CHAPTER 3

Evolutionary scenarios for agricultural business models

Marco Medici[1], Giacomo Carli[2], Maria Rita Tagliaventi[3], Maurizio Canavari[1]
[1]Department of Agricultural and Food Sciences, University of Bologna, Bologna, Italy; [2]Department for Strategy and Marketing, The Open University Business School, Milton Keynes, United Kingdom; [3]Department of Sociology and Business Law, University of Bologna, Bologna, Italy

3.1 Introduction

Growth and productivity remain major challenges in the global economy. According to some estimates, the demand for agricultural products is expected to grow by 60% in 2050 compared with yearly figures between 2005 and 2007, thus representing an average increase of 1.1% per year (Alexandratos and Bruinsma, 2012). This will drive demand for greater food production in terms of both quantity and quality, in a context characterized by several intervening contingencies, such as the stagnation of expansion of arable lands, the scarcity of water resources, the declining agricultural labor force, and the rapid urbanization (FAO, 2013).

Improvements in agricultural technologies, tools, and practices are considered as promising opportunities to foster sustainable food production. Precision agriculture, which can be defined as "a new management technology based on georeferenced information for the control of agricultural systems" (Varella et al., 2015, p.185), is bringing agriculture into the digital and information age and is expected to trigger wide societal changes influencing work conditions inside and outside farm boundaries. Precision agriculture favors best management practices of agricultural inputs (Delgado et al., 2013), while enabling remote collaborations involving the whole food supply chain with use of big data (Carlson, 2012; Wolfert et al., 2017; Barmpounakis et al., 2015). Under these circumstances, technology innovation can foster an integration of the food supply chain to meet information requirements concerning location and process characteristics, allowing to keep track of all the actions undertaken by the different actors in the supply chain (Dabbene et al., 2014).

Being precision agriculture more capital-intensive than labor-intensive, farm acreage becomes a major factor for investment amortization. Accordingly, corporate farming, i.e., the practice of large-scale agriculture on farms owned by large companies, will be more likely to adopt highly specialized technologies compared to smallholder organizations. Mergers in the form of plot consolidation will drive the achievement of economies of scale as well as processing and usage of big data, which can be afforded only by large companies, thus appealing to financial investors (Corsini et al., 2015; EPRS STOA, 2017).

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In this context, the presence of small farmers will increasingly become riskier: often unable to fix or adjust equipment, they will likely be subjected to additional expenses of time and money for appropriate technical support.

The combination of the above factors, increased productivity and demand for capital-intensive technology, will reshape the role played by small farms, with many retiring farmers forced to sell their land (Corsini et al., 2015): many senior farmers have no successors in their family (the so-called "continuers"), while a growing number of "newcomers" are seeking to enter farming, even without any prior experience. Examples of extra-family successions, often turning toward slightly different forms of farming characterized by higher levels of innovation and different approaches, such as organic farming and short supply chain, are documented in Belgium, France, Italy, Romania, Spain, and United Kingdom (Cavicchioli et al., 2015; Access To Land, 2018).

Other social macrotrends influence the dimension of business model types in agriculture. Urban areas are expected to host more population in the near future (UNDESA, 2015), and this will prompt a demand for tools and services able to improve food production within cities. Urban agriculture, defined as "a permanent and dynamic part of the urban socioeconomic and ecological system, using typical urban resources, competing for land and water with other urban functions, influenced by urban policies and plans, and contributing to urban social and economic development" (FAO, 2007, p.59), has been studied from different points of view (Zasada, 2011; Bryant et al., 2013; Martellozzo et al., 2014; Optiz et al., 2015; Pölling et al., 2016). Current estimates of agriculture within and near city boundaries suggest that food production is not only a rural phenomenon: according to Thebo et al. (2014), 6% (67.4 million ha) of global cropland is located in cities exceeding 50,000 inhabitants. Another much debated concern is whether organic or conventional farming would be able to feed the world population by 2050, implying challenges for farmers in redefining their business to address this goal (Goulding et al., 2009; Badgley et al., 2007).

This chapter presents possible innovative agricultural business models to be applied in Europe and in low-income countries, which are undergoing uneven changes and modernization, with the aim of understanding how the evolution of agricultural technology will change the way agribusiness is conducted. It depicts a dynamic picture of agriculture combining several sources and giving insights on how the scenarios may develop in a couple of decades. In today's modern markets, farmers must cope with considerable constraints and opportunities, dealing with the evolution of food supply chains. This review contributes to the debate by providing evidence on the strengths and weaknesses of different business models in agriculture and helps to understand how the agricultural development process unfolds in relation of business and technology. To do so, key facts and figures about worldwide agriculture have been gathered and main socioeconomic and technological trends over the last years were identified. All projections are characterized by uncertainty; nevertheless, expected developments in both food offer and demand seem to be nowadays quite clear, in particular with respect to demand stemming from novel uses of agricultural products and the underlying resources requirements; to name but a few, the cases of organic and urban farming are intuitively significant in this regard, in terms of upstream demand of organic resources and land use, respectively. This contribution enables farmers and technology providers to converge their interests, and it could help also actors of food value chains understand drivers and trends of the agriculture of the future.

3.1.1 What is a business model?

In broad terms, a business model can be defined as the way an organization creates and captures value (Gambardella and McGahan, 2010, p. 263). More in depth, there are several interpretations offered in the literature, with still a lack of agreement by scholars on operational definitions of business models. Some peculiarities distinguish business model research from traditional perspectives in strategic research. While the latter approach assumes that value creation is a supply-side phenomenon, i.e., value is created exclusively by producers of goods and services, and competitive advantage is single-sourced, the business model concept implies that value creation is both a supply- and demand-side phenomenon and competitive advantage can be multi-sourced (Massa et al., 2017). The business model concept has become increasingly important, particularly in the fields of technology and innovation management and environmental sustainability (Tripsas and Gavetti, 2000; Massa and Tucci, 2014), offering a new perspective on how organizational processes can be managed to attain sustainable performance. To this regard, it is worth mentioning the definition provided by Nielsen and Lund (2014, p.9): "The business model is (…) the platform which connects resources, processes, and the supply of a service which results in the fact that the company is profitable in the long term. This definition emphasizes the need to focus on understanding the connections and the interrelations of the business and its operations so that the core of a business model description is the connection that creates value. This statement merges traditional elements like cost structure, profit potential, and market segment identification with other concepts such as the definition of the value chain, the need to identify potential complementors and competitors. The business model construct seems to represent an additional contribution to the realm of strategy in terms of value captured and economic sustainability" (Demil et al., 2015).

The business model construct significantly helps in interpreting the domain of precision agriculture in which farmers, like all other stakeholders within the agricultural value chain, face the diffusion of information technologies and the need to improve food production in terms of quality, quantity, and efficiency. As highlighted by Velu et al. (2016), the business model concept can help to represent new propositions in which organizations are increasingly collaborating with customers, suppliers, and complementors to drive innovation and growth and to cope with the demands of changes in the technological landscape. This idea resonates also with the concept of "inclusive business model" suitable for smallholders in low-income countries. Business models can be considered inclusive to the extent to which they involve close partnerships with rural smallholders and food chain operators, entailing value sharing among all partners (Vermeulen and Cotula, 2010), including "the poor on the demand side as clients and customers and on the supply side as employees, producers, and business owners at various points in the value chain" (UNDP, 2008, p.14). In this context, the benefits related to inclusiveness clearly go beyond immediate profit, with a focus on securing staple food chains. Inclusive business models can build bridges between companies and disadvantaged people in quest for diffuse benefit: higher productivity, sustainable earnings, and greater farmer empowerment constitute undeniable priorities, while possible business reinforcing relies on driving innovations, opening new markets, and tightening supply chain relationships.

3.2 Business models for European farming

European agriculture is affected by several long-term trends. Gradual consolidations to form larger farms, a decline in the number of holdings, and weak generational turnover imply substantial changes in farm dimension and ownership in the years to come. The average yearly rate of decline in the number of holdings was 3.7% between 2005 and 2013, with the average holding area rising from 14.4 to 16.1 ha (EPRS STOA, 2016). On top of that, a growing number of family members choose to pursue a career outside agriculture: 31% of farmers in the European Union (EU) are older than 65 years and only 6% are younger than 35 (EPRS STOA, 2016; Carbone and Subioli, 2008).

Another relevant point deals with consumer eating habits and product differentiation. In Europe, increased demands for high-quality products will be driven by consumers' preference for organic products, whose demand is constantly growing (Mockel, 2015; IAASTD, 2009). Organic farming can be considered as a distinct farming approach with its own processing and distribution channels which is compliant to separate legal standards. The EU is the second largest market for organic food (26.2 billion euros) after the United States (27.1 billion euros), with the amount of organically cultivated land in the 28 EU member countries growing, on average, by 6.3% per year from 2002 through 2015 (DG Agriculture and Rural Development, 2016). At the end of 2014, more than 340,000 European farmers were managing approximately 11.6 million hectares of organic agricultural land with arable, grassland, and cereals (Willer and Lernoud, 2016).

The issue of traceability is becoming a tool for securing safety, quality, and reliability of food products, representing an added value for customers whose demand for details about location and process characteristics is increasing (Bánáti, 2014), especially for long food chain; traceability is also subjected to producer's choices, even beyond minimum law requirements (Asioli et al., 2014). On the other hand, short food chains are associated to the need to find models addressing global problems related to food production concerns on urban scale, ensuring reliable food supply within urban centers (Despommier, 2011; Winiwarter et al., 2014). Along with the urbanization trends already discussed, urban production and distribution of food has received growing attention in recent years (Zasada, 2011; Bryant et al., 2013; Thebo et al., 2014). The socioeconomic and technological trends and the environmental concerns cited above delineate possible pathways for the consolidation or the introduction of various types of business models, which are reported in Table 3.1 and discussed below.

3.2.1 Large-scale agricultural enterprise

This business model configuration, whose key characteristics are reported in Table 3.2, is linked to a rapid adoption of precision farming technology to gain in operational efficiency. An increase in the scale of production contributes indeed to lessening fixed costs due to benefits arising from large plots and high machinery operating times. Scale economies can be achieved through mechanization of cropping systems, particularly for sugarcane, cereals, and soya (Vermeulen and Cotula, 2010). The gradual shift toward this large-scale business model can produce not just a horizontal integration in the form of plot consolidation or land lease but also in vertical integration. Upstream integration can address adjacent business areas including technology and service suppliers (a significant case of how a company can expand into adjacent business is provided by Monsanto) and, at the same time, close collaborations with other firms, such as chemical companies, producers of precision equipment, big data modelers, and software industry, are expected

Table 3.1 European business models and main characteristics.

	Business model features	Main cropping systems	Technology adoption rate
Large-scale agricultural enterprise	Corporate farm Cooperative	Arable, grassland, cereals, sugarcane, soya	Very high
Organic farming	Corporate farm Family farm Contract farming	Arable, grassland, cereals, sugarcane, soya, vegetables, orchards	High
Effective smallholder organization	Family farm Contract farming	Vegetables, orchards, perennial crops	Moderate
Urban agriculture	Family farm	Vegetables, nursery crops, fruits, high-value crops	Low

Table 3.2 Main characteristics of the large-scale agricultural enterprise.

Main patterns	Business model features	References
Main cropping system	Arable, grassland, cereals, sugarcane, soya	Vermeulen and Cotula (2010), Willer and Lernoud (2016)
Farm governance	Corporate farm	Corsini et al. (2015)
Precision technology	Sensors, monitoring technology, variable rate (VR) fertilizer application, VR pesticide application, VR manure/lime application, guidance technology and controlled traffic farming, unmanned ground vehicles	McBratney et al. (2005), Llewellyn and Ouzman (2014), Molin (2017), Schimmelpfennig and Ebel (2016), Colaco and Bramley (2018), Chamen (2015), Bonadies et al. (2016)

to take place (Corsini et al., 2015). Moreover, processing and use of big data products appeal to financial investors (Lesser, 2014; Corsini et al., 2015; Wolfert et al., 2017).

The product and process efficiencies could make the large-scale agricultural enterprise a cost leader in consumers' markets, with larger yields achieved through the serial use of precision agricultural technologies. In the long term, the effects of the use of reinforced crops, biomolecular tools (e.g., molecular-assisted breeding, sequencing, and annotation techniques), or genetic modified organisms (GMOs) to further increase yields is hard to predict (Fischer et al., 2011), but it is reasonable to expect that the reaction against GMOs, which is currently strong in the United Kingdom, Austria, Italy, Hungary, Greece, and France (Associated Press, 2010), will be balanced and maybe reduced by scientific evidence of larger yields and better crop quality.

Given the large size of crops, the management of inputs will be integrated, and farm owners will gain better control on them thanks to analytics software. Online sensors will provide information about soil and crop health, and guidance systems will rapidly confer economic advantage without the need for any former integration with decision support systems (McBratney et al., 2005). Part of the technologies (sensors and variable rate or VR fertilization) listed in Table 3.2 is documented by Colaco and Bramley (2018) who reviewed several studies analyzing the application of technology in various agricultural contexts. Recent surveys indicate that the adoption of VR technology amounts to about 15%–25% of grain growers (Llewellyn and Ouzman, 2014; Molin, 2017; Schimmelpfennig and Ebel, 2016), while Chamen (2015) has recently highlighted the rapid expansion of controlled traffic farming (CTF) for large-scale farming. The diffusion of monitoring technology has been acknowledged by Schimmelpfennig and Ebel (2016), whereas Bonadies et al. (2016) demonstrated increased profitability stemming from the implementation of unmanned ground vehicles (UGVs) technology.

3.2.2 Organic farming

Environmental movements increased their focus on organic production targeting consumers in early 1970s (Lockeretz, 2007). Since then, the growth of organic farming out of the niche has been impacting on the whole food value chain, as testified by the opening of the related markets to new customers, by the sale of organic products in conventional stores and the diffusion of organic supermarket chains (Willer and Lernoud, 2018; Haas et al., 2010; Badgley et al., 2007; Wier and Calverley, 2002). Its core features are summed up in Table 3.3. On the supply side, changes are affecting small farms and family farming that are likely to give way to larger farms with increased mechanization, industrialized monocropping, and vertical integration or contract farming (Buck et al., 1997). These tendencies have been argued by several empirical studies investigating the development of organic farming conducted in Germany (Best, 2008), Italy and Portugal (Dinis et al., 2015), Czech Republic (Zagata, 2009), the Netherlands (De Wit and Verhoog, 2007), and Spain (Luetchforf and Pratt, 2010). It is important to note that adoption of organic practices seems to be unrelated to farm size (Malá and Malý, 2013; Dinis et al., 2015), which does not emerge as an entry barrier to organic food production. As organic farming avoids artificial fertilizers and chemical pesticides, yields reach only 70%–80% of the level attained by conventional cropping systems. A quest for strong innovation to increase productivity is therefore foreseeable (de Ponti et al., 2012). In turn, the growing demand of organic fertilizers such as by-products of the meat industry, algae, and plant-based composts, as well as raw mineral phosphorous- and potassium-based fertilizers will drive the development of site-specific fertilizer application

Table 3.3 Main characteristics of the organic farming.

Main patterns	Business model features	References
Main cropping system	Arable, grassland, cereals, sugarcane, soya, vegetables, orchards	Willer and Lernoud (2016)
Farm governance	Corporate farm/family farm/contract farming	Buck et al. (1997), Best (2008), Zagata (2009), De Wit and Verhoog (2007), Luetchforf and Pratt (2010), Dinis et al. (2015)
Precision technology	Sensors, monitoring technology, variable rate (VR) fertilizer application, VR manure application, guidance technology and controlled traffic farming, unmanned ground vehicles	de Ponti et al. (2012), Colaco and Bramley (2018), Bonadies et al. (2016), Vermuelen and Mosquera (2009)

systems. Mechanical and biological appraisals will be adopted to maintain and improve soil fertility and plants protection. UGVs such as autonomous mechanical weeding and crop harvester can strongly reduce environmental impacts in line with the aims of organic farming (Bonadies et al., 2016). Guidance technology and CTF are, for example, already used in organic arable and vegetable farms in the Netherlands, as reported in Vermuelen and Mosquera (2009).

3.2.3 Effective smallholder organization

In a context characterized by low economies of scale and labor-intensive crops, the so-called "effective producer organization" can enable smallholders to participate in agricultural value chains, particularly when crops are characterized by intensive production with significant contribution of manual labor, as is in the case of fruits, vegetables, and perennial crops (Vorley et al., 2007; Vermeulen and Cotula, 2010). Family farming shows some peculiar characteristics, as highlighted by Pritchard et al. (2007), who acknowledged distinctive social properties mainly based upon family ownership: agricultural activities are carried out mostly through family labor or the resort to seasonal wage labor, and controlled by family members, without landlords or external investors. de Janvry et al. (2001) argued that small farms may be favored in self-employed farming and in negotiating and monitoring costs associated with hired labor. Family farming may face higher transaction costs than large-scale corporate farming because of higher costs related to bargaining with farm management to access new land, obtaining information about tenure regulations, implementing delineation of the land, and dealing with inheritance and co-owners. Conversely, family farming emerges as more effective organization in labor-intensive product types for which labor control is important and specialization hardly occurs (Ciaian et al., 2009). Being more labor-intensive, the rate of adoption of innovative technology is likely lower than for the previous business models. However, it is expected that sensors and equipment linked to GPS systems will enable more precise decision support systems, able to model and simulate for automation, monitoring, and forecasting (Maru et al., 2014). Several studies demonstrated the economic convenience of the VR technology adoption even for small plots, for example, in fertilizing (Aggelopoulou et al., 2011; Dobermann et al., 2002), lime application (Weisz et al., 2003), pesticide application (Aita et al., 2015), and site-specific weed control (Timmermann et al., 2003; Pérez-Ruiz et al., 2015). Finally, Matese et al. (2015) revealed how the use of unmanned aerial vehicles (UAVs) appears to be the most cost-effective solution due to their low cost for data acquisition in small-scale farming. All the above features are reported in Table 3.4.

3.2.4 Urban agriculture

Urban environments can reshape traditional farming activities and result in alternatives to conventional business models as shown in Table 3.5. The urban dimension of food is associated with small-scale family-run production (Halweil, 2002). Several strategies

Table 3.4 Main characteristics of the effective smallholder organization.

Main patterns	Business model features	References
Main cropping system	Vegetables, orchards, perennial crops	Vorley et al. (2007), Vermeulen and Cotula (2010)
Farm governance	Family farm/contract farming	de Janvry et al. (2001), Lobley and Potter (2004), Vorley et al. (2007), Vermeulen and Cotula (2010)
Precision technology	Sensors, monitoring technology, variable rate (VR) fertilizer application, VR manure/lime application, VR pesticide application, site-specific weed control, unmanned aerial vehicles	Maru et al. (2014), Aggelopoulou et al. (2011), Dobermann et al. (2002), Weisz et al. (2003), Aita et al. (2015), Timmermann et al. (2003), Pérez-Ruiz et al. (2015), Matese et al. (2015)

Table 3.5 Main characteristics of urban agriculture.

Main patterns	Business model features	References
Main cropping system	Vegetables, nursery crops, fruits, high-value crops	van der Schans (2010), Zasada (2011)
Farm governance	Family farm	Halweil (2002)
Precision technology	Sensors	Duan (2012)

are exploited to maintain farm viability in cities, trying to overcome the limited possibility of attaining economies of scale (Mougeot, 1999; Zasada, 2011). Some farm activities like production of high-value crops and niche crops have already showed good adaptability to urban conditions (Heimlich and Barnard, 1992). Similarly, different strategies from global marketing and vertical integration of services are exploited to maintain farm viability in cities. In this chapter, we focus on "low-cost specialization" and "differentiation."

The "low-cost specialization" refers to products characterized by comparative advantages in the form of highly added values generated by production, such as vegetables, fresh fruit, nuts, and nursery crops (van der Schans, 2010). As highlighted by Pölling et al. (2016), efficiency, productivity, and intensification are closely linked to such approach. Productivity and efficiency are often used as synonyms, but they cover different dimensions: productivity is commonly defined as a ratio of a measure of output and a measure of input (OECD, 2001), whereas efficiency can be seen as the ability to produce something without wasting production inputs. Intensification means a large concentration of inputs (and outputs) per unit area, which is often attained at the expense of environmental integrity; in the last years, the concept of sustainable intensification, implying more production on the same land area while reducing environmental impacts and maintaining ecosystem functioning, has been developed (Struik and Kuyper, 2017). Accordingly, technologies able to improve efficiency and productivity in nursery can be associated to low-cost specialization. In general, this kind of business foresees also the commercialization of dairy products, characterized by high transportation costs, freshness, and high perishability (Heimlich and Barnard, 1992).

On the other hand, urban differentiation is related to greater quality with respect to conventional agricultural production; examples include imported products like heirloom vegetables, exotic, ethnic, and ancient varieties. These examples refer to all kinds of products that are hard to be found in an ordinary grocery store and that create a unique selling proposition or perishable and vulnerable products requiring more attention during transport, such as some strawberry varieties (van der Schans, 2010) and dairy products (Heimlich and Barnard, 1992). In this context, according to Porter's generic strategies (Porter, 1985), the sale of organic products can be considered an instance of market differentiation too (Pölling et al., 2016). By making the supply chain shorter, city farmers can deliver products to consumers on the same day that they are harvested. In addition, besides specific product features, transparency and reliability in producer–consumer relationship represent other tenets of this business model (Zasada, 2011). Due to the urban context characterized by relatively small space availability, the adoption of innovative technology is still currently scant in comparison with other business models: we have only found specific applications of sensors for urban agriculture as acknowledged by Duan (2012).

Vertical farming can be considered a particular instance of urban agriculture, driven by the growth of urban areas that places additional emphasis on the reduction of urban carbon footprints, with main concerns targeting water and land use (Chambers et al., 2000; Saraei and Zaree Farshad, 2009). City-scale food systems in the form of vertical farming are viewed as a means to (a) break the dependence from land and soil quality that characterizes traditional farming systems and (b) reduce emissions related to food processing and transport (Boyer and Ramaswami, 2017; De Anda and Shear, 2017; Despommier, 2011; Winiwarter et al., 2014). Kalantari et al. (2017) reviewed 60 studies on vertical farming and concluded that it can potentially increase food production maintaining high quality and safety, thus contributing to sustainable urban farming. Vertical farming is based on hydroponic and aeroponic technologies which allow crops to grow indoor with mineral nutrient solutions or in air without a growing medium, with water used to transmit nutrients. This innovative instance of urban farming represents a possible scenario for future vegetable production, enabling an increase in yield and profitability per unit area (Touliatos et al., 2016; He, 2017). Many operative advantages over conventional agriculture can be detected: year-round production, safer crops, low use of fossil derived energy to harvest, transport and refrigerate, low use of pesticides or herbicides, and a significant reduction in the use of water—up to 70% with respect to outdoor farming (Despommier, 2011). Nowadays, the high cost of technologies involved in vertical farming represents the main barrier to the diffusion of multitier systems, but evidence of equipment costs reduction has been reported in the past years, such as LED lightning (Gerke et al., 2015; He, 2017) and zero energy buildings (Reeder, 2016).

3.3 Inclusive business models in developing countries

Rural smallholders in low-income countries grow crops for their food security, selling surplus if present. To promote inclusive business models, the reviewed literature highlights four points, intrinsically intertwined with each other. First, it is essential for farmers to have a say in the decision-making processes at an institutional level, as often farmers' associations are not fairly represented in the regulatory authorities (Sulle, 2010). Second, close working partnerships between farmers and other food operators should be established to share value along the food chain (Vermeulen and Cotula, 2010). Third, innovation is needed in products, processes, and services to reduce obsolescence and perishability (George et al., 2012). Fourth, innovation is needed also in agricultural education, from the knowledge of ecosystems to data and information management (FAO, 2013). Finally, the adoption of Information and Communications Technology (ICT) is considered a key element to achieve sustainable business models, as it has been playing an important role in promoting innovation in the agriculture sector (Hudson et al., 2017; Tembo and Maumbe, 2009).

Governments, research organizations, and nongovernmental organization (NGOs) are expected to move forward along these pathways, supporting local smallholders by raising food safety standards, improving farmers market linkages, and providing technical assistance (Kaganzi et al., 2009; Randall and Stepanovic, 2015). In particular, NGOs are able to establish ties between governments and private companies. The Food and Agriculture Organization (FAO), for instance, helps rural communities define rankings of priorities, conveys technical support and knowledge, and offers financial solutions evaluations. To implement the "inclusiveness" undergirding this business model, robust intervention approaches like provision of free services and inputs should be balanced with commercially oriented services, to avoid the risk for smallholders' supporters to be overprotective and prevent farmers from gaining awareness of real market forces; it is hence important that NGOs go beyond the provision of support to build competencies in farmers and adopt a gradual exit strategy with the aim of increasing smallholders' independence (Sulle et al., 2013). Improvements in ICTs can enable rural communities to communicate with, and be heard by, their peers, local institutions, and other producers. In general, advisory services enabled by ICTs facilitate not just networking at all levels but also grant access to information and organization of the knowledge base, thereby leading to collaborative approaches to problem solving. In addition, ICTs can empower rural communities so that they can negotiate better deals with other actors in value chain: ICTs give farmers a better understanding of costs and knowledge of variations in market prices (Nyirenda-Jere, 2010; Rudgard et al., 2011).

With over 80% of smallholders located in Asia and Africa operating on plots of land smaller than 2 hectares, the surveyed literature stresses farmers' collaboration to achieve food security, suggesting that organizations like agricultural cooperatives are definitely a viable possibility. This point emerged also from an interview with Dr. Gerard Sylvester, the Knowledge and Information Management Officer at FAO conducted by the authors in 2017: farmers need to cooperate to generate profit, booking the use of common machinery and sharing technologies and know-how. In this context, advanced technology solutions like sensor networks and Internet of Things (IoT) are able to provide appropriate information at the right time and become a priority for rural communities that can help overcome technology constraints in the form of limited access to technology and the capacity to introduce them in their productive processes. In terms of future technology adoption, next steps can be traced back to blockchain technology and food traceability in order to improve shared information along food value chains enhancing transparency and shifting the focus to the uptake of precision agriculture equipment like VR machines and precision harvesters.

We report on two kinds of inclusive business models based on farmers' cooperation in the form of plot consolidation, which are producer-driven models and buyer-driven models and on instances of urban farming. These models may constitute realistic answers to present and future challenges posed by rural agriculture. The adoption of precision technology is still limited, with just a few solutions likely to be adopted by smallholders: this is mainly due to the low levels of education in low-income countries (Takács-György et al., 2013; Daberkow and McBride, 2003). In addition, the topic of family farming will be addressed for developing countries subjected to increasingly growing urbanization, as citizens' food security take center stage. The socioeconomic trends cited above delineate possible pathways for the consolidation or the introduction of three types of business models, which are reported in Table 3.6 and discussed below.

Table 3.6 Business models in developing countries and main characteristics.

	Business model features	Main cropping systems	Technology adoption rate
Producer-driven models	Cooperative	Arable, cereals, vegetables, sugarcane, orchards	Low
Buyer-driven models	Contract farming Smallholder procurement	Arable, cereals, vegetables, sugarcane, orchards	Moderate
Urban farming	Family farm	Vegetables, nursery crops, fruits, high-value crops	Very low

3.3.1 Producer-driven models

These models, whose core features are displayed in Table 3.7, describe how small-scale farmers' put together their plots to form a block and cultivate, irrigate, fertilize, harvest, and manage the production collectively, while also sharing means of transportation, with the aim of improving market access through collective actions. How farmers can be organized depends on the local context (e.g., laws governing group associations, cultural norms), local commodities, and market structure (FAO, 2008). Examples of smallholder organizations are vertically integrated cooperatives, farmers' associations, registered producer groups, and informal farmers' groups (FAO, 2008, 2011a). Following this model, farmers gain the opportunity to face demand from large buyers and a better control of market prices, thanks to their increased bargaining power, lower transaction costs, and economies of scale (FAO, 2013; Sylvester, 2017). The adoption of conventional technology is widely considered as a possible solution to address smallholders' challenges: harvesting and transportation machines are affordable technologies able to improve the quality of agricultural outcomes (Sulle et al., 2013). Novel ICTs for rural and agricultural development have been advancing quite rapidly over the last decade, as reported by several case studies in Bangladesh, India, Pakistan, Sri Lanka, Thailand, and Indonesia (FAO, 2013, 2014).

3.3.2 Buyer-driven models

In these models, buyers constitute a link between food producers and final markets. Buyers are agricultural enterprises such as traders, retailers, or agricultural processors that buy farmers' produce. In general, farms integrated downstream with retailers govern supply networks defining what is to be produced and at which conditions. These configurations include contract farming, outgrower schemes and cooperatives, in which access to inputs (seed, fertilizers, pesticides), technical advice, and financial resources are provided depending on buyers' needs (FAO, 2011a, 2014; Sulle et al., 2013). Supply agreements between farmers and buyers usually report on the purchase price or how it

Table 3.7 Main characteristics of producer-driven models.

Main patterns	Business model features	References
Main cropping system	Arable, cereals, vegetables, sugarcane, orchards	FAO (2008, 2011a, 2013), Sulle et al. (2013), Sylvester (2017)
Farm governance	Cooperative (or similar formal and informal farmer groups)	FAO (2013), Sylvester (2017)
Precision technology	ICT, sensors	Tembo and Maumbe (2009), FAO (2013, 2014), Hudson et al. (2017)

Table 3.8 Main characteristics of buyer-driven models.

Main patterns	Business model features	References
Main cropping system	Arable, cereals, vegetables, sugarcane, orchards	FAO (2008, 2011a, 2013), Sulle et al. (2013), Sylvester (2017)
Farm governance	Contract farming/smallholder procurement	FAO (2011a, 2014), Sulle et al. (2013)
Precision technology	ICT, sensors	Tembo and Maumbe (200)9, FAO (2013, 2014), Hudson et al. (2017)

will vary according to prevailing market prices and may also include terms on delivery dates, volumes, and product quality. Literature has highlighted different contract farming deals in developing countries, such as detailed outgrower schemes and smallholder procurements (FAO, 2011a, 2014). Regarding technology adoption, the same considerations on business models formulated above apply: on one hand, the strong need for appropriate technology like harvesters and transportation machines is expected to be met, and, on the other hand, empirical evidence shows the diffusion of ICT (Table 3.8).

3.3.3 Urban farming

The urban context in low-income countries is generally characterized by populations spending a large percentage of their income in food, readily available in local markets (see Table 3.9). Yet, the high costs of shelter and transport undermine the affordability of the necessary food quantity, and most households could face scarce access to the food safety nets characterizing rural agriculture (Cohen and Garrett, 2010). These social systems protect vulnerable households against livelihoods risks, maintaining an adequate level of food consumption and improving food security. Examples of safety net instruments include the distribution of cash or food vouchers and the provision of public works and employment guarantee schemes (FAO, 2011b). Urban agriculture is defined as "small areas (e.g., vacant plots, gardens, verges, balconies, containers) within the city for growing crops and raising small livestock or milk cows for own consumption or

Table 3.9 Main characteristics of the urban farming.

Main patterns	Business model features	References
Main cropping system	Vegetables	Gallaher et al. (2013), Gockowski et al. (2003)
Farm governance	Family farming	FAO (1999), Cohen and Garrett (2010)
Precision technology	ICT	Briz et al. (2014)

sale in neighborhood markets" and can provide a source of food and income for urban dwellers (FAO, 2020, p.5). In this model, food security can be achieved in different ways, as acknowledged by Poulsen et al. (2015). For instance, households can reduce food expenditures freeing up money for other kinds of food, allowing a more varied and higher quality diet, or other needs. In addition, urban agriculture can enhance food security of the whole urban community by increasing diversity, quantity, and quality of perishable foods in urban areas. To this regard, dietary diversity is recognized as a useful indicator of household food security (Godfray et al., 2010) and micronutrient intake (Warren et al., 2015). Family farming in low-income countries can take on a variety of forms: producers may either rely on both crops and livestock or only crops in the form of cultivated plots (home gardening, vacant lot cultivation), varying between seasonal and year-round cultivations, although traditional leafy vegetables are the most widely produced crop (Gallaher et al., 2013; Gockowski et al., 2003).

As highlighted in the previous discussion about inclusive business models, most food producers in low-income countries engage in agriculture to produce food for their own consumption, and economic returns are only secondarily targeted. This paradigm acquires major emphasis in the urban environment, characterized by small areas that hinder scale economies. Several studies showed, indeed, that most of the food produced through urban agriculture is consumed by farmers rather than sold (Poulsen et al., 2015; Warren et al., 2015). There is scarce evidence regarding the adoption of novel technologies in urban agriculture contexts, where food production still relies heavily on traditional technology. An exception may reside in the resort to ICTs that may play a significant role in the years to come, promoting sustainable development through innovative exploitation of natural resources; examples of technological innovations are broadband infrastructures, enhanced internet access, and mobile applications (Briz et al., 2014).

3.4 Conclusion

The understanding of agricultural business models helps to explain how agricultural organizations increasingly collaborate with customers and suppliers to cope with the demands of changes in the technological landscape, driving innovation and growth. Several socioeconomic and technological trends influenced also by environmental concerns delineate possible pathways for the consolidation of various types of business models in Europe. The large-scale agricultural enterprise model is associated with a rapid adoption of novel technology to improve operational efficiency and is based on the reduction of fixed costs allocated to unit products through economies of scale and the increase of yields in the production of food commodities. The organic farming model constitutes a kind of differentiation tentative from the large-scale firms and it is characterized by the focus on sustainable products and processes. The adoption of organic practices seems to be unrelated to farm size and a quest for innovation to increase agricultural yields is foreseeable. Family farming emerges in a context characterized by small possibility of achieving scale economies. This model is associated to labor-intensive crops such as fruit, vegetables, and perennial crops. Urban contexts require the deployment of specific approaches focused on overcoming the limited possibility of attaining scale economies. Urban business models share the combination of short value chains and reduced quantities with the high value-added type of crops, and, additionally, important tenets like transparency and reliability in producer—consumer relationship are fundamental for this type of business model.

In developing countries, food security plays a prominent role in the definition of business models. In general, rural smallholders sell surplus only if present and the benefits related to inclusiveness go beyond immediate profit: inclusivity can be seen as the developing of products, services, and practices suited to the growth needs of people living in poverty, with a focus on securing staple food chains. It is possible to distinguish producer-driven models from buyer-driven models. In the first case, small-scale farmers united in collective forms and supported by local institutions play a pivotal role in the food supply chain, whereas, in the second case, other downstream actors like retailers acquire more negotiating power. An instance of urban farming is possible also in developing countries, mainly associated with enhanced food security for the whole urban community and an increase in diversity, quantity, and quality of perishable foods available.

Acknowledgments

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