpacing food productivity gains. The total factor productivity (TFP), which is the production per unit input, has been either stagnating or on the decline in various parts of Asia (Prabhakar and Elder 2009).

Achieving gains in agricultural production and productivity without harming the environment is an important concern of most governments in the region. Practices to achieve these outcomes exist, but require further development and upscaling (Ladha, et al. 2016). Agricultural research systems in the region are increasingly investing in developing farming practices and methods such as integrated management of water, nutrients and pests, and innovative irrigation techniques to sustainably improve land productivity. However, in some places some of these practices and methods may not be successful due to irreversible structural changes that have already taken place in the agriculture sector. For example, rapid mechanisation has displaced animal power from agriculture, and this has cut down the supply of organic manure that most farmers in the region once used as a staple fertiliser.
The means | The End
---|---
Smart subsidies | Potential to reduce demand for agricultural land | Potential to ease the pressure of agricultural intensification
Unconventional productivity gains |  |  
Sustainable agriculture |  |  
Improved input use efficiency |  |  
Agricultural water pricing |  |  
Food labelling |  |  

**Figure 3.10. Potential of various agricultural approaches for reducing demand for agricultural land and easing agricultural intensification pressures**

*Note: Bars indicate the extent of change brought by the means listed on the left, based on author’s judgement of these policies. Source: Author*

| The means | The End
---|---
Prudent bioenergy policies | Potential to reduce demand for agricultural land | Potential to ease the pressure of agricultural intensification
Renewable energy use |  |  
Food lifestyle changes |  |  
Food waste reduction |  |  
Addressing changing food consumption patterns |  |  
Urban & vertical farming |  |  
Integrated land governance |  |  
Land degradation neutrality |  |  

**Figure 3.11. Potential of various approaches that need policy coordination across different ministries of governments**

*Note: Bars indicate the extent of change brought by the means listed on the left, based on author’s judgement of these policies. Source: Author*

As irrigated areas are exhibiting productivity fatigue, most countries are focusing on productivity gains from rainfed agriculture, which seems to have huge potential. There is a need for renewed investments in rainfed farming with more private sector engagement, which has largely been confined to irrigated well-endowed agro-ecologies. Private sector investment can especially benefit rainfed agriculture by expanding irrigation facilities through the build-operate-transfer mode. This could substantially reduce the burden on government in expanding irrigation facilities.
Sustainable agriculture: There is growing recognition among countries of the need for sustainable agriculture. There has been an increase in the area under organic and other forms of sustainable agriculture in the region (Sano and Prabhakar 2009). Growing consumer awareness of the health benefits of organic food is driving demand for organic food from domestic and international markets. While organic agriculture can effectively address the perils of agricultural intensification including land degradation, it cannot fully address the region’s burgeoning food demand (Reganold 2016). The impact of organic agriculture on demand for agricultural land can be mixed. It may be negligible or it can lead to renewed interest in agriculture, due to high revenue potential per unit output compared to conventional agricultural products.

The Food and Agriculture Organisation of the United Nations (FAO) has been promoting climate-smart agriculture (CSA) as a form of sustainable agriculture, with a view to reducing the impact of agriculture on climate and reducing the impact of climate change on food production and farming communities (Lipper, et al. 2018). The “smart” in CSA involves utilising the opportunities provided by climate change while tackling the challenges associated with it. CSA seeks to integrate global environmental and developmental issues in a single approach. CSA practices aim to reduce the demand for off-farm inputs, energy and water, and increase production and productivity within sustainability bounds, while protecting food production and rural livelihoods from climatic vagaries. CSA is attracting growing attention from policymakers in many Asian developing countries. CSA practices can be scaled up by capacity building of farmers and stakeholders engaged in the agricultural supply chain and making available relevant technical information that is location specific.

Labelling and certification: Food certification and labelling can support sustainable agriculture and could help significantly diminish the negative impacts of agricultural intensification. Countries such as Japan, Australia, New Zealand and South Korea have made great inroads into food certification and labelling. However, current food certification and labelling are largely restricted to providing information on food composition (especially for processed food), nutritional information and to an extent the origin of the food. Food certifications and labels that cover environmental burdens, such as water consumed in producing the food, chemical and pesticide load, and carbon emissions, and that carry other information on ecological footprint can help consumers make responsible food choices. Organic certifications and related labelling have largely been successful in promoting organic food and helped the organic food sector to grow in the region; however, the proportion of the total food supply that is certified as organic remains very low.

There is a need for further development of certification and product labelling schemes. Governments should coordinate their various ministries to ensure that information on environmental burdens and health are included on product labels. To more widely promote sustainable agriculture, food certification and labelling requires a coordinated effort between multiple ministries including the ministries of agriculture, health, and trade and other government agencies engaged with consumers.

Smart subsidies: In Asia, agricultural input subsidies play a critical role in agricultural intensification. Subsidies can help with meeting certain national objectives, such as poverty reduction and food security, but they can also result in inefficiencies and excessive use of inputs. Smart subsidies that better target poor farmers and others who really need them should replace the blanket subsidies that are currently prevalent in most countries (Dorward 2009).
Price support given by governments to agricultural commodities is another area of concern. Although such support has been declining with more governments employing direct cash transfers, agricultural commodity price support is still a major policy intervention in many countries, including India and China. Agricultural commodity support has been argued as necessary to support a country’s food security and rural development goals, but it distorts markets, can maintain the use of off-farm inputs at unnecessarily high levels and can contribute to land degradation from unsustainable agricultural intensification. However, targeted commodity price support for sustainable and healthy food could contribute to the long-term viability of the agriculture sector, and the health and wellbeing of food producers and consumers. When properly designed, such support could help ensure adequate nutrition for the poor and can be implemented as part of nutrition assistance programmes.

Avoiding food-fuel conflicts: Food-fuel conflicts are a concern for the region and were observed during the biofuel boom of early 2000s. With declining fossil fuel prices globally, the biofuel fervour has also been on the decline with several major private sector plans to invest in biofuels in the region either being put on hold or scrapped. Biofuel production in India has either stabilised (as in the cases of ethanol) or has risen continuously at a low pace (as in the case of biodiesel) (USDA 2014).

Some governments have introduced policies to mitigate the risk of food-fuel conflicts. The Government of India, for example, introduced its National Biofuel Policy in 2009, which succeeded in limiting biofuel production to non-food feedstock from degraded lands, thereby lessening the likelihood of food-fuel conflicts by promoting the production of jatropha, a biodiesel feedstock that is largely grown on marginal and degraded lands (Prabhakar and Elder 2010). The success in limiting feedstock production to degraded and marginal lands could also be attributed to the way the policy was implemented, i.e. close monitoring by the local agricultural departments with the involvement of private agencies that supply the seed and procure the feedstock (ibid). While this policy has restricted biofuel to non-food feedstock, there is no policy in the region that restricts the growing of feedstocks to marginal and degraded lands, as feedstocks include cassava, sugarcane and corn, which are also grown for human food. Farmers are not restricted to growing jatropha or any other biofuel crops only on degraded lands. Perceived profits could lure them to cultivate biofuel feedstock rather than food crops on fertile cultivable lands (The Guardian 2009). This indicates the limitation of policies in having precise impact on the ground even though they are well intentioned. Hence, it is essential to combine such policies with support from local farming groups such as cooperatives and other pressure groups to ensure that farmers do not convert fertile lands for biofuel production.

While the uncontrolled cultivation of biofuel feedstocks should be avoided as they can displace food crops, there is a case to be made for biofuels when these fuels can be obtained from environmentally, socially and economically sustainable sources. In this regard, third generation biofuels such as those produced from algae could have immense potential (Alswad, et al. 2015). Producing third generation biofuels at the scale at which they make economic sense requires significant investments by the private sector and governments to develop affordable technologies.

Renewable energy in agriculture: Increased energy access is an important driver of agricultural intensification, one that is supported by agricultural electricity subsidies in some Asian countries. The current forms of energy employed for agriculture are largely carbon intensive and their use leads to high GHG emissions. Interventions promoting the use of renewable energy in agriculture can reduce the demand for grid-electricity, the use of coal and the associated use of water for
thermal power generation. Alternative energy sources can lead to cleaner air and reduce GHG emissions from the power sector.

Biogas plants can reduce the demand for fossil fuels such as kerosene for domestic consumption and increase the energy security of rural households. They can also provide a number of indirect benefits associated with motivating farmers to keep cattle. Cattle provide manure, which can to some extent replace fertilisers generated from fossil fuels, and help improve agriculture yields and soil health. Governments in South Asia are promoting biogas in their rural energy programmes, and this can generate significant benefits for rural development, food and energy (Practical Action 2014; Government of the People’s Republic of Bangladesh 2011; Ministry of Science, Technology and Environment 2008; Ministry of New and Renewable Energy 2014). Such integration into rural development programmes is a way to scale up sustainable energy production.

**Improving water use efficiency:** Crop production technologies that promote efficient water use could conserve energy by reducing the need for pumping and make water available for other priority sectors. Asian countries have promoted water efficient practices in agriculture over the past several decades albeit with limited scaling up of these practices. The challenges to upscaling include lack of farmers’ capacities, lack of positive incentives and the presence of disincentives such as electricity subsidies, lack of required water control and management infrastructure, and absence of dependable water sources (Hasanain, Ahmad, et al., 2012). Appropriate water pricing, as a means to improve water use efficiency, has been advocated, though efforts are needed to convince policymakers of its merits. Water pricing can be applied to both surface and subsurface water resource use and could mitigate the problem of excess irrigation. When combined with irrigation water rationing, the overall impact on water resource utilisation could be substantial.

**Reducing food waste:** Food waste has often been thought of as an issue of developed countries (Parfitt, Barthal and Macnaughton 2010); however, in developing Asia huge volumes of food also end up as waste. In India, for example, an estimated USD 12 billion worth of food is being lost as waste every year (Rabo India Finance 2007).

Food waste is an issue for sustainable production (including processing, transportation and storage) and consumption, as well as for food security. The reasons for food wastage include lack of proper storage and transportation facilities, lack of training and knowledge about the shelf life of the food, absence or poor enforcement of food handling standards, changing food consumption patterns, insufficient development of the food processing industry, food pricing and ill-informed food production decisions by the producers leading to gluts (World Food Program 2009). Addressing food waste can have multiple environmental and social benefits beyond reducing pressure on land, but policy development to reduce food waste is still at nascent stages in Asia, which has been preoccupied with increasing food production.

Multi-sectoral and multi-stakeholder collaboration is required to address the issue of food waste as the problem stretches beyond the agriculture sector. Comprehensive national food waste minimisation strategies should be promoted by targeting the entire lifecycle of food. At the consumer end, introduction of food waste reduction campaigns could be effective, as in the case of Republic of Korea which introduced a national food waste reduction plan in 1996 (Lee 2006). At the producer end, food wastage in the perishable food markets can be reduced by a) providing seasonal price forecasts to farmers, b) introducing futures contracts, c) establishing food storage facilities, including cold storage facilities, in the vicinity of production centres, and promoting public-private partnerships and involvement of farmer cooperatives in installation and operation of the facilities.
and d) small-scale on-farm food processing. Food wastage can also be reduced through supply chain initiatives. The introduction of food labelling with appropriate expiry dates, and making available suitable sizes of food packs would help consumers make responsible purchase choices. Establishing networks for distributing unsold food, including cooked food from restaurants and households, among the needy sections of the society may help in reducing hunger and food wastage, for example as is happening in Mumbai (Pasricha 2018; BBC 2016).

Natural hazards are a major proximate cause of crop loss and food wastage in Asia. Cropping patterns, crop selections and agronomic practices aim at maximising productivity under average conditions, making agriculture highly vulnerable to natural hazards such as extreme events for which production systems are not designed. Countries are undertaking agricultural research and development efforts to address natural hazard-associated losses through changes in crop varieties, crop management practices and crop diversification approaches. Further efforts are required. These can include improved seasonal forecasts to enable farmers to better manage risks when making seasonal decisions, including by modifying seasonal calendars to better reflect weather and climate patterns. Some of these approaches have been incorporated into climate-smart agriculture, but are yet to be widely scaled up. The ability to forecast extreme events also needs to be improved. Another useful investment would be strengthening the local farming input supply and support systems for seeds, fertilisers and irrigation, so that farmers can take advantage of the short favourable window that may open up after a major monsoon failure.

Urban and vertical farming: Urban and vertical farming have potential to reduce pressure on existing agricultural land and reduce conversion for agriculture if designed and promoted appropriately. The idea of promoting food production within urban areas has gained increasing attention among sustainability professionals and policymakers. The FAO and international initiatives such as 100 Resilient Cities have started looking at urban farming as a means of promoting livelihoods, local fresh food and waste recycling (FAO 2018; Fox 2013). As urban areas procure food from faraway places, food production within or in the vicinity of urban areas has potential to reduce carbon emissions from food transport and water miles as well as the larger ecological footprint of urban areas. While there are no macro-level comprehensive assessments on the food production potential of urban areas in Asia and the associated environmental benefits and costs, pilot initiatives have already been introduced in Asia for promoting urban food production. However, there is no evidence that these pilot initiatives have taken a broader view of the competition for resources that is already taking place in urban areas. As cities are increasingly facing electricity and water shortages, urban farming should be promoted in ways that do not place high demands on energy and water from conventional systems, nor should urban farming increase demand on already strained urban spaces.

Promotion of food production in urban areas should be coupled with the promotion of renewable energy, water harvesting, organic inputs, waste reduction and recycling approaches including composting (Prabhakar and Ramanjaneyulu 2016). The elements of sustainable urban food production would also include appropriate agricultural practices (selecting varieties and adjusting practices to reflect urban microclimates), the enforcement of environmental standards and quality controls, and linkages between the food producers and local markets to ensure there is no food waste. Sustainable urban food production could be made one objective of urban planning, which can optimise urban spaces to fully realise the potential of urban food production. Vertical farming, a form of growing food in vertically stacked layers resembling multi-storied greenhouse structures or buildings with appropriate climate control systems, could be a sustainable solution for urban areas that are already space constrained as it enables more food to be produced per unit area. Vertical
farming promotes sustainable input use through rainwater harvesting for water, renewable energy for lighting and organic urban compost for fertilisers. Through climate forcing, vertical farming can produce food throughout the year and isolate food production from the surrounding microclimate and related vagaries.

**Integrated land governance:** Land must be governed in an integrated manner to avoid environmental harm, social conflict and suboptimal outcomes of land use. Integrated land governance consists of structures and processes that bring sectors, different levels of government and stakeholders together to agree on how land should be used and managed. Forests and agricultural land must be managed together because of the two-way flow of ecosystem services that exist between them. Also, a narrow focus on the management of one of these sectors could result in great harm to the other, as is especially obvious in the high rates of forest conversion for agriculture that can be observed in parts of Southeast Asia. Integrated landscape approaches to land management such as *satoyama* (see Chapters 5 and 8) recognise these interlinkages and the need to manage ecosystems and the relationships between them. However, land governance today is highly fragmented, and initiatives to promote *satoyama* and forms of community-based landscape management are yet to make a significant impact at the regional and global scale.

There are a number of challenges to the realisation of integrated land governance. First, integrated land management approaches must reflect the scale, diversity and severity of the problem, which requires them to be tailored to diverse contexts. Existing approaches cannot simply be copied from one place to the next. Second, an information problem exists as government agencies focus on their mandates, yet integrated land governance requires each agency to be cognizant of the impacts of its decisions on the purview of other agencies responsible for land. Third, land-use planning processes should be informed by environmental and socio-economic impact assessments of alternative land uses. This knowledge provides certainty for decision makers about the consequences of allocating land to specific use categories and to land investors. Resources and capacities for such assessments are often lacking, however. Fourth, integrated land governance will bring in the perspectives of disaster risk reduction and climate change adaptation into land-use decision making and land management. While this is certainly needed, it loads up the expectations that are being placed on the land.

Countries such as the Philippines are slowly moving towards land-based decision making for designing their development strategies. Several countries in the region have established specialised land management bureaus for managing land as an integrated unit so that sectoral policy decisions are well informed. Digitisation of land records, establishing clear land tenure and land budgeting have been introduced, albeit at a slow pace. These all help build the foundations for integrated land governance. Integrated land governance requires land management bureaus to have a bigger say in the land management decisions of individual ministries, beyond their current role of mere information providers. They should be given the authority and sufficiently resourced to validate the impacts of proposed policies on the overall land resources in the country in the same way a congressional budget office provides transparent analysis on impacts of proposed budgets on the overall wellbeing of a country.

**Land degradation neutrality:** The Land Degradation Neutrality (LDN) agenda is a result of a decision made at the 12th Conference of Parties of the UN Convention to Combat Desertification (UNCCD). LDN is an integrated target-based overarching policy approach to limit land degradation. LDN is defined as “A state whereby the amount and quality of land resources, necessary to support ecosystem functions and services and enhance food security, remains stable or increases within
specified temporal and spatial scales and ecosystems” (UNCCD 2015). The notion is that countries should counterbalance the loss of productive land with the recovery of degraded lands. Though LDN is an overarching concept and can be applied to a variety of land use classes, it is especially relevant to agricultural lands, as the discussion earlier in this chapter highlights. LDN for agriculture means putting long-term interests ahead of short-term interests for resilient ecosystems and societies. Countries can begin working towards LDN with their available resources. For example, they can strengthen and scale up available approaches such as watershed management, land-use planning and integrated land administration.

3.6 Conclusions
In this chapter an effort was made to identify trends in land-use changes within agriculture and understand various drivers behind these changes and their consequences. Important underlying drivers affecting land conversion to and from agriculture include population growth, economic growth and transformation, urbanisation, and developments within agriculture such as increasing private sector investments and technological developments. Important drivers for agricultural intensification in Asia were found to be access to inputs such as fertilisers, pesticides and improved varieties, and food security priorities reflecting the need to produce more from the limited available land.

Agricultural land changes have social, environmental and economic impacts, not all of which receive sufficient attention from decisionmakers. These impacts interact with each other, with serious implications for many of the SDGs. Agricultural intensification has caused great harm to the land in the form of land degradation and pollution, with serious impacts for health, biodiversity, ecosystem services and long-term human security. Identifying the precise impacts of agricultural land-use changes on the SDGs at the macro level is challenging, as impacts are masked at the macro level by wider economic and social changes. Detailed case studies can help in characterising the impacts of agricultural land-use changes on the SDGs by isolating these impacts from those of other changes.

Achieving the SDGs while safeguarding the sustainability of agricultural lands and the health of agricultural soils presents a paradoxical problem for Asian countries. The food production and productivity improvements in the region have contributed to lifting millions of people out of poverty and reduced hunger and malnutrition, but they are associated with patterns of land intensification that have degraded agricultural land and caused great environmental harm. For the short term, the strategy to achieve SDG goals such as zero hunger could mean sustaining the current food production levels while addressing the food loss and distributional issues so that a significant part of the current disparities in food security are addressed without further stressing the agricultural systems. Policies such as land degradation neutrality would support such a strategy well. Over the long term, more transformational changes in agricultural production systems and consumption patterns will be required. They could include innovative means of food production such as urban and vertical farming, initiatives to change food habits towards healthy and sustainable choices, and introduction of new sources of food that may demand significant cultural adjustments but do not burden the environment.

The implications of agricultural land-use decisions extend beyond the agriculture sector and have wider consequences for human wellbeing and human security. Hence, there is a need for agricultural land-use decisions to be informed by a broad vision that captures these wider
implications. This calls for integrated land-use decision support systems, but these are currently not well researched and developed in Asia. To the contrary, land continues to be governed in a fragmented manner. Without a paradigm change towards integrated land governance, unsustainable agricultural land transformations will continue to take place.
References


Prabharak, S.V.R.K., and M. Eldor. 2010. Not all Biofuels are Bad: A Rural India Case. 17 09.


http://www.worldwatch.org/agricultural-subsidies-remain-staple-industrial-world-0.
Asia-Pacific landscape transformations: Solutions for sustainability

Edited by Henry Scheyvens and Binaya Raj Shivakoti