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Farm structures: current shaping forces and future farms

Catherine Donnars, Marie de Lattre-Gasquet, Jacques Marzin, Laurent Piet

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Land Use and Food Security in 2050: a Narrow Road

Agrimonde-Terra

Chantal Le Mouël, Marie de Lattre-Gasquet,
Olivier Mora, eds

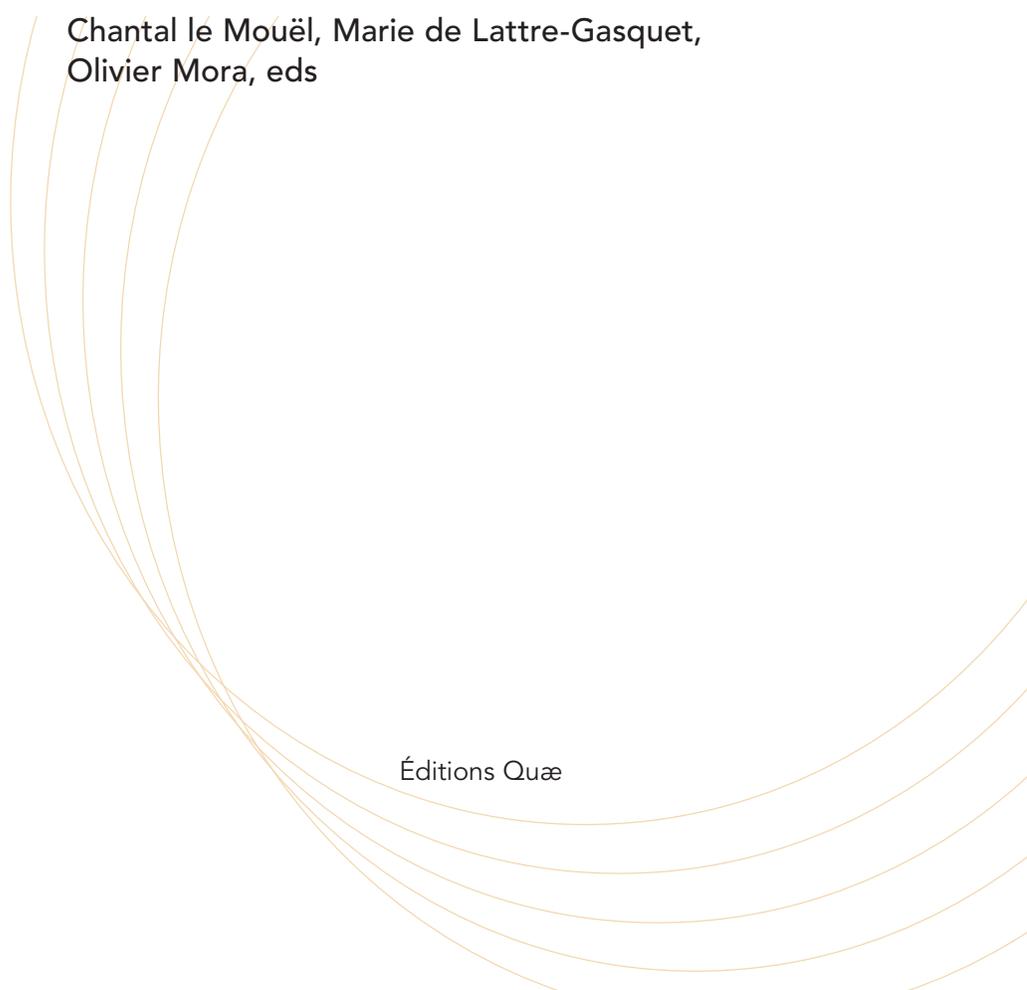


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Éditions Quæ

The cover features several thin, parallel, orange-colored curved lines that sweep across the bottom and right side of the page, creating a sense of movement and depth.

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10. Farm Structures: Current Shaping Forces and Future Farms

Catherine Donnars, Marie de Lattre-Gasquet,
Jacques Marzin and Laurent Piet⁴³

Introduction

WHY LOOK AT FARMS AND FARMERS in a foresight process on land use and food security? The answer lies in the fact that, in concrete terms, it is farmers who manage most of world's land used to feed humans and animals. Their production choices govern farmland use. At the frontiers of farmlands they contribute, on the one hand, to deforestation and the draining of wetlands in order to replace them with fields and grasslands and, on the other hand, they have to abandon degraded lands or are pushed off their land through social exclusion, poverty, war or urban development.

With regards to food security, although farmers are food producers, most of the poor and hungry people in the world live in rural areas and are, paradoxically, small farmers (HLPE, 2013). International reports (World Bank, 2007; Hazell *et al.*, 2007; IAASTD, 2009; HLPE, 2013; Riesgo *et al.*, 2016) converge on the assertion that supporting small farms can be considered a 'win-win' proposition for hunger and poverty reduction. At the same time, massive land acquisitions and development of large-scale landholdings are taking place, putting the spotlight on the increasing role of finance in the agricultural sector. Farming models split opinion on the best way to improve food production and rural livelihoods. Two radical visions are in opposition: those who praise mechanized farming integrated into mass markets and those who recommend smaller farms practicing agroecology focused on local food systems (*e.g.*, Altieri *et al.*, 2012). There are many different options in between these positions. Another dispute concerns farmers' relations to upstream and/or downstream agro-industrial corporations: is it an indicator of economic development or a path to dependence? (McMichael, 2009).

43. The authors thank M. Barzman for his review.

Box 10.1. Members of the expert group on farms structures.

Name	Institution
Expert present in workshops in Paris (06/19 and 11/07 2013)	
Agnes Andersson Djurfeldt	Department of Human Geography, Lund University, Sweden
Lubica Bartova	Faculty of Economics and Management, Slovak University of Agriculture, Nitra, Slovakia
Martine François	GRET, France
Pierre Gasselin	INRA, UMR Innovation, Montpellier, France
Philipp Heinrigs	Club du Sahel, OECD, Paris
Frédéric Landy	University Paris-Ouest Nanterre, Nanterre, France
Eric Lambin	University of Louvain, Louvain, Belgium
Bruno Losch	CIRAD, UMR ARTDev, Montpellier, France
William Masters	Friedman School of Nutrition Science and Policy at Tufts University, Boston, USA
Michel Merlet	AGter, Nogent sur Marne, France
François Purseigle	ENSAT, Toulouse, France
Miroslava Rajcaniova	Faculty of Economics and Management, Slovak University of Agriculture, Nitra, Slovakia
Adrian Rodriguez	CEPAL, Economic Commission for Latin America and the Caribbean (ECLAC), Santiago, Chile
Dimitri Skuras	Department of Economics, University of Patras, Patras, Greece
Jan Douwe van der Ploeg	Department of Rural Sociology, Wageningen University, Wageningen, The Netherlands
Other experts interviewed	
Perrine Burnod	CIRAD, UMR Tetis, Antananarivo, Madagascar
Marie-Hélène Schwoob	IDDRI, Sciences Po, Paris, France
Harris Selod	World Bank, Washington, USA and INRA, PJSE, Paris, France

This chapter is based on the learning points of a workshop held in 2013 with international experts and stakeholders (Box 10.1).⁴⁴ We first examined the drivers of change in farms and management practices, and their trends all over the world. Then we identified seven

44. The authors thank all the participants of the two sessions listed in box 10.1.

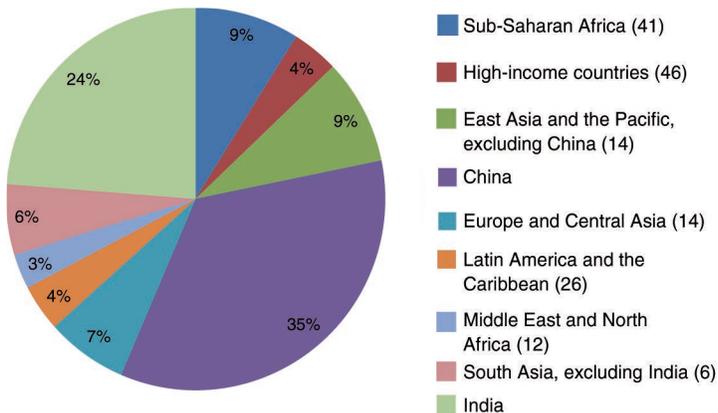
shaping forces, and for each of these we suggested alternative assumptions for the future. Finally, combining all the hypotheses, the Agrimonde-Terra team built six assumptions for the future of farms up to 2050 and constructed their narrative.

Past and on-going changes in farms

I Dealing with a high diversity of farms

Farms are highly diverse because of the interplay of external and internal driving forces. Therefore, defining a typology of farms is a gamble (FAO, 2007). A brief analysis of FAOStat data underlined the limits of worldwide statistics (FAO, 2012b) which estimate the total number of farms in the world at around 570 million (Figure 10.1). We considered farms as the basic unit for production irrespective of their status: family farm, cooperative, agribusiness, state farm, subsistence farm and also landless farmers, who are still around and can even find new niches in urban areas. We chose to characterize them by their combination of production factors (land, labour and capital) and through their integration into social and economic dynamics (household and community networks, and upstream/downstream relationships). These factors become our key drivers to describe the distinctive

Figure 10.1. The distribution of farms around the world (570 millions farms in 161 countries*, by region or country group).



Source: Lowder *et al.* (2014), Figure 1, p 5. Reproduced with permission.
 Note: Numbers of countries included are shown in parentheses. Country regional groupings are the same as those used by the World Bank (2011). * Only 161 of the 167 countries with observations are classified by World Bank groupings.

farming patterns. There are, of course, many other ways to distinguish the different “farming styles” (van der Ploeg *et al.*, 2009). Some other potential drivers are examined in detail in other chapters: the global context (Chapter 6), rural-urban relationships (Chapter 9), changes in diet, food chains and food demand (Chapter 8), cropping systems (Chapter 11) and livestock systems (Chapter 12), for instance. We decided to consider them as background elements here. Some of their consequences, when important for shaping farm structures, are nevertheless pointed out. In the following, we describe the trends in our drivers observed over past decades. Farming patterns are also changing in space. The coexistence of different types of farms within a region is dependent on input and output market options, public policies, trade rules and power relationships. This balance is in constant flux.

Agricultural policies generally reflect roles that agriculture plays in the economy. In general terms, they seek to develop competitive and efficient farms as well as ensuring a fair standard of living and a stable income for farmers. Though they are usually generic in the sense that they apply to all farms together, agricultural policy measures sometimes target specific farming styles: smallholders (the main issue in developing countries according to international institutions), commercial farms, state farms, cooperatives etc.

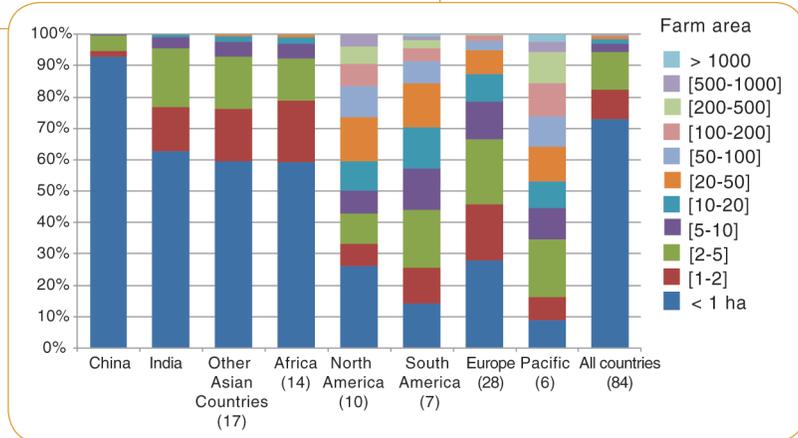
■ Farmland: size and access

Increasing number of farms of less than 2 hectares

One common way to define a farm is its size, as measured by the amount of land used (Eastwood *et al.*, 2009; Hazell *et al.*, 2007), though some database systems may instead consider the number of livestock or gross sales as criteria. However, depending on the type of production or the agro-ecological zone, farm size in hectares provides only an approximate measure of production potential. The World Bank – like other international organizations – uses 2 hectares as the threshold to define ‘small-scale farming’ (World Bank, 2003). While this may be an appropriate limit in many countries, it is not the case worldwide. A Chinese farmer with 2 hectares is considered the head of a large farm, whereas a Brazilian farmer with 50 hectares would be considered to have a small farm in Central Brazil. The farm area criterion is also unsuitable for land held by several families or groups, as in the case of common land farming (Schwoob, 2012).

The extreme disparity of farmland distribution between farmers is a striking feature of world farming. Bélières *et al.* (2013) estimate that about 70% of farms use less than 1 ha which just about represents 10% of the total agricultural area. In contrast, 0.1% of farms represent one-third of the global farmland area (Figure 10.2). These results are consistent with others studies on farm area distribution (Lowder *et al.*, 2016; HLPE, 2013). However, the situation varies greatly according to the region. Farms of more than 100 hectares represent more than 35% of all farms in Oceania, more than 25% in North and Central America, and more than 15% in South America. Farms of less than 1 hectare represent more than 90% of farms in China, around 60% of farms in India,

Figure 10.2. Number of farms according to their farm area in world regions.



Source: Bélières *et al.* (2013), Figure 4, p 37.

other Asian countries and Africa, and about 28% of farms in North America and Europe (Bélières *et al.*, 2013).

Because of the demographic weight of Asia and sub-Saharan Africa, the average area of farms in the world has been falling since 1950 (FAO, 2013; Masters, 2013; Lowder *et al.*, 2014) (Figure 10.2). But it also fell in regions such as Latin America and the Caribbean where the average size shrunk from about 80 ha per farm in 1960 to 54 ha in 2000 (Lowder *et al.*, 2016). The decrease in the average farm area in South Asia and Africa is primarily due to rapid population growth, with the young generation exerting strong pressure on farmland (Losch, 2012; Djurfeldt and Jirstöm, 2013).

The issue of whether an optimal farm size exists has a long tradition in the debate on “agriculture for development” (the title of the World Bank’s 2008 report). In particular, the role of smallholders is frequently discussed. According to one narrative, smallholders will never be ‘competitive’ and the main policy focus should be the provision of social safety nets and education to help the youth find employment beyond agriculture. For the other narrative, smallholders represent efficient and resilient family ‘peasants’ who are seeking autonomy and territorial insertion (Via Campesina, 2010; van der Ploeg, 2014). There are no clear answers to the relationship between increases or decreases in farm size and general growth in the economy (Eastwood *et al.*, 2009). According to empirical studies, there is an inverse relationship between farm size as measured by area and farmland productivity in Africa and Asia, even though labour productivity of small farms is low (Larson *et al.*, 2013; Ali and Deininger, 2014). Several recent works update this question by highlighting and quantifying the contribution of smallholders to production and food security (HLPE, 2013;

Wiggins and Keats, 2013; Herrero *et al.*, 2014; Samberg *et al.*, 2016). For example, Samberg *et al.* (2016) conclude that smallholders produce more than half of the food calories produced globally. Herrero *et al.* (2017) show that farms smaller than 2 ha produce more than half of all food nutrients in China and are of key importance in South Asia, sub-Saharan Africa and East-Asia Pacific. And if we consider farms under 20 ha, then their contribution to most food commodities grows to up to 75% in sub-Saharan countries, South-East Asia, South Asia and China. These authors add that both production and nutrient diversity diminish with increasing farm area and that the greater the diversity of farm sizes in a region, the greater the diversity of the nutrients produced.

Insecure access to land is still widely the case

It is generally recognized that there is a dynamic relationship between land rights and food security (Maxwell and Wiebe, 1999; ECA, 2004; Miggiano *et al.*, 2010; Kepe and Tessaro, 2014). Many households that experience land insecurity also face food insecurity. Women are particularly affected by land insecurity because land regimes are often detrimental for them (Agarwal, 1994). Land rights are secure when there is a high degree of confidence that land users will not be arbitrarily deprived of land use and when an individual's rights are accepted. Land rights are supported by land tenure systems, *i.e.* the sets of formal or informal rules and institutions which reflect relationships between people in their dealings with land.

Land tenure systems play a very important role (de Lattre-Gasquet *et al.*, 2014). Many configurations exist such as verbal contracts, long or short-term leases, tenancy, sharecropping, public or community commons and illegal occupation. Depending on the arrangement, land can be owned by the farmer, belong to someone else or be a common good. For landless farmers, common lands often constitute a safeguard against social exclusion. Numerous local innovations underline the vigour of customary land laws, especially for irrigation networks or in pastoralist regions. Contrary to widespread opinion, titling is far from being generalized nor socially validated around the world. Nevertheless, it has been the object of significant effort in the 20th century and considered a necessary condition for securing access and investments in agriculture by many international donors (Binswanger and Feder, 1995). Nonetheless, the advantage of the land market over informal local arrangements is not obvious because it is not always transparent or fair, and public institutions sometimes fail in recording rights and adjudicating disputes (Binswanger and Feder, 1995). Furthermore, property rights and land use rights often overlap. A farmer can use plots having a different status: individual, collective, sharecropping etc. In many cases, large farmers are often absentee landlords. Therefore, some authors have suggested that land tenure systems should be evaluated as 'bundles of rights' (Lavigne Delville, 2010). Finally, securing access to land seems to be more important than the formal status of the land (Macours *et al.*, 2010).

There are situations which deserve specific mention. Some countries have opted for generalized state ownership of land, while in other countries unregistered land and land presumed vacant or without an owner constitutes 'a partial state monopoly on land' (Chouquer, 2011). Land then can become a source of state revenue via the allocation of

concessions or sales. Moreover, protected areas, parks and reserves prohibit access to crops and livestock. On the one hand, this contributes to conserving biological systems that would otherwise be degraded or destroyed, but on the other, people are displaced or denied access to resources (Brockington and Wilkie, 2015). Finally, land reforms are on the agenda in a few countries thanks to government programmes (Brazil, Namibia, the Philippines, Guatemala, Cuba etc.). But, with the exception of Zimbabwe, the proportion of concerned farmers rarely exceeds 1% of the national total.

Climate change has a large impact on land-use change. Climatic phenomena and environmental hazards such as floods, cyclones, droughts and wildfires increase insecurity of land tenure (Reale and Handmer, 2011). In particular, global warming exacerbates conflicts between nomadic cattle herders and crop farmers due to the scarcity of water and fodder.

Another striking phenomenon concerns large land acquisitions by foreign investors, mostly for agriculture and mining (Woodhouse, 2010; Anseeuw *et al.*, 2012a). It is a subject of concern for NGOs and multilateral organizations (Grain, 2008; World Bank, 2010; Geary, 2012). Large acquisitions affect all continents and are no longer restricted to developing countries as recent debates in France show (Levesque, 2016). Such acquisitions result from the combination of increasing demand for food and biomass for energy and growing opportunities for financial gains from raw materials (Grataloup, 2007). According to 'Land Matrix', between 2000 and 2016, 26.7 million hectares of farmland have been handed over to foreign investors who own about 2% of the global farmland. The average area in these transactions was 35,756 hectares and the median size 8,650 hectares (Nolte *et al.*, 2016), which means that some transactions involved very large areas. Purchases concern primarily land with high agronomic potential, densely populated and accessible. However, many of these investment projects cause a media outcry and do not reach a conclusion. Lack of transparency and respect for local users' rights, as well as competition with local elite powers, explain the high failure rates of land grabbing projects and undermine business viability (Burnod and Tonneau, 2013). International institutions are trying to promote 'good practices' (World Bank, 2007; FAO, 2012a) but some studies highlight that the balance of power usually works against small farmers, who are sometimes excluded or dispossessed (Anseeuw *et al.*, 2012a; Deininger and Byerlee, 2012; Oya, 2013). Moreover, the agribusiness plans of large companies to develop rural services and infrastructure seldom come to fruition (Dayang Norwana *et al.*, 2011). There are, for example, too many cases where the authorities displace local people on the grounds that the agricultural project will serve the general interest, even though the venture is of a commercial nature. Such exclusion is also observed in Eastern Europe (Bazin and Bourdeau-Lepage, 2011; European Parliament, 2015).

■ Farm labour force

The agricultural population is decreasing at the global level, growing in SSA and located mainly in Asia

The FAO defines the agricultural population as "all people depending on agriculture, forestry, fishing and hunting for their livelihoods. It comprises all the people economically

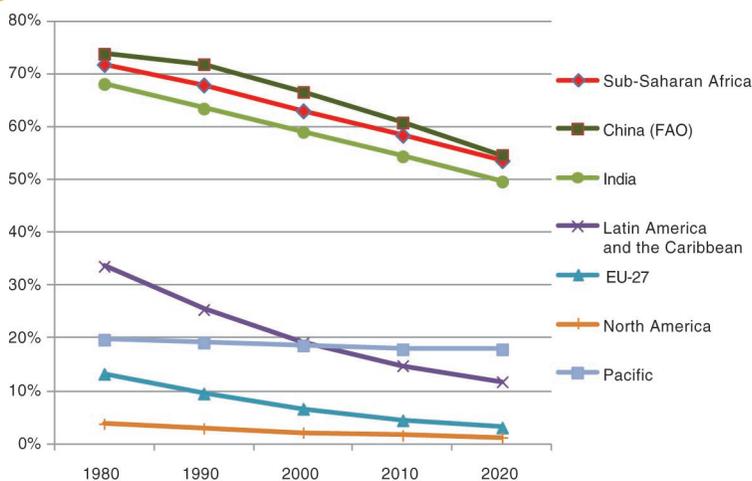
active in agriculture and their non-working dependents, but the agricultural population does not necessarily live exclusively in rural areas” (FAO 2013, p 4).

Until 2000, agriculture was the mainstay of employment around the world. Although the share of employment in agriculture declined, the number of people working in agriculture still reached about 1.3 billion in 2011. This corresponds to 40% of the global workforce (FAO, 2012b) but the share of agriculture in national labour forces varies considerably.

Over the past 40 years, the share of the agricultural sector in the active world population has been decreasing (Figure 10.3) especially in industrialized countries, but also in East Asia, Latin America and the Caribbean regions since the 2000s (FAO, 2012b). However, the total of people making a living from agriculture expanded in many regions: it almost doubled in Asia and multiplied by 2.5 in sub-Saharan Africa between 1961 and 2006, and is expected to increase until 2050 (Dorin, 2014). As a result, 91% of the world’s agricultural population are now concentrated in these two regions (77% in 1961) where they still represent 60% of the total workforce (80% in 1961). Hence, there are almost 500 million people working in agriculture in China and more than 200 million in India and in sub-Saharan Africa (Bélières *et al.*, 2013).

Women and the elderly are important labour forces on farms. At the global level, women are more active in agriculture than men (FAO, 2012b). They produce more than 50% of foodstuffs (FAO, 2011a), this percentage rising to 60% in Asia and 80% in sub-Saharan Africa (ILO, 2005a). According to the FAO, 90% of the labour force involved in rice production

Figure 10.3. Active agricultural population in the overall active population: past situation and projections for 2020.



Source: Bélières *et al.* (2013), Figure 1, page 68 , based on data from FAOStat.

is female. Ageing in agriculture is significant in Latin America, China, Northern Asia and Western Europe. Young rural generations tend to prefer urban or industrial jobs, which are better paid (Leavy and Smith, 2010; Proctor and Lucchesi, 2012). But they also give up farming because of the cost. Based on very substantial investments, doubts have been raised about the viability and capacity to self-reproduce of many modern farms (Hervieu and Purseigle, 2009). On the contrary, young people still represent 65% of the farm workforce in sub-Saharan Africa (Losch *et al.*, 2011).

People working in agriculture have very diverse statuses

World statistics do not provide information on the status of workers in agriculture. These may be independent farmers, contractors, permanent employees, daily-paid workers or even forced into slavery-type conditions. The labour force on a farm often includes a variety of people who provide formal and informal contributions, thereby often making it difficult to determine the relative shares of family, unpaid and paid labour. However, the order of magnitude highlights the overwhelming majority of family labour. Despite the growing farm size, persisting high shares of family farmers in North America show that family farms remain even in modern agriculture due to labour-displacing capital accumulation and mechanization (Eastwood, 2009).

Waged employment in agriculture not only concerns large industrialized farms but also smaller-scale plantations as well as family farms. The rate of paid workers in agriculture is highly variable across the world and the figures are also controversial. According to FAO-ILO-IUF (2007), it concerns 450 million people. The share of waged work is generally low but can grow when farm size increases. It represents around half of the farm labour force, notably in three large countries: India (100 million paid workers of which many also have their own plot of land and hire their own workforce to complete the household income, World Bank, 2008), Brazil (4 million, OECD, 2015) and United States (1.4 million, OECD, 2015).

Farm labour is usually poorly paid. The gap between a farmer's income and the national average income is often in the order of 1 to 10 in OECD countries and maybe up to 1 to 150 in the poorest countries (McMillan and Rodrik, 2011). There is also a lack of equity among farm workers as women and young people often contribute with unpaid work. Since the Millennium Summit, the International Labour Organization has supported national agricultural programmes on 'decent work' (ILO, 2005b).

All around the world, farm households are increasingly pluri-active in order to diversify their income. In 2010, off-farm income had reached 40% or more of total farm household income in many Asian and African countries and 70% of total farm household income in China (Riesgo *et al.*, 2016). Diversification may be imposed by unfavourable economic conditions or chosen as a strategy to spread risk (Ellis, 2000). The household configuration determines the level of multiple jobs and the activities on the farm. One or several members can contribute to income from an off-farm job and undertake non-agricultural activity on the farm (Losch *et al.*, 2011; Anderson Djürfeldt and Jirström, 2013).

To complement this global snapshot, some recent studies have highlighted new forms of labour governance in agriculture. They partly appeared due to economic fluctuations and crises, which affect farms everywhere but are particularly detrimental to farms with few resources to cope with risk. Contract farming is one possible response (Cotula and Berger, 2014). The Ugandan sugar sector and the Mozambican biofuel plant sector, for example, seem to prefer contracting with family farms rather than recruiting employees. New jobs such as 'local development brokers' have emerged. These function as intermediaries between investors, local authorities, technical advisers and those who implement production (Bierschenk *et al.*, 2000). In some countries, large farms and landholdings tend to outsource farm work through service providers and machinery syndicates. Where there is complete delegation, the land owner no longer works on the farm (Hervieu and Purseigle, 2009). For example, in Argentina, the 'pooles de siembra' (sowing pools) are the result of contracts between a club of investors, landowners who expect an annuity, and agricultural machinery enterprises hiring out labour and equipment from sowing to harvesting (Albaladejo *et al.*, 2012).

I Capital: access to credit and technical improvement

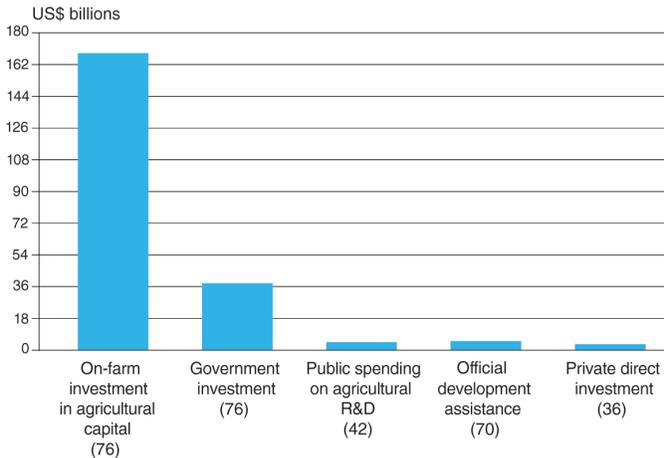
International statistical indicators on capital are especially inappropriate with regards to the large number of farms which are not directed towards markets (Vatn, 2002; Losch, 2012). The more farms substitute labour with capital, the more they need financial instruments to manage their investments and working capital.

Difficult access to finance for poor farmers

Agricultural investments are generally considered high-risk because of production's susceptibility to climatic hazards. Loans take the form of seasonal credits paid to farmers for a period of up to a year, but also finance investments land purchase, irrigation, machinery, post-harvest and processing equipment that are only amortized over several years. These term investments are often beyond the self-financing capacity of farmers (FAO, 2017b). Hence, a great number of agricultural households are in debt. High indebtedness is a big issue for farm transfer and farmers' social well-being. Within vertical integration processes, food-processing firms may invest directly in farms which benefit from this external capital (inputs, buildings and equipment) but, in turn, farmers lose part of their decision-making autonomy.

Poor farmers, who have reduced access to savings, also have a low investment capacity (World Bank, 2007). This is especially true for women (Fletschner and Kenney, 2014) and those who live in remote areas where retail banking is limited and production risks are high (Kloppinger-Todd and Sharma, 2010). In middle- and low-income countries, national budgets and development aid dedicated to agriculture remain limited (Figure 10.4). Nevertheless, widespread Internet coverage benefits remote rural populations by improving access to banks and telecommunication companies now increasingly offer financial services via mobile phones.

Figure 10.4. Investment in agriculture in low- and middle-income countries by source in 2005-2007 (annual average). The number of countries covered is shown in parentheses.



Source: FAO (2017b), citing FAO (2012b), Figure 5, p. 14. Reproduced with permission.

Recent trends

Two radically different scales for outsourcing agricultural capital have recently arisen: macro-actors at the world level and local communities. During the 1980s and 1990s, financial liberalization led to a downward trend in agricultural finance. But since the 2000s, growth in food and biomass demands has attracted investors who include agricultural raw materials in their portfolios (Ouma, 2014). The promoters of agricultural 'financialization' are macro-actors such as banking corporations, investment funds, pension funds, private equity firms and wealthy individuals often coming from outside agriculture. Their investments usually concern agro-holdings and farms involved in cash crops and biofuels. At a much smaller scale, social initiatives in credit have been re-emerging since the 2000s. For example, the NGO 'Terres de Liens' in France and 'Viva Sol' in Lithuania collect funds from the local community to provide land and equipment to farmers.⁴⁵ An increasing number of local or regional authorities now operate in the same way (Bahner, 2011). Such initiatives are usually based on local solidarity in which the producer-to-consumer link is favoured (Fraticeilli, 2011). These operations allow new farms to be established without inter-generational transfer and make it possible to overcome situations where farmers face unmanageable levels of debt.

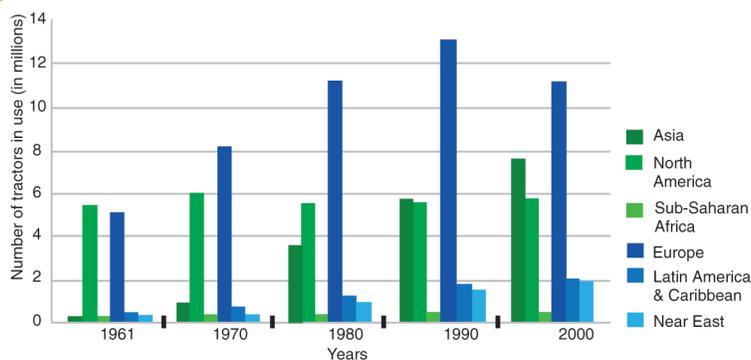
45. <https://terredeliens.org/> and <http://www.accesstoland.eu/Viva-sol-Lithuania> (accessed 12 April 2018).

Mechanization remains a key driver

Manual equipment and limited capital still characterize large parts of agriculture in the world, especially in pioneering zones where land may be cleared with very low capital input using slash and burn systems (Mazoyer and Roudart, 1997). In general, technical change is closely dependent on access to credit, information and output markets. This means mechanization is still unevenly spread across the continents (Figure 10.5). It is more common among wealthy and larger farms, which have easier access to finance. But several options can help small farmers who cannot afford to purchase equipment: rentals, recourse to machinery syndicates or the sharing of machinery within farmer communities or cooperatives.

Substituting labour with mechanization has been associated with the industrial revolution and, more recently, with the Green Revolution (Timmer, 2009). Techniques and equipment made it possible to intensify production and to irrigate crops. In Asia, the Green Revolution model was that of double-cropping, improved genetics, high input use and low mechanization. Land productivity increased considerably, generating surpluses to feed the growing urban populations. However, labour productivity remained low, which is the main reason for the high level of rural poverty observed. In the Soviet world, agricultural intensification was based on large collective production units relying on mechanization and intensive input use. In OECD countries, the Green Revolution model

Figure 10.5. Tractor use by region.



1. Asia includes the People's Republic of China, Japan and India as well as Oceania and Pacific countries.
2. North America includes United States, Canada, Bermuda and Greenland.
3. Sub-Saharan Africa includes all countries on the continent except North African Arab countries (Algeria, Morocco, Tunisia, Libya, Egypt and Sudan).
4. Europe includes ex-USSR up to 1990, thereafter including the Russian Federation and Ukraine and the Baltic States, ex-Asian Soviet Republics are excluded.
5. LAC includes Latin America and the Caribbean.
6. Near East includes all mid-Eastern countries and North African Arab countries.

Source: FAO (2016b), FAOStat (2008). Reproduced with permission.

oscillated between extensive mechanized agriculture in the United States and Australia, and intensification in Europe, leading to a major rural exodus that spanned two generations. The Green Revolution is now criticized because of its role in soil degradation and loss of biodiversity, which made many agricultural regions more vulnerable than they were prior to the Green Revolution (Ostrom *et al.*, 1999).

Recently, information technology has brought innovations that claim to offer smarter resource use and better monitoring of livestock and agricultural production thanks to email and chat applications, remote sensing, spatial mapping technologies and robots (Torero, 2014). The impact of this 'digital revolution' on agricultural sustainability is controversial. But it is supposed to become important due to the need for higher precision in the use of chemicals and in animal care, and due to demands for food documentation. Agro-ecology, that is agriculture based on biodiversity and natural processes, is another source of innovation and an alternative to capital-intensive, high-technology approaches.

■ Integration into markets and food systems

Food systems are prominent forces shaping output markets and farm management. The growing urban consumer class is a worldwide trend; it has led to a standardization of food products through mass-market retailing and to globalized flows of agricultural commodities (Rastoin and Gherzi, 2010). The spatial distribution of production and farms is impacted by urban concentration and food supply industrialization as global markets give priority to regional specialization (Gaigné *et al.*, 2011). On the one hand, international corporate concentration in the food sector strengthens the asymmetry between farms and upstream and downstream stakeholders (Woodhouse, 2010). Recent observations suggest a greater vertical integration due to the weight of supply-side drivers. This trend tends to transform independent farmers into 'service providers' for big companies which oversee the process from input supply to harvest sale, processing and retailing. It has many implications for farm trajectories and regulations. Anseeuw and Ducastel (2013) describe, for example, South Africa's new agricultural model based on foreign investments and a 'corporatization' of the agricultural sector. On the other hand, a product consumed in one country is often produced in another and exchanged via international trade. Thus, local consumption is increasingly met by global supply chains involving tele-connections between different countries (Liu *et al.*, 2013). Some studies underline the high rate of land use displacement currently needed to satisfy local food consumption (Yu *et al.*, 2013). Farmers' production choices are then increasingly driven by changing factors in distant markets (Lambin and Meyfroidt, 2011; Meyfroidt *et al.*, 2013; Weinzettel *et al.*, 2013; Kastner *et al.* 2014). Policymakers have to face this new challenge and are called upon to design policies which include risk management tools so that any adverse shock in another part of the world is unlikely to jeopardise both national food production and food security.

Besides global commodity markets, regional 'terroirs' are promoted on all continents and there is a growing demand for products with specific attributes such as local, organic, fair trade, geographical indication or cultural heritage. The development of certified products leads to a large range of private and public regulations, including labels and private standards.

This diversification might also be a response to economic and climatic risks: niche markets with high value may connect marginal rural areas with urban demand. Statistics show that land use under certified production is more stable (Rueda and Lambin, 2013).

Urbanization also creates new needs and new services for farmers living near cities as there is a trend towards the shortening and relocation of food supply chains. 'Community farming' develops, offering environmental and social benefits, which may be promoted both by urban upper and middle classes and by poor farmers and consumers looking for local markets and affordable products.

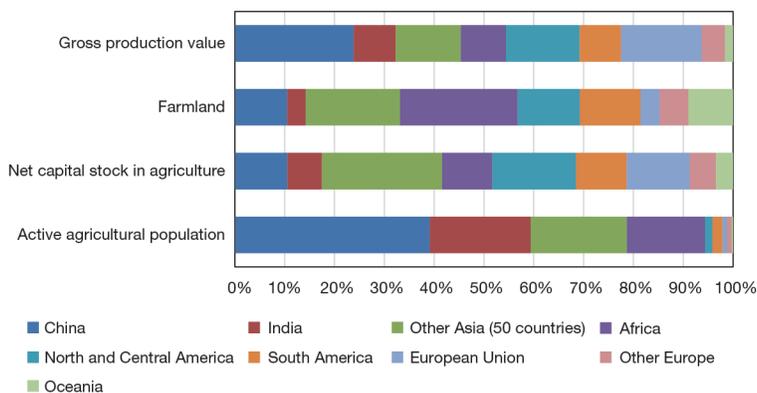
As for farmers who live farther away, their capacity to benefit from growth in urban demand, especially in fresh fruit, vegetables, meat and dairy, can be limited by the lack of infrastructure connecting rural areas to cities and to logistic platforms for exports. Weakness in rural road systems, electrical power grids, warehousing, refrigerated storage and transportation explain the weakness of downstream food processing or agro-industry in many low-income countries.

■ The combination of previous factors

The combination of farm land, labour, capital and markets provides information about the world distribution of farming styles (Figure 10.6):

– While farms in Asian countries account for almost 80% of the world's agricultural labour force, they produce 45% of its agricultural value, hold 40% of capital stock and one-third of farmland.

Figure 10.6. The distribution of production, farmland, capital and employment by world region (FAO classification) in 2007.



Source: FAOStat (2007), calculation by the authors.

Note: Caribbean Islands are included in North and Central America. Other Asia includes 50 countries among which are Japan and Uzbekistan, and countries from the Near and Middle East.

- Abundant land and labour are available for African farms, but their capital stock and output are low compared to other regions.
- Farms in North and Central America, Caribbean, Europe and Oceania concentrate almost half of the capital on 40% of the world's farmland. However, they utilize only 5% of the global agricultural labour force.

Looking at the forces reshaping farms

THANKS TO THE EXPERT GROUP DISCUSSIONS, we identified seven forces acting on farm redesign: farm governance, mobility of production factors, labour organization, land use rights, the diversification of sources of income, distance to consumers and the rationale underlying land use. For each force, assumptions have been formulated for 2050.

I Governance distribution

Governance determines who makes decisions about production factor and output combinations, and how other stakeholders make their voice heard. Rapid and major changes redistributing farming governance are currently occurring in agriculture across the world. Farm expectations, performance criteria and strategic horizons vary according to this governance. Decision makers may prioritize family income, return on investments, employment, market outputs, environmental quality etc. Five assumptions for future farm governance have been identified:

- Governance by financial investors, *e.g.* banks, pension funds, investors' clubs etc. The management of farm production is delegated from outside the farm by brokers.
- Governance by agro-industrial firms (public or private) as in the case of vertical integration. Downstream operators in the agri-food systems or States are investing in farms in order to secure their supply of agricultural raw materials or to ensure a return on investments and develop commercial networks. Farm management depends on the aggregators' strategy.
- Shared governance by farmers and non-farmers (*e.g.*, consumers and local communities), with reciprocal exchanges and recognition of the multi-purpose nature of farm activities. Farm management results from local agreements.
- Collective governance by a group of farmers who jointly manage their land, share equipment, negotiate with buyers in order to improve their economic, social and political recognition (HLPE, 2013). Farmers' groups can also develop sanitary or environmental standards and quality certifications that would not be possible individually because of the excessive costs involved. Farmers may organize themselves in cooperatives or through other formal or informal collective agreements.
- Family governance. This is the most traditional mode of governance and largely the case in subsistence farming. Farmers and their extended families make decisions. They own or rent the farmland and can buy their inputs from whom they choose and sell to whom they want.

I Segmentation of production factors

Traditionally, production factors in agriculture are rooted at the farm level. However, the internationalization of markets, growing farm size in some regions and various dimensions of farming systems complicate resource needs and farm management. We have witnessed a rapid development of new forms of production that separate capital, land and labour managements, especially in Eastern Europe and Latin America (Cochet *et al.*, 2011). While segmented, production factors are also more mobile. Farms may share or delegate part of these production factors. Five assumptions have been formulated for the future:

- High degree of segmentation and mobility of all production factors, *i.e.* land is rented, capital and labour are outsourced. Farm is run by one or several foremen who do not carry out the practical work but manage rented land and paid labour and rely on external sources of capital including that from the non-banking financial sector.
- High capital mobility. Farms rely on capital coming from investors with a wide range of profiles: industrial companies, urban investors' clubs, international traders etc. High capital mobility leads to the 'financialization of agriculture'. Investors seek rapid profitability.
- High labour mobility. Farmers or members of their households can migrate, either on a daily or seasonal basis. The quantity of labour on farms varies depending on the economic context and family needs.
- Local rooting of production factors. Farmers use their own labour force, have the full use of their farmland and investment relies on the family's self-financing capacity and access to banking.
- Difficult access to land and capital. Labour is the main production factor and may be partly hired.

I Labour organization

Most farms are held by families whose members constitute the labour force. Substitution of family labour is related to mechanization. This evolution has been facilitated by the capacity of urban areas and developments in the industrial and service sectors to absorb labour from agriculture. However, situations and issues are diverse. In countries with large agricultural populations and few opportunities for leaving the farming sector, the maintenance of more people working in agriculture is crucial. In countries with an ageing farming population, the issues at stake include ensuring the renewal of the farming population, but also attracting workers for seasonal employment when the farm labour force is insufficient. Four assumptions were formulated:

- Family labour remains crucial. This is the case when there are few employment opportunities outside agriculture or low capital availability on the farm, but also for the production of high-value goods requiring manual work (hand-harvesting, for example), or even when there are biological or technical constraints (*e.g.*, pollination by hand or additional weeding). In many situations, agricultural households have to perform off-farm jobs to complement their income and maintain their farm. Family off-farm jobs come from other farms or activities such as food processing, tourism, community services, industry and mining.

- Collaborative work. Farmers become organized collectively within cooperatives, mutual support or even other collaborative networks involving alternative sectors (tourism, natural space maintenance, food processing etc.). These alternatives often include the non-monetary exchange of skills.
- The labour force is substituted by mechanization and there is little family labour.
- The labour force is outsourced to service providers or machinery enterprises.

■ Land use rights

This dimension relates to the capacity of farms to exercise their right to use land. Securing land rights is an evolving process which does not exclusively depend on property titles. Customary or informal rights are secured when local rules are clear and when land rights are the subject of a social consensus. Various forms of contract exist that set out the modes of direct or indirect enforcement and make land available from seasonal to long-term leases. Land use insecurity arises from short-term tenancies, weak State regulatory capacity, social conflicts, corruption and non-compliance with local norms. The expansion of agricultural frontiers (Brazil, Indonesia, Malaysia, Congo etc.), the development of food and energy cash crops (*e.g.*, in Western Africa) and also urban expansion are increasing pressure on land use rights. Three assumptions have been formulated:

- Insecure land rights. This pathway is on-going in regions with social and economic conflicts or wars. At the local level, land insecurity concerns corruption, power imbalances between genders and social groups, and land grabbing.
- Partial move towards land use rights, with an unstable balance between farmers' control and pressure on farmland. This process occurs with urban expansion or the implementation of large agricultural projects.
- Land rights secure land access and use.

■ Income source diversification

This process involves household strategies for diversifying income sources either through off-farm employment or on-farm through the increased added-value of outputs by integrating downstream activities or exploiting the multifunctional nature of agriculture. Diversification can be imposed by low prices or be a strategy to reduce production risks. Environmental subsidies or payments for ecosystem services can provide a significant part of farm incomes in regions with strong environmental issues. Four assumptions have been formulated:

- Diversification of income by off-farm jobs. Household pluri-activity provides a safety net for farming income.
- Diversification of income by diversification of activities on farms. Rural policies can encourage such income diversification.
- Income comes exclusively from the farm, potentially including subsidies related to farming activities.
- Few options for additional income

I Distance to consumers

The geographical and/or social distance between farmers and consumers can vary considerably. It has increased over past decades with a larger number of actors involved in agri-food commodity chains and the spread of ultra-processed food and numerous agricultural derivatives (Clapp, 2014). The distance is minimal in the case of subsistence farming, where home-consumption is the exclusive outlet. It is very long in extensive supply chains with a lot of intermediaries from faraway countries, to the extent that consumers no longer know where their food comes from. Alongside this trend, local markets and short supply chains develop, often supported by public or private labels. Four assumptions were developed:

- Long distance and many intermediaries between farms and consumers; products are sold as raw materials for processing on world commodity markets. Agricultural products become one of many ingredients in mass marketing food supplies.
- Short distance between farms and local markets. Awareness of ecological footprints and the renewed importance of regional dynamics have increasingly led consumers to pay special attention to the local and social dimensions of their consumption. Consequently, this encourages the reduction of the geographical distance between producers and consumers.
- Markets for certified products (fair trade and labels) create differentiated markets. Distance to the consumer in terms of affinity based on shared values is reduced (social distance), but the distance in terms of number of intermediaries and/or in geographical terms may remain high.
- No market. Self-subsistence farming is the livelihood strategy with the main outputs consumed on farm and few, if any, inputs purchased.

I Rationale underlying land use

This rationale describes what drives farm strategies with regard to the use of resources such as soil, water and biodiversity. The idea is to highlight the way human activities take into account changes in the earth's physical and biological functions and the potential consequences on future livelihoods. Beyond environmental considerations, land use management also relates to social perspectives. Short-term strategies focusing only on productivity may play against sustainable development and its precautionary principles, which strive to prevent future damage and encourage resilient resource management and ecosystem services (Walker *et al.*, 2004). Five assumptions were identified:

- Extractivism. The objective is to maximize cash value. Land is seen as a means to obtain financial returns from product sales (and potentially subsidies). No or little attention is paid to the sustainability of land use.
- Heritage strategy. Land is for transmission to heirs. It is a capital that must be preserved.
- Shared land use. Land is considered as a common good that can be used simultaneously for human services and natural processes. Land management is flexible and diverse but promotes the capacity of ecosystems to absorb shocks resulting from human activities.

– Protected land use. Land is recognized as having both environmental and productive value. The two functions are kept geographically separate to protect natural resources. Agriculture and pasture are prohibited in wetlands, degraded savannahs and other sensitive areas.

Future farms in 2050

HYPOTHESES FOR THE POSSIBLE FUTURES OF FARMS are presented in Table 10.1 as well as in narratives. These hypotheses are the results of the coherent combination of the assumptions relating to each of the forces which shape the redesign of farms.

I Hypothesis 1: Marginalized farms for livelihood survival

Farmers are poorly integrated geographically and socially. They are isolated in hinterlands and mountain areas. They are excluded from markets and off-farm jobs, and are neglected by national policies. The number of marginalized farms expands, especially in countries with few natural resources and few opportunities for employment. Production factors are weakly segmented. Access to credit is poor. Labour is rarely substituted by capital. Land rights are usually insecure. Family members provide on-farm labour. Diversification is a strategy for household survival (Meert *et al.*, 2005) but there are very few options outside agriculture except for improper or illegal jobs. Production is mainly for subsistence. It does not however cover household needs. Raising farm animals, at least poultry, is a common strategy to seek food security.

This trend is already occurring among smallholders in some African, Asian and Latin American regions where rural living standards are deteriorating. In other regions experiencing economic crises, some urban dwellers, attracted by farms which function as a refuge to avoid poverty, move to rural areas. This occurred to some extent in Greece following the 2008 financial crisis.

I Hypothesis 2: Hit and run strategy for agro-investments

Financial attractiveness and the mobility of production factors enable hit and run strategies for agro-investments. A growing world population, changes in consumption patterns, globalization and climate change fuel this hypothesis. High demand for energy biomass and animal feed drives the development of large agro-projects involving a diversity of new actors. Brokers in agricultural development negotiate resources with financial investors, who buy or rent land in a way that is not always ethical, and hire labour or rely on machinery service providers to cultivate the land. Finance is therefore central in this hypothesis. Capital is held by financial companies or urban clubs of investors. Hit and run agro-investments involve fixed-term contracts. In soya and fresh vegetable production, they cover at a minimum the sowing to harvest period. But in perennial plantations such

Table 10.1. Characteristics of the six hypotheses for future farms in 2050, each of which corresponds to a combination of different assumptions of the processes reshaping farms.

Hypotheses for 2050	H1. Marginalized farms for livelihood survival	H2. Hit and run strategy for agro-investments	H3. Agricultural coops emphasizing quality	H4. Farms producing goods and services for surrounding community	H5. Resilient farms embedded in urban processes	H6. Independent farms but commercial dependency
Farm governance	Family governance	Governance by financial investors	Collective decision-making by farmers	Governance is shared with local stakeholders	Family governance	Vertical integration
Segmentation of production factors	Difficult access to land and capital. Low labour mobility	High degree of mobility of all production factors	Local rooting of production factors		High labour mobility	High capital mobility
Organization of labour	Family work is crucial and some members of family get off-farm jobs	Work is outsourced	Collaborative work		Family work is crucial and some members of family get off-farm jobs	
Land use rights	Land rights are insecure				Progress towards land rights	
Income source diversification	Few options for additional income	Income comes exclusively from production and related subsidies	Diversification of farming activities	Diversification of farm income through off-farm activities and jobs	Diversification of farming activities	
Distance to the consumer	No market (self-subsistence)	Long distance and intermediaries between farmers and consumers	Short and long distances between farmers and consumers for certified products and niche products	Short distance between farms and markets. Importance of social and geographical proximity	Long distance and intermediaries between farmers and consumers	
Rationale underlying land use	Extractivism		Protection of land	Shared land use		Heritage strategy

Note: Lines are the seven forces shaping farms and their set of assumptions. Columns are the six hypotheses for farm futures in 2050. Hypotheses (H1 to H6) are the combination of seven different assumptions. Assumptions are then sometimes repeated for convenience when reading the table by column.

as oil palm, miscanthus for biofuel and cocoa, they can last several years. As commodity prices are volatile, agro-investors have the freedom to rapidly break their contracts and seek better financial returns from other countries or sectors. Partners involved in such agro-projects can easily change. Consequently, it is brokers and engineers, who supervise production, that operate as farm managers. Landowners rent their farmland and the annuity becomes an inter-generation family asset. The priority given to cash and short-term returns ignores common goods such as soil fertility and biodiversity. Farming practices aim to maximise production. Agricultural production tends to concentrate on profitable lands and farms. Nevertheless, stakeholders can recognize the potential of the circular economy (cycling and recycling) and social innovation in improving the economics of their agro-projects. Moreover, citizen and consumer movements may encourage environmental and social concerns.

Argentina is currently experimenting with this hypothesis through the 'pooles de siembra' mentioned earlier. Such agro-projects can also be found in Eastern Europe and sub-Saharan Africa.

I Hypothesis 3: Agricultural cooperatives emphasizing quality

This hypothesis combines collective farming organization with an enhancement of product quality. Farms are driven by consumer demand for quality products recognized by geographical or quality labels. Consumers require diverse, tasty and healthy nutrition, as well as ethical and environmental certification. Food processing industries adopt quality specifications and establish contracts with farmer cooperatives. Consumers support producers via higher prices. Guaranteed purchases by subscription or contract expand and limit price fluctuations. Public policies support these new collaborative schemes as well as regional food diversity. Benefiting from certification, land use is more stable and usually more environmentally friendly. However, protected geographical indications can lead to an intensification in land use and risk disrupting ecosystems in some regions. This is the case for argan oil plantations in Morocco and quinoa expansion in the Andes, for example, at the expense of fallow. Cooperatives improve the bargaining power of farmers and reduce their costs by pooling capital and resources. They can also achieve economies of scale by reducing the unit cost of inputs and services. The products of the cooperatives are sold locally or on international markets.

There are many current examples of processes facilitating the development of such cooperation: Europe's Protected Geographical Indication, fair trade products, organic farming, and niche markets such as Peruvian blue potato and local pulses in France and Italy (Ricard, 2007). In many countries, cooperatives benefit from agricultural policies.

I Hypothesis 4: Farms producing goods and services for the surrounding community

An emphasis on commons and collective management is the trademark of this hypothesis. The farms producing goods and services emerge in the context of a new social model based

on environmental stewardship. This hypothesis implies new types of agricultural policies. The rationale underlying land use is leading this change. Environmental managers and others local actors agree on and share the use of land and natural resources. Agroforestry and agroecological practices are favoured in this logic. Policies can also fix critical charges that ecosystems may 'accept' in terms of pollution and disturbance, such as limits in animal densities and the quantities of chemical fertilizers and pesticides applied etc. In this hypothesis, local agriculture is diversified in order to respond to a wide range of baskets of goods and services comprising a large variety of food products and renewable biomaterials, ecosystemic and cultural services. Property rights may continue to operate but use rights override the logic of appropriation. The business model moves from an economy of ownership and consumption to one of functionality and service management. The recycling of resources and re-use are therefore widely promoted. The idea is that of a circular economy where resource inputs and waste, emissions and energy losses are minimized by slowing, closing and narrowing material and energy loops. Governance is shared and requires strong political or community regulations on planning and cooperation through contracts or informal arrangements. The main challenge concerns the management of demand for agricultural services.

Various current initiatives illustrate the diverse trajectories this hypothesis can take. We can, for example, mention the development of renewable and sustainable biomaterials, the Redd++ initiative for forest carbon sequestration, arrangements between livestock farmers, crop growers and foresters to recycle nutrients and maintain open landscapes and even community agreements between local authorities and landless herders whose cattle graze urban green spaces.

I Hypothesis 5: Resilient farms embedded in urban processes

Holding multiple jobs and diversifying sources of income at the household or farm level drive this hypothesis. Farms become more resilient by embedding themselves within urban networks. Farm labour is constantly fine-tuned depending on the rise and fall of urban job opportunities. If off-farm jobs are available, household employment is split between on-farm and urban jobs. The strong links with cities make it possible to diversify and add value to farm activities. In the absence of off-farm jobs, farming guarantees a minimum income and access to staple foods. Which members – young or adult, women or men – of the household leave varies according to the needs of the labour market. Elderly parents may stay on the farm and produce staple foods for relatives living in urban areas and for the neighbourhood. This high level of adaptability in family labour creates resilience. Such flexibility also implies an acceptance of low farm incomes. When there is a surplus of income, households have more capacity to invest in processing or other cottage manufacturing. Households can also support the emigration of younger family members. With such mobility, on-farm skills are not stabilized. On the positive side, migration generates benefits through the transfer of knowledge, skills and technology (de Brauw and Harigaya, 2007). Land use is rather stable and farm size tends to decrease.

These types of resilient farms embedded in urban dynamics can be found at present where there is a high agricultural population or high rates of urbanization. For example, in Vietnam many farms mix urban and agricultural activities. This hypothesis requires a situation of strong rural-urban inter-connectedness and a favourable economic environment.

I Hypothesis 6: Independent farms but commercial dependency

Small farmers sign pre-agreed contracts with private or public firms for the purchase of farm products. The firms may also supply inputs, run processing operations and/or provide storage, marketing and distribution services (Cotula and Berger, 2014). Contract farming is particularly suited to products that need to be processed, shipped or that provide quality standards. Generally exclusive, the relationship with the firm puts farmers in a dependent position, although the farm remains an autonomous entity in terms of land, labour and even capital ownership and management. Firms are responsible for the commercial development of specified products and usually provide inputs and technical advice to farmers in order to meet the specifications in cost and quality. As a consequence, farmers adopt a technical package including fertilizer and pest control solutions. In return, the contract offers a commercial outlet and sometimes guaranteed minimum prices. This hypothesis favours the specialization of production as well as the homogenization of farming practices and market outlets. It also results in a concentration of leading agribusinesses. Contract farming allows State and private firms to maintain their marketing functions while foregoing their responsibilities on land management and social protection. Farmers bear the inherent climate and pest risks. Land rights can be only moderately secured.

Many governments and development agencies have promoted such contract farming as an opportunity for small farms to participate in the agricultural commodity markets. Around 10-20% of the world's small-scale farmers are already involved in such downstream partnerships (IFAD, 2016). The type of arrangement varies widely depending on the country, crop and company. For example, the Moroccan and Tunisian governments are supporting agro-industrial companies contracting with farms; they are called 'integrators' or 'aggregators' respectively. In many countries, contract farming is increasing in the sugarcane, oil palm, dairy, poultry and export horticulture sectors.

Conclusion

THE WORKSHOP HIGHLIGHTED THE VERY LARGE DIVERSITY OF EXISTING FARM TYPES. Their future is strongly dependent on changes in land use and farming practices, and the states of the environment, food supply chains, commodity markets, rural-urban interactions and household strategies. Our six hypotheses describe only some of the possible futures. To complicate things, they can coexist within a single region and be unevenly distributed across the world. They may also appear at different time scales. In addition, though they

constitute a result they can also be considered as a new starting point, from which we can imagine further consequences on land use and food security.

Concerning land use, hypotheses 3 and 4 can be considered to yield the most stable situations. In H₄, negotiations among a wide diversity of stakeholders ensure lasting agreements on the way land should be used. In H₃, the strong focus on quality associated with *terroirs* confers a high cultural and economic value to natural resources and landscapes that is likely to be sustainable. In spite of their different nature, H₁ and H₂ appear unstable because they could lead to over-exploitation of natural resources, soils in particular. The source of instability stems from poverty in the case of H₁, and from strategies based on short-term profit gains in H₂. Land use changes in H₅ depend on urban dynamics. Land in H₆ is likely to be stable in terms of tenure and maintenance of fertility because family farmers and smallholders under contracts strive to secure income and farmland – which has high heritage value – for future generations. On the other hand, land use depends on market demand and could therefore fluctuate in terms of types of production.

Concerning global food security, the consequences stemming from our six hypotheses are only one contributing element and are difficult to assess. Clearly, the living standards of farmers are key to improving food security among rural populations. Regarding food availability for both rural and urban populations, farmers' access to land, equipment and credit as well as the integration of farms into supply chains are essential. When looking at food security, however, we have to take into account all the interactions with the dimensions addressed in the other chapters. Nevertheless, even without referring to the other dimensions, we can still make a few observations. H₁ jeopardizes food availability. H₃ holds the potential to generate food diversity and quality. In H₂ and H₆, food production is dependent on commodity markets and downstream organization. H₄ and H₅ are rooted in urban or territorial dynamics and are therefore associated with shorter supply chains and local or regional food systems.